19/RC/85

The Hearing Commissioners

30 September- 4 October 2019
2.30 pm

Staff Report for Hearing

The recommendation in the staff report represents the opinion of the writer and it is not binding on the Hearing Commissioners. The report is evidence and has no greater weight than any other evidence that the Commissioners will hear and consider.

Hearing of Application – APP-20191052
Woldwide One Limited and Woldwide Two Limited

Author: Aurora Grant – Consents Team Leader

Hearing:	The hearing is scheduled to commence at 2.30 pm on Monday, 30 September 2019 in the Council Chambers, Environment Southland, corner of Price Street and North Road, Waikiwi, Invercargill.
Application:	Woldwide One Limited and Woldwide Two Limited have applied to: • use land for farming; • discharge agricultural effluent to land; • use groundwater for dairy shed operations and stock drinking water; • use land for wintering barns.
Notification:	The application was publicly notified on 4 April 2019. Six submissions were received, three in opposition, two in support and one neutral.
Recommendation:	I recommend that the application is declined for the reasons that are detailed in this report.

1.0 Executive Summary

1.1.1 This report considers a resource consent application made to Southland Regional Council from Woldwide One Limited and Woldwide Two Limited to use land for farming. The need for resource consent arises from their proposal to expand an existing dairy farm operation by adding dairy cows to the herd above the number authorised as at 3 June 2016. The application also seeks to authorise associated activities being the take and use of water, discharge of agricultural effluent and the use of land for winter barns.

1.1.2 The proposed Southland Water and Land Plan and the operative Regional Water Plan for Southland are the Council's principal planning documents regulating these activities. Broadly speaking, both plans have objectives that seek to avoid further decline in water quality and improve water quality where it is already degraded.

1.1.3 The water quality (ground and surface water) in the receiving environment where this proposal is located is significantly degraded.

1.1.4 The application offers a number of measures that seek to mitigate the adverse effects of the proposal. Despite these measures I consider that the adverse effects will be considerable and that granting consent would detract from achieving the objectives, and would be inconsistent with key policies, of both the operative or proposed plan.

1.1.5 In my view, the key issues that the hearing commissioners need to consider when making the decision on the proposal are:

The effects arising from an increase in cow numbers on the dairy platforms and support blocks, in particular from the operational block of the WW1 platform:

1.1.5 I consider that there is a high probability that adverse effects on surface and groundwater from the operation will increase, especially from specific blocks. While the overall losses from the proposed landholding may stay neutral or decrease in some areas, in others such as WW1 platform and Horner Block there will be an increase in losses. Effects arising from this are likely to be increased algal growth, nuisance plant growth, turbidity and deposition of sediment in in downstream waterbodies, which are already degraded. There will likely be an increased risk to the health of aquatic ecology from high N concentrations, and a risk to human health from exposure to pathogens via surface water.

Effects on drinking water supplies

1.1.6 The proposed intensification on the WW1 side of the proposed platform is likely lead to an increase in contaminants lost to the groundwater used for drinking water supply by the Heddon Bush School.

Effects on soil

1.1.7 The increased stocking rate and the associated feed demand, through pasture or supplementation, has the potential to increase the nitrogen surplus in the soil, especially within the oxidising physiographic zone, and loss to the wider environment through leaching, volatilisation and gaseous loss. There is also a high risk to the soil structure from intensive winter grazing, and sediment loss to surface water during intensive winter grazing, that will continue to occur (and increase in area) on the WRO.

The state of the existing environment

1.1.8 The surface waterbodies in the receiving environments, including the Waimatuku Stream, Oreti River, Waiau River, and Aparima River show impacts from land use processes and are already significantly degraded.

Cumulative effects

1.1.9 The cumulative effects of the proposal are significant due to the already degraded nature of waterbodies and estuaries that will be affected.

Uncertainty around the relevance and accuracy of modelled losses shown by Overseer, particularly for the Central Plains physiographic zone

1.1.10 The dairy platform is located partly on the Central Plains physiographic zone with Braxton soils that have ‘swell-crack’ characteristics. Overseer does not accurately model nutrient losses from cracked soils, which adds uncertainty to the accuracy of the Overseer modelling results and may mean calculated nutrient losses are underestimated. Furthermore, the Overseer modelling provided by the applicant does not include the most recent farming season and the “baseline” and “future” scenarios have been modelled in different versions of Overseer.

Uncertainty regarding the effectiveness and appropriateness of the proposed good management practices and mitigations

1.1.11 A number of mitigations and good management practices have been proposed and will have varying degrees of effectiveness. Exactly what mitigations are being proposed by the applicant has changed multiple times over the course of the processing of this application and it is expected that further additions or removals to GMPs or Mitigations will be made prior to the hearing commencing.

1.1.12 Despite the changes to the application, I consider that the expansion of the size and use of the wintering barn facilities may be effective in mitigating some of the effects of the intensification of farming.

1.1.13 However, the “on paper” budgeted removal of fodder crop rotation on WW1 and WW2 platforms, as proposed, are not genuine mitigations that I am able to consider. WW2’s current land use consent for dairy farming was granted with conditions that fodder cropping cease on WW2, and this occurred. Therefore, the application seeks to be approved on the basis of a mitigation which cannot be implemented as there are no crops in the existing environment to remove.

1.1.14 There are also questions regarding the ability to implement offered mitigations on the Merriburn block for the WRO property, due to conflict between the offered mitigations and the applicants lease arrangements. At the time of writing, the mitigation plan for WRO block has been withdrawn from the application entirely, and as such, there are no mitigations or GMPs for me to consider for this part of the operation.

The suitability of the effluent storage system as a mitigation for the discharge of effluent on WW2

1.1.15 I have significant concerns regarding the integrity of the soil/clay lined pond WW2 uses for the collection and storage of winter barn and dairy shed effluent.

What forms the landholding for the proposal

1.1.16 It is appropriate to consider the applications as presented, but also to determine that the landholding is the entirety of the WW operation. This is because the whole Woldwide farming operation has common ownership, works together for a single business purpose, its individual farms cannot function without the others as currently set up and detailed in the application, and there is a transfer of environmental effects between the various farms. My understanding of the intent of the pSWLP is that resource consents granted for farming encompass the whole of the relevant landholding. In this instance, this means the two current applications are for activities within the same landholding and should be considered and decided together.

Consistency of the proposal and effects arising from it with Council's policies and objectives

1.1.17 The objectives to maintain water quality generally and improve water quality where it is degraded are central to the Council's operative and proposed plans. However the proposed Southland Water and Land Plan implements the National Policy Statement for Freshwater Management, and incorporates land use controls on farming operations. I therefore consider the proposed Plan should be afforded more weight and relevance than the operative Plan for this application.

1.1.18 The proposed Plan contains policies that, in relatively direct terms, contemplate (among other things):

- Resource consent applications generally not being granted where contaminant losses will increase as a result of proposed activities (Policies 5, 10 and 12)
- Resource consent applications generally not being granted where adverse effects on water bodies cannot be avoided or mitigated (Policy 16)
- Water quality being improved where standards are not met, by avoiding, remedying or mitigating any adverse effects of new discharges that exacerbate breaches of standards (Policy 15) and
- Effluent systems to be maintained and operated in accordance with best practice guidelines in order to avoid significant adverse effects on water (Policy 17)

1.1.19 In reference to these particular policies, I consider that if consent were granted:

- contaminant losses will increase;
- adverse effects on water bodies will not be avoided or mitigated;
- water quality will not improve in areas where standards are not currently met; and
- best practice will not be observed in the maintenance and operation of the effluent system.

1.1.20 In my opinion granting consent would not be consistent with the proposed Plan, and would weaken the prospect of achieving planned objectives in relation to water quality in Southland. Similarly, granting consent would be contrary to the objectives and policies of the National Policy statement for Freshwater Management and the Southland Regional Policy Statement, which direct that water quality is maintained or enhanced.

Conclusion

I recommend the application is declined.

2. Introduction

2.1.0 Status and purpose of this report

2.1.1 This report has been prepared under Section 42A of the Resource Management Act 1991 (RMA) to assist in the hearing of the application for resource consent made jointly by Woldwide One Limited and Woldwide Two Limited. Section 42A allows local authorities to require the preparation of such a report on an application for resource consent and allows the consent authority to consider the report at any hearing.

2.1.2 The purpose of the report is to assist the Hearing Commissioners in making a decision on the application.

2.1.3 At the outset I consider that it is important to record that this application is complex. It involves a range of land use, discharge and water take activities over a number of blocks of land. Those activities are proposed in the context of a complex existing environment, where some parts of the applicants' existing operations are authorised, but others are not. While the application was accepted as complete, there are some areas where I consider that the information provided in support of the application and AEE is insufficient. For this reason, I have engaged technical support on surface and groundwater effects, soils and Overseer.

2.1.4 A further important issue is relationship between this application and another related application (APP-20191140), and the applicants' wider farming enterprise. Through a number of related companies, the applicants own and operate a number of farms in close proximity, which are closely related and, in my opinion, work together as a single enterprise. This is one of the first applications to be considered under the new framework for determining what is a "landholding" for the purposes of a land use consent for farming activities.

2.1.5 This complexity has required careful consideration of the application, as well as its relationship with the applicants' other activities, to ensure a full assessment of the proposal's effects on the environment. This has resulted in this thorough Section 42A report, which seeks to assist the commissioners by addressing the application, environment and effects in detail. I urge the commissioners to carefully consider this proposal – in my opinion, it has the potential to cause further degradation of the environment, including effects on surface and groundwater quality that the proposed Southland Water and Plan seek to avoid.

2.2 About the author

2.2.0 My name is Aurora Grant. I am a Team Leader in the consents team employed by the Southland Regional Council. I have six years' experience in regulatory teams within the Council, and have expertise specifically relating to resource consenting, plan implementation and enforcement matters.

2.2.1 I hold a Diploma of Environmental Management and a Certificate in Sustainable Nutrient Management in New Zealand Agriculture (intermediate Overseer). I am studying towards a Bachelor of Environmental Management and a Masters of Business Administration (MBA). I am an accredited decision maker through the Ministry for the Environment Making Good Decisions course.

2.2.2 I have been involved with the application since it was received by Council. I have also visited the site numerous times and was the primary contact for undertaking pre application reviews of the proposal. I am familiar with the background of this application and previous ones made by the applicant.

2.2.3 In the processing of this application I have been assisted by Mr Alex Erceg, Consents Officer, who will also appear at the hearing.

2.2.4 For completeness, I have read the Environment Court of New Zealand Practice Note 2014 Code of Conduct for expert witnesses and agree to abide by it.

2.3 Background and information relied on in preparation of this report

2.3.0 The purpose of this section is to set out the background to this application, and detail information that I have relied on in preparing this report.

2.3.1 Various versions of this proposal and related applications have been submitted to the Council since new rules for the regulation of intensification of farming came into force with the first version of the pSWLP in 2016.

2.3.2 Due to incorrect information occurring on the public notices with the precursor to this application, the proposal was unable to be granted without being re-notified, and was subsequently withdrawn. This fault occurred due to mistakes made by the Council in regards to the notification process.

2.3.3 As a show of goodwill, the Council waived the processing costs from the precursor application and agreed to process this new application (and related application APP-20191140) with no timeframe holds for further information, as the applicant considered themselves ready to proceed and that the application was an adequate representation of their proposal.

2.3.4 This agreement occurred on the proviso that the application was lodged complete, was an accurate representation of what the applicant wanted to achieve and that no further changes would be made to the proposal after lodging. The applicant detailed that a decision on the proposal was essential for dictating future farming operation decisions and wanted a hearing as soon as possible.

2.3.5 While the above information is not directly relevant to the effects of this proposal, I consider that it is important to give context for the lack of further information requests made for this application, and the somewhat hurried timeframes. It also informs the timeframes of the process to date and the documents referred to below.

2.3.6 Despite the above background, there have been multiple substantial changes made to the application throughout the process. This report details and addresses, as much as practically possible in the short timeframes available, information provided by the applicant up to and including 4 September 2019 with documents known as “sharepoint 4” and earlier versions. The applicant provided further documentation known as “sharepoint 5 documents”, after the issue of a minute from the Commissioners directing any further changes to be incorporated into their evidence, on 5

September 2019. As directed by the Commissioners minute, I will provide a supplementary response to those documents after the receipt of the applicants evidence, the day before the hearing.

2.3.7 These changes included providing an updated Water Quality Assessment which covered both this application and related application APP-20191140 which was provided to Council on the 23 August 2019. Updated FEMP's, Overseer budgets and other supporting reports were also updated or added several times (referred to as Sharepoint 4 and Sharepoint 5 changes throughout this report).

2.3.8 In the preparation of this report I have had regard to the following documents and, to try and describe the extent of the changes, I have detailed what documents have been changed throughout the process. The documents in green text are those which have been updated throughout the process. The documents in blue text are new reports that have been submitted after the application was notified. The documents in red have been removed entirely:

2.3.9 The application:

Document	**Document dated**	**Comments**
Original Application for Land use consent for farming, discharge permit and water permit – titled "Woldwide Farming Group: Woldwide One Limited and Woldwide Two Limited" 27/3/2019 Author: Dairy Green Limited	Lodged 27 March 2019 Updated 3 September 2019 Further updated 5 September 2019	An updated application was provided to council on 3 September, which removed large sections of the original application and contained no appendixes. (Sharepoint 4). Changes detailed in that application have been discussed as much as possible in this report. The applicant then replaced the "Sharepoint 4" application document with "Sharepoint 5" application document. As Sharepoint 5 document was received after a minute from the Commissioners directing the applicant to not provide any changes to their application until their evidence is circulated, and as the changed documents were provided to me 2 working days prior to the circulation of this report, I have not been able to adequately assess the nature of these changes in the time available.

Supplement information – titled "Woldwide runoff – proposal and AEE"	No date, no author. Submitted with original application on 28 March 2019 Updated document provided 31 August 2019	Now superseded and replaced with new document.
Woldwide One Limited Farm Environmental Plan titled "Woldwide 1 & 2 dairy farm WW1 Unit Farm Environmental Plan – Appendix N Version 1.3 1 June 2019 – 31 May 2020"	Submitted with original application March 2019 but dated 1 June 2019-31 May 2020	Removed. This plan contained details regarding the effluent system management.
Woldwide Two Limited Farm Environmental Plan titled "Woldwide 1 & 2 dairy farm WW2 Unit Farm Environmental Plan – Appendix N Version 1.3 1 June 2019 – 31 May 2020"	Submitted with original application March 2019 but dated 1 June 2019-31 May 2020	Removed. This plan contained details regarding the effluent system management.
Woldwide Runoff Farm Environmental Management Plan – Appendix N Version 1.0 1 June 2019-31 May 2020	Submitted with original application March 2019 but dated 1 June 2019-31 May 2020	Removed from Sharepoint 4 files. Partially replaced with Sharepoint 5 files.
Original Application for Land use application for a feed pad/ lot Woldwide 1 titled " Woldwide One Limited and Woldwide Two Limited Land use consent application for a feed pad/ lot – Rule 35A of pSWLP (2019) Woldwide 1 unit – wintering barn	26 March 2019	Current but with outdated effluent system calculations.
Original Application for Land use application for a feed pad/ lot Woldwide 2 titled " Woldwide One Limited and Woldwide Two Limited	26 March 2019	Current but with outdated effluent system calculations

Land use consent application for a feed pad/ lot – Rule 35A of pSWLP (2019) Woldwide 2 unit – wintering barn		
WW1 & 2 Consent application "Appendix A"	No date but submitted with original application on 28 March 2019	Appendix A includes the following documents, some of which I have been provided with updated reports for, but not the appendix in its entirety. • Certificate of incorporations for WW1, WW2, WWFL, WROL • DESC for WW1 (Superseded) • DESC for WW2 (Superseded) • WW1 ART dated 14/11/2016 • PDT for AUTH-20171278-01 (WW2) dated 17-19 2017 • Effluent storage and treatment structures visual inspection October 2018 • Compliance monitoring reports
WW 1&2 Consent application "Appendix B"	No date but submitted with original application on 28 March 2019	Appendix B includes the following documents, some of which I have been provided with updated reports for, but not the appendix in its entirety. • Soil type assessment of soils at Woldwide 1&2 dairy farms (has been resubmitted – unsure if original is superseded) • Investigation of cracking soils: Heddon Bush, January 2018 – Michael Killick • Brief of Evidence from APP-20171445 of John Scnadrett 20 March 2018 • Agronomy Plan Horner Block for Woldwide Farm Limited 15 July 2018.
WW 1&2 Consent application	Submitted with original	Appendix C includes the following documents. To the best of my

"Appendix C"	application28 March 2019	knowledge these are still relevant, however they have not been provided again with the new application: - Bore search - Invercargill city water sample result test
WW 1&2 Consent application "Appendix D"	Submitted with original application 28 March 2019	Appendix D includes the following documents. To the best of my knowledge these are still relevant, however they have not been provided again with the new application. - Wynn Williams legal opinion on landholding dated 13 July 2018
WW 1&2 Consent application "Appendix E"	Submitted with original application 28 March 2019	Appendix E includes the following documents. To the best of my knowledge these are still relevant, however they have not been provided again with the new application. - Average N losses from farms within 20km radius of WW1&WW2 - Drummond swamp vegetation report dated June 2008
Nutrient budgets/ analysis WW1,2, SH96 &Marcel	No date but submitted with original application c	- Superseded and replaced with updated versions 23 August, which were subsequently updated in sharepoint 4 file updates on 3 September, and again in sharepoint 5 files on 5 September 2019.
Nutrient budgets/ analysis Woldwide Runoff	No date but submitted with original application 28 March 2019	- Superseded and replaced with updated versions 23 August. which were subsequently updated in sharepoint 4 file updates on 3 September, and again in sharepoint 5 files on 5 September 2019.
Document titled "Water quality assessments Woldwide One	26 August 2019	- This document details updated water quality

Limited and Woldwide Two Limited & Woldwide Four Limited and Woldwide Five Limited”		aspects relating to both applications. It replaces areas of both applications in part. - This was provided again with Sharepoint 5, with an updated date of 5 September 2019.
WW 1 & WW2 Phosphorus mitigation plan	Submitted 23 August 2019	- Superseded and resubmitted with updated version 3 September 2019 in Sharepoint 4 files.
Phosphorus Mitigation Plan Woldwide Runoff – Merrivale & Merriburn	2 August 2019	Withdrawn New file plan provided with sharepoint 5 files on 5 September 2019.
Woldwide Runoff – proposal and AEE	31 August 2019	Replaces the original Woldwide runoff proposal and AEE provided with the original application. Resubmitted with Sharepoint 4 files 3 September 2019.

2.3.10 Correspondence/ legal matters/ requested further information:

2.3.11 There has been a wide range of correspondence and other information provided during the processing of the application. This includes the six submissions received, the further information requested and received, numerous letters from the applicant’s lawyer and a large number of emails.

I have summarised the key information below:

Submissions		- Joanne Flett & Susan Flett - Mid-Aparima Catchment Group - Ivan Lines - Public Health South - Te Runanga o Oraka Aparima - Ministry of Education
Response to request for further information S92(1)	Dated 15 August 2019 Received by Council 1 September 2019	Assessment of effects on the freshwater resources associated with the proposed abstraction of groundwater.
Letter from applicants legal	Dated 3 September 2019	Direction regarding information in applications and basis for

counsel to processing officer		recommendation discussion
Transcript from informal meeting	From meeting 9 August 2019	
Letter from applicants legal counsel to processing officer	Dated 22 August 2019	Titled "APP-20191140 Clarification of "Landholding" issue. While the title of this letter refers to the other application, it provides details that relate to both applications on how I should consider the landholding.
Various email correspondence	Multiple dates	Details changes/ additions to the application.

2.3.10 Expert evidence:

To assist with the preparation of this report, I commissioned reports from technical specialists on water quality, overseer and farm systems, and soil and contaminant pathways. Initial reports were provided in July 2019, with updated reports in September 2019 to address the changes made to the application. The evidence is:

Review of Resource Consent Application technical report	Dated 2 July 2019	• Earth & Environmental Science Limited ("the Earth and Environmental Science review")
Overseer and farm systems review expert evidence report	Dated 2 July 2019	• Irricon Limited ("the Irricon review")
Soils and contaminant pathways technical memorandum	Dated 8 July 2019	• Pattle Delamore Partners Limited ("the PDP review")
Supplementary response to applicants "Water quality assessment"	Dated 2 September 2019	• Earth & Environmental Science Limited ("the Earth and Environmental supplementary report")
Overseer and farm systems brief of evidence Nicole Phillips	Dated 1 September 2019	• Nicole Phillips Brief of Evidence (Irricon)

Soils and contaminant pathways brief of evidence Belinda Meares	Dated 4 September 2019	- Belinda Meares Brief of Evidence (Pattle Delamore Partners)

2.3.11 Planning Documents:

In preparing this report, I have considered the relevant provisions of the following documents:

- Resource Management Act 1991 (RMA);
- National Policy Statement for Freshwater Management 2014 (NPS-FM);
- Southland Regional Policy Statement 2017 (RPS);
- Regional Water Plan for Southland 2010 (RWP);
- Proposed Southland Water and Land Plan (decisions version) 2018 (pSWLP);
- Te Tangi a Tauria (Iwi Management Plan) 2008 (IMP);

2.4.0 Definitions and abbreviations used and adopted in this report

2.4.1 For clarity, I have included this section to detail the way in which I interpret the following definitions related to the application. I have also included abbreviations used in this report.

Definitions and interpretations

- *Agricultural effluent* – the application details both dairy shed effluent and wintering barn "slurry". Both types of effluent enter the same storage ponds and as such I have not distinguished between the two as, when combined, both fit the definition of agricultural effluent in the pSWLP.
- *Young stock* – for the purposes of the report I have collectively combined calves, R1s, R2s that are not yet of milking age into the term "young stock". For the purposes of this report, and because the applications use a number of different descriptions stock of various ages, I have explained the common descriptions here:
    - Calf – newborn to weaning (around 6 months) aged stock;
    - Weaner – Calf at the stage of being weaned;
    - R1 – stock rising 1 year, aged between weaning and one year old;
    - R2 – stock rising 2 years, older than a yearling and up to two years old;
    - Heifer – young female cattle animal, until she has raised her first calf;
    - Cow – female cattle animal after she has reared her first calf.
- *Dry stock* – for the purposes of the report I have collectively combined bulls and dry cows over the age of 2 that are not being milked as "dry stock".
- *Intensive winter grazing* – Grazing of stock between May and September (inclusive) on forage crops (including brassica, bett and root vegetable crops), excluding pasture and cereal crops.

Abbreviations used

Woldwide One Limited	WW1
Woldwide Two Limited	WW2
Woldwide Farm Limited	WWFL
Woldwide Run-off Limited *(including both Merrivale and Merriburn blocks)*	WRO
Woldwide Three Limited	WW3
Woldwide Four Limited	WW4
Woldwide Five Limited	WW5
Horner block	HB
Marcel and State Highway 96	SH96/M
Intensive Winter Grazing	IWG
Resource Management Act 1991	RMA
National Policy Statement for Freshwater Management	NPSFM
Southland Regional Policy Statement	RPS
Regional Water Plan for Southland	RWP
Proposed Southland Water and Land Plan	pSWLP

Note: A number of the above acronyms refer to a legal entity and the blocks owned by it, depending on the context. For example, WW1 means both Woldwide One Limited and the blocks owned and operated by Woldwide One Limited.

3. The application

3.1.0 The proposed activities

3.1.1 The application is for a suite of resource consents associated with the operation and expansion of a dairy farm, that I consider, when bundled, are to be decided as a discretionary activity. The proposal includes:

Table 3.1.2: Consents required

Activity	Detail	Location
1. Discharge permit – agricultural effluent (Dairy shed effluent)	To discharge dairy shed effluent from up to 1,500 cows and winter barn effluent from up to 1,250 cows, underpass effluent and silage leachate to land via travelling irrigator at 10 mm depth, slurry tanker with a trailing shoe at 2.5 mm depth, umbilical system at 3 mm depth, low rate pods with an instantaneous rate of 10 mm/hr at 10mm depth and a low rate cannon/rain gun with an instantaneous rate of 10 mm/hr at 10 mm depth.	Dairy platforms - 1200 Hundred Line Road East, Otautau/State Highway 99, Winton.
2. Discharge permit – Agricultural effluent (Winter barn slurry effluent)	To discharge winter barn slurry effluent from up to 1,250 cows to land via a slurry tanker at 2.5 mm depth and a nitrogen loading that shall not exceed 250 kilograms per hectare per year.	Land known as the “Horner block”, Woldwide Farm Limited – Bayswater Road, Otautau
3. Water permit	To take up to 180,000 litres per day of groundwater from three bores in the Waimatuku Groundwater Zone.	Dairy platforms - 1200 Hundred Line Road East, Otautau/State Highway 99 Winton
4. Land Use Consent – For farming	To use land for farming, including an increase in cow numbers by 160 on the existing dairy platforms.	Dairy platforms one and two - 1200 Hundred Line Road East, Otautau/ State Highway 99, Winton WRO blocks known as Merrivale and Merriburn blocks at 20 Gill Road, Otautau and 1711 Otautau Tuatapere Road, Otautau
5. Land Use Consent - for a winter barn	To use land to use a winter barn for up to 625 cows at WW1.	WW1 dairy platform – 1200 Hundred Line Road East, Otautau
6. Land Use Consent – for a winter barn	To use land to use a winter barn for up to 625 cows at WW2.	WW2 dairy platform – State highway 99 Winton.

I consider that the proposal will also require the following consents:

Table 3.1.3: Consents required but not applied for

Activity	Detail	Location
1. Use of land for a bore	Consent is required under Rule 53(d) of the pSWALP and Rule 22(d) of the RWP for the use and maintenance (or decommissioning) of a bore.	The permitted activity rules of both plans for the use and maintenance (or decommissioning) of a bore requires that the headworks prevent the infiltration of contaminants, which in regards to Bore E45/0622, the headworks is not adequate and do allow for contaminants to enter the bore and subsequently the groundwater. Several examples of this occurring have been given throughout the application.
2. Use of land for farming – WW3 inclusion to landholding	To use land for farming, including an increase in cow numbers and land. See further details in section 4.5.2 of this report.	WW3 dairy platform utilises Horner block and other parts of WW related land platforms for its activities. There is a clear transfer of effects. In addition, the WW3 platform utilises WW5's dairy platform to discharge effluent. This platform is increasing in land area and cow numbers, subsequently triggering Rule 20 for WW3. WW3 is also operating outside of the permitted activity rules for the second half of rule 20, relating to IWG. This is detailed further in section 4.5.2.

3.2.1 *Particulars of the Proposal*

Background and existing consents

3.2.2 As detailed in the application WW1 and WW2 operate two adjoining dairy farms. The companies are related companies which will be joint consent holders on the resulting permits, if the application is granted.

3.2.3 WW1 currently operates under a discharge permit (AUTH-301663) and water permit (AUTH-301554). These consents will expire in 2027.

3.2.4 WW2 currently operates under a land use consent for expanded dairy farming (AUTH-20171278-03), discharge permit (AUTH-20171278-01) and water permit (AUTH-20171278-02). These consents will expire in 2027.

3.2.5 Both WW1 and WW2 utilise a nearby cut and carry block (Horner block) to discharge sludge from the wintering barns. The discharge of agricultural effluent at this block is currently authorised under respective effluent discharge permits for WW1 and WW2, and the applicant's third dairy farm (WW3), which is not part of this proposal but is considered by Council as part of the wider landholding.

3.2.6 As part of this consent proposal the applicants have applied for a separate discharge permit for the Horner block. The application details that this has been separated out in order to separate the Horner Block from the landholding (page 11 of the original and updated applications) however in other parts of the application (page 2 of the original nutrient budget, Appendix A companies register and WW2 current land use for farming, removed from page 2 of updated nutrient budgets) detail that the block does form part of the landholding.

3.2.7 A variation to WW3 discharge permit has not been applied for and is not required provided mapped discharge areas are followed and remain independent of each other.

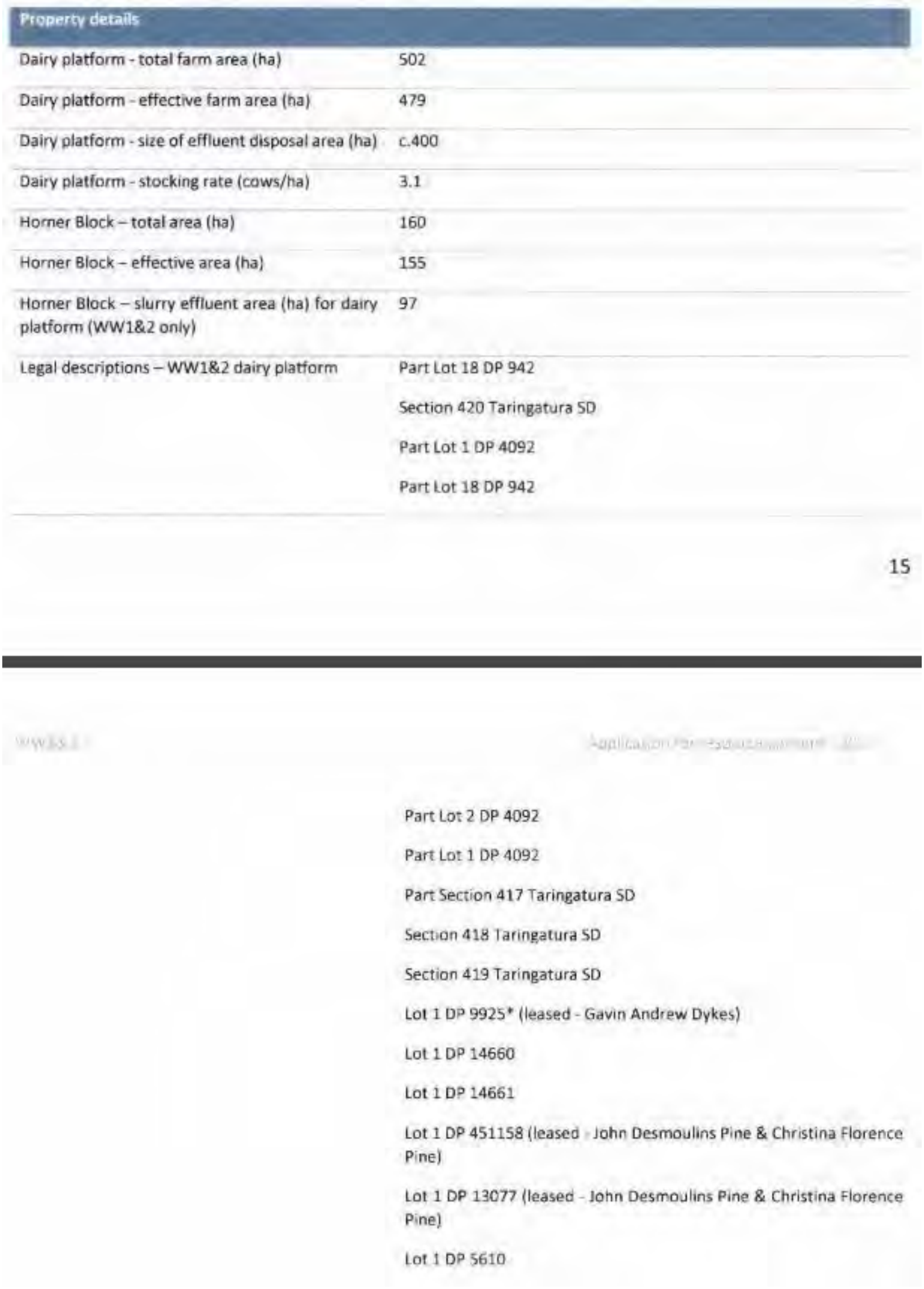
3.2.8 Both the WW1 and WW2 graze dry stock and young stock at WRO. While the application includes WRO and states in parts that it forms part of the landholding and will be included on the consent for farming (page 42 of the original and updated applications), the application in other areas disputes that WRO is part of the landholding for this application and propose that it is not included in any subsequent land use for farming consents (page 11 "It is the applicants view that WRO is not part of the landholding for WW1&2).

3.2.9 WRO receives stock from all five of the WW dairy properties.

3.2.10 Woldwide's current operations create a scenario in which there is a transfer of effects between all their dairy platforms (including those not subject to this proposal), with WRO acting as a support block for all the properties. Further discussion on the landholding for this application and my determination of it is contained in section 5.15.0.

3.2.11 The following table summarises particulars relevant to the applicants' proposal:

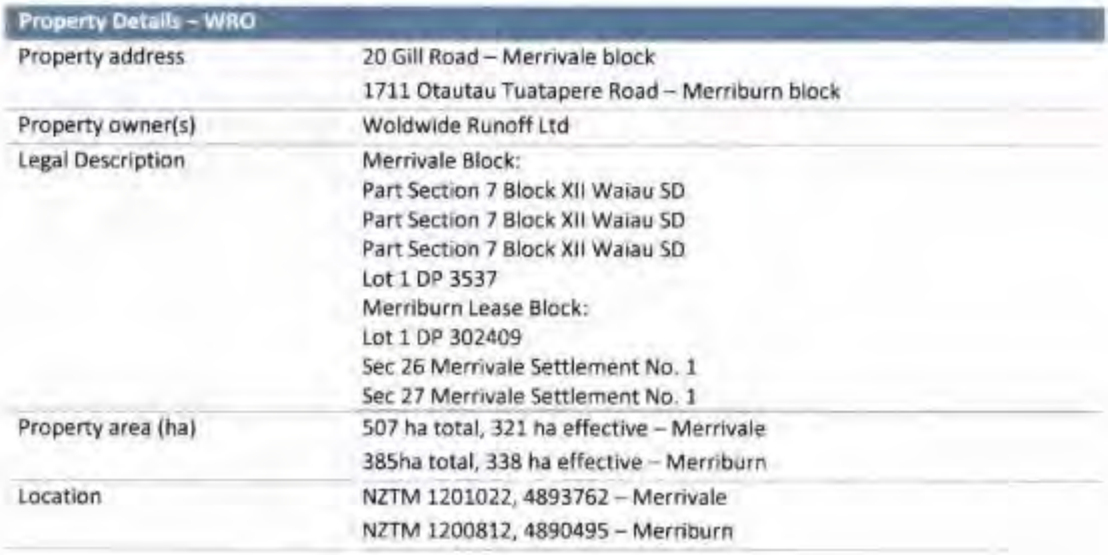
Table 3.2.13: Particulars of the proposal, taken from the application:



Property details	
Dairy platform - total farm area (ha)	502
Dairy platform - effective farm area (ha)	479
Dairy platform - size of effluent disposal area (ha)	c.400
Dairy platform - stocking rate (cows/ha)	3.1
Horner Block – total area (ha)	160
Horner Block – effective area (ha)	155
Horner Block – slurry effluent area (ha) for dairy platform (WW1&2 only)	97
Legal descriptions – WW1&2 dairy platform	Part Lot 18 DP 942 Section 420 Taringatura SD Part Lot 1 DP 4092 Part Lot 18 DP 942 Part Lot 2 DP 4092 Part Lot 1 DP 4092 Part Section 417 Taringatura SD Section 418 Taringatura SD Section 419 Taringatura SD Lot 1 DP 9925* (leased - Gavin Andrew Dykes) Lot 1 DP 14660 Lot 1 DP 14661 Lot 1 DP 451158 (leased - John Desmoulins Pine & Christina Florence Pine) Lot 1 DP 13077 (leased - John Desmoulins Pine & Christina Florence Pine) Lot 1 DP 5610

	Lot 1 DP 10885
Legal descriptions – Effluent discharge area at WW1&2	Part Lot 18 DP 942 Section 420 Taringatura SD Part Lot 1 DP 4092 Part Lot 18 DP 942 Part Lot 2 DP 4092 Part Lot 1 DP 4092 Part Section 417 Taringatura SD Section 418 Taringatura SD Section 419 Taringatura SD Lot 1 DP 14660 Lot 1 DP 14661 Lot 1 DP 5610 Lot 3 DP 5610 Lot 1 DP 10885
Legal descriptions – Effluent discharge area at Horner Block	Lot 4 DP 399915

*Part of Lot 1 DP 9925 is leased by the applicants and is already within the boundary of the existing land use consent for dairy farming (see figure 1.1).



Property Details – WRO	
Property address	20 Gill Road – Merrivale block 1711 Otautau Tuatapere Road – Merriburn block
Property owner(s)	Woldwide Runoff Ltd
Legal Description	Merrivale Block: Part Section 7 Block XII Waiau SD Part Section 7 Block XII Waiau SD Part Section 7 Block XII Waiau SD Lot 1 DP 3537 Merriburn Lease Block: Lot 1 DP 302409 Sec 26 Merrivale Settlement No. 1 Sec 27 Merrivale Settlement No. 1
Property area (ha)	507 ha total, 321 ha effective – Merrivale 385ha total, 338 ha effective – Merriburn
Location	NZTM 1201022, 4893762 – Merrivale NZTM 1200812, 4890495 – Merriburn

Note: *The following amendments to fix minor errors in the application, to the information in the above table have been made:*

1. *Amendments to application for resource consent – WW1&2*
    - *Remove Lot 3 5610*
    - *Replace location GPS coordinates with:*
        - *Merrivale: 1202164E, 4885024N*
        - *Merriburn: 1199656E, 4885435N*
2. *Amendments to application for resource consent – Woldwide Run-off Proposal and AEE*
    - *Replace location GPS coordinates with*
        - *Merrivale: 1202164E, 4885024N*
        - *Merriburn: 1199656E, 4885435N*

3.3.1 ***Current and proposed farm system***

The current system consists of operations occurring on five separate blocks:

3.3.2 WW1 dairy platform is one of the current milking platforms operated by the applicants - operation of a dairy farm here, absent the additional cows in the proposal, is a permitted activity. The discharge to land of collected dairy shed effluent from up to 540 cows and wintering barn effluent from up to 400 cows is authorised by a resource consent. The discharge area covers approximately half of the dairy platform (less standard buffers), and the Horner block;

3.3.3 WW2 dairy platform is the second dairy platform in the applicant's proposal - operation of WW2 is authorised by a land use consent for farming, which was granted in 2017 and expires in 2027. This consent authorised the addition of blocks known as "Marcel and SH96" to the north of the platform to be incorporated into the platform. Conversion of these blocks has been completed recently with laneway installation and pasture renewal occurring. The discharge of agricultural effluent to land, from collected dairy shed effluent from up to 800 cows and wintering barn effluent from up to 600 cows, on the platform and Horner block is authorised by a resource consent;

3.3.4 The Horner block is a cut and carry block, located near the dairy platforms - effluent from both dairy platforms is spread on the block via slurry tanker. Fresh grass is grown and either fed directly to cows in the wintering sheds, or is made into silage. The block as a whole also receives effluent from WW3, and has been apportioned into three discharge areas for the purposes of the respective discharge permits (see Figure 3.3.9). The respective permits currently authorise N loading on the Horner block as 150 kg/N/ha/year (for the WW1 portion) and 200 kg/N/ha/year (for the WW2 portion).

3.3.5 WRO block, which comprises of two blocks – Merrivale (owned by the applicants) and Merriburn (leased by the applicants) - the two are separate blocks which are located adjacent to each other. Collectively, these blocks provide support to all of the WW dairy platforms. Young stock, (cows up to rising two years of age), dry stock and support stock such as bulls, are grazed on the blocks, including intensively on crop over the winter months. Additional feed is supplemented through the use of baleage. The properties carry approximately 2,637 head of stock from the five Woldwide properties.

3.3.6 The Cochranes block - which is located to the south of the dairy platforms and Horner block, is currently being used to intensively winter graze up to 3,000 young stock, support stock and milking cows from WW1, WW2 and other WW farms.

3.3.7 The proposed farm system seeks to combine both the WW1 and WW2 dairy platforms into one permit for farming; one discharge permit for effluent discharged on the combined platforms, a separate discharge permit to discharge effluent to the Horner block, one combined water permit and two land use consents for the wintering barns.

3.3.8 This also includes an increase of milking cows by 160 across the combined platforms which represents an increase of 11% if calculated over the landholding, and 30% on WW1's operational platform. Operationally, little will change under the proposal aside from cows being added to the system. The two platforms will continue to be stocked separately, and the actual increase of cow numbers will be added to WW1. Young stock and dry stock will continue to be raised and intensively winter grazed on WRO. Cows of milking age will be wintered over June-July in the wintering barns (and during adverse weather events) which will remove existing IWG on the platforms. Recent updates to the application have included increases to the amount of time cows will be in barn for 2 hours per day in April and May. Winter grazing on pasture during the shoulder months will continue to occur as it has been.

3.3.9 Due to the increase in stock numbers, both from this proposal and WW4 and WW5's related application (APP-20191140), the total area of IWG on WRO will double, increasing from 50 ha to 100 ha* (this figure was later reduced to 72ha in a report detailing the management of the WRO blocks, however at the time of writing this report has been withdrawn).

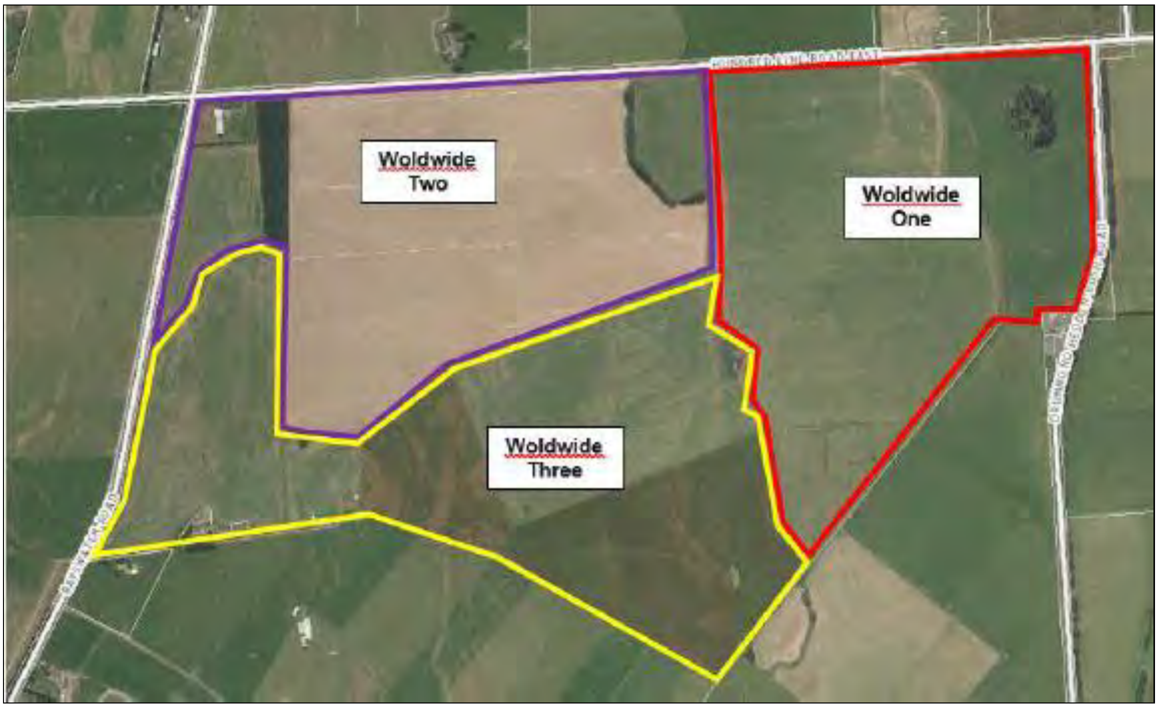


Figure 3.3.9: Diagram of discharge areas used by the three WW platforms on Horner block

3.4.1 *Effluent System*

The effluent system as described in the application is as follows:

For WW1:

3.4.2 Agricultural effluent is collected at the dairy shed, where it is then gravity-fed to a small stone trap and sump at the dairy shed. Effluent is then fed to the lined storage pond at the northern end of the wintering shed. The system at this shed is made up of older ancillary and treatment infrastructure, with a new effluent storage pond.

3.5.2 Effluent generated in the wintering barns is scraped by mechanical scraper in the barns to concrete bunkers located at the northern end of the barn. Liquid is then pumped from the bunkers to the storage pond located immediately adjacent to the bunkers.

3.5.3 The effluent storage pond was built in 2018 by Nightcaps Contracting. The construction of this pond was authorised by resource consent AUTH-20181124, which has now expired. The pond supplies sufficient storage for the effluent produced from 540 cows milked twice a day and 400 cows housed in the wintering barn to enable deferred irrigation.

For WW2:

3.5.4 Agricultural effluent from up to 800 cows is collected at the dairy shed and gravity fed to a small stone trap and concrete effluent saucer. Effluent is then transferred to a clay/soil effluent pond to the east of the wintering barn. This pond is the subject of a separate consent application for the maintenance and use, which has been submitted to Environment Southland, but has yet to be accepted under S88. The issues with this pond will be addressed as part of that application, however, the effects still form part of the consideration for the farming activity subject to this application due to its inclusion as a mitigation measure.

3.5.5 As with the wintering shed at WW1, effluent generated in the wintering barn from up to 640 cows is scraped by mechanical scrapers into concreted bunkers at the end of the wintering barn. However, unlike WW1, the solids are not as well separated with this system. Consequently, the effluent pond contains a very high degree of effluent solids. Effluent from this storage pond forms a slurry consistency and is referred to by the applicant as such. Despite this, it meets the definition of agricultural effluent and I have assessed it as such.

3.5.6 Silage leachate from the silage facilities at the wintering shed are also captured at the silage stack and feed into the effluent storage pond via a small containment sump.

3.5.7 Effluent generated at the underpass on the property is also collected and discharged under the property's current discharge permit. This is proposed to also be included on the new discharge permit.

3.6.1 *Irrigation System*

3.6.2 The applicants utilise a high rate travelling irrigator and high rate slurry tanker as their primary systems for irrigating the collected agricultural effluent to land. The applicants have demonstrated that the travelling irrigator and slurry tanker are capable of achieving their proposed application rates with an instantaneous rates of 10 mm/hr with an application depth of 10 mm and a depth of 2.5 mm respectively.

3.6.3 The applicants have also proposed to install low rate irrigation systems in order to future-proof the activity. An installation date has not been provided, nor have details of where on the properties these will be operated.

3.7.1 *Irrigation areas*

3.7.2 The application details that under the proposal, effluent will continue to be spread on both dairy platforms (minus the SH96/M block on WW2 as is currently consented), and the Horner block.

3.7.3 The application seeks a separate permit to discharge effluent to the Horner block from both WW1 and WW2. It needs to be noted that WW3 also holds a consent to discharge effluent to Horner block. Currently, the WW1 and WW2 and WW3 discharge areas are mutually exclusive and do not overlap.

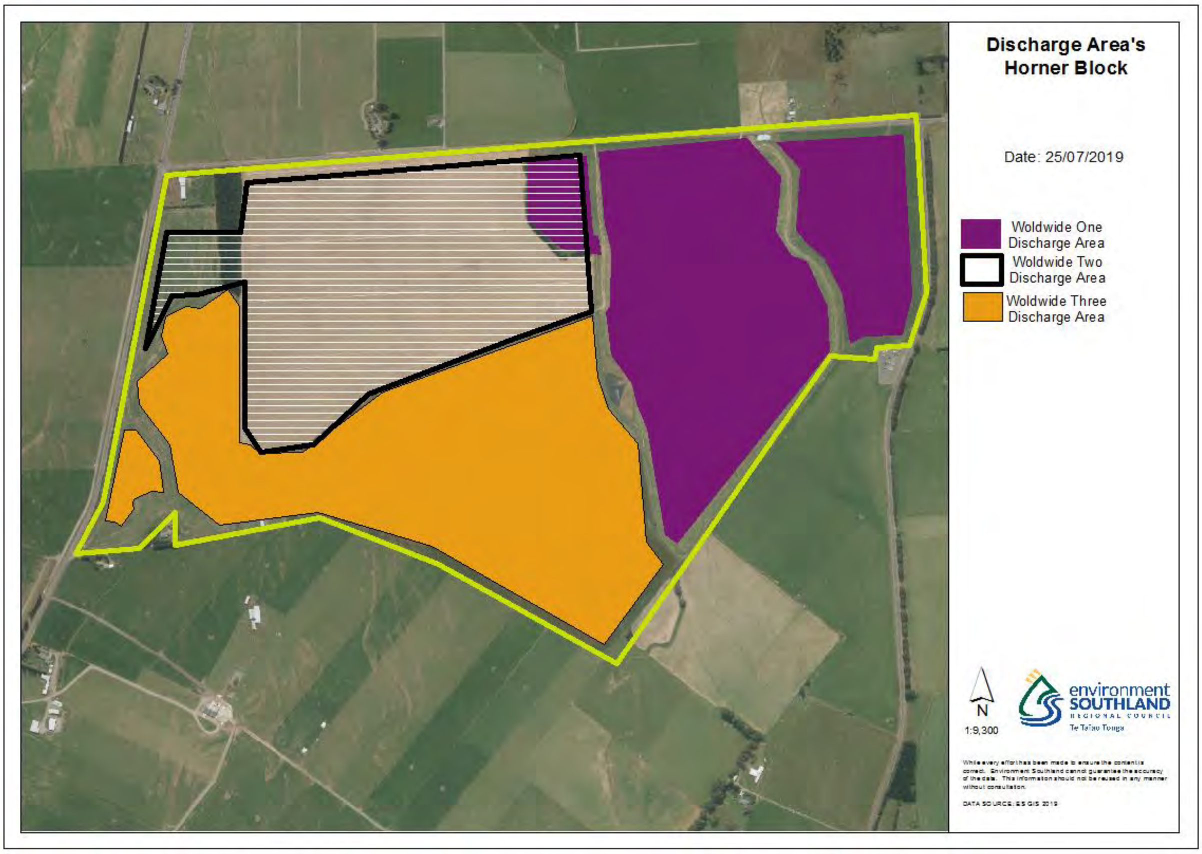


Figure 3.7.4: Current Discharge Areas – Horner block

3.7.5 Under the proposal the areas for WW1 and WW2 would be combined into one discharge area under the combined permit, and the discharge area will remain mutually exclusive.

4. The existing environment

4.1.0 Existing environment summery

4.1.1 In a planning sense, the "existing environment" upon which effects should be assessed is defined as the existing and reasonably foreseeable future environment. When considering an application I am required to consider the environment as it is at the time of the application. Also for consideration under the existing environment umbrella is the likelihood of change to that environment in the future based upon activities that could be carried out as of right or with respect to resource consents that have been granted but not implemented.

4.1.2 In order to determine what the difference in effects is between what is proposed in the application, compared to what is currently part of the existing environment, it is important to set out what makes up the existing environment in terms of both the current farming operation and the current state of the receiving environment.

4.1.3 The individual and overall effects from the proposal "on the environment" can then be considered by evaluating the changes that will likely occur from the existing environment.

4.1.4 When considering actual and potential effects from the proposal on the environment, I have taken two approaches in order to fully and adequately assess all the effects of the proposal. The first being a wide approach of considering the landholding as a whole; this is because the landholding spans and influences several catchments. I have also taken a narrower approach of considering environmental effects on individual blocks allowing consideration of more isolated effects.

4.1.5 What is considered to be the existing environment and current farming operation from both my interpretation of the application and expert evidence is set out in detail below, including areas of dispute.

4.1.6 To summarise my consideration of what defines the existing environment for this application:

- two separate dairy platforms with wintering barns and associated effluent discharge, as described above in section 3.2.1;
- all young stock up to R2s grazed on WRO, including IWG on crop during winter months;
- the cut and carry operation on the Horner block (*Note that LU consent AUTH-20171287-03 requires this block to be part of the current dairy farm operation, allowing effluent discharge and cut and carry only*);
- permission "for the use of land for dairy farming" to occur on the M/SH96 and Horner block as part of WW2 dairy platform;
- the take and use of groundwater for dairy operations and stock drinking water;
- the discharge of silage leachate to land;
- the state of the receiving environment as detailed in expert evidence[1];
- other permitted farming activities within the catchments;
- registered drinking water supplies;
- water takes for domestic supply, other farming operations, stock water etc.

---

[1] Lovett A., 2019. Review of Resource Consent Application by Woldwide One Ltd. and Woldwide Two Ltd. Earth & Environmental Science Report 2019/02, prepared for Southland Regional Council.

4.1.7 To add complexity, there are several aspects of the current operation that I consider require resource consent and are currently illegal. I am not able to consider effects from these activities as part of the existing environment[2]. They are:

- cows from both WW1 and WW2 platforms are currently being intensively winter grazed on the Cochrane block (owned by WWFL):
  - this block has recently been purchased by the applicant and this is the first year cows have been wintered on this block;
  - previously it was used as sheep grazing, however the operation has wintered approximately 3,000[1] cows from all the Woldwide platforms here this winter;
  - Section 20A rights do not apply to this part of the operation and Rule 20 of the pSWLP requires good management practices, and a number of other criteria to be used and met for IWG;
  - a site visit to the property on 20 June 2019 identified that the operation was not using the required GMPs and other criteria of the permitted activity rule under the proposed plan, nor did it align with the requirements for IWG under the operative plan. The operation failed to meet the following from the proposed plan;
    - back fence stock;
    - use transportable water troughs;
    - graze critical source areas last;
    - have and maintain a 5 m vegetated buffer strip from the waterway; and
  - the operation failed to abide by the rules under the operative plan which require that stock grazing and access is excluded within 3m of water in a watercourse when IWG is occurring;
  - an application which will also be heard by the decision makers concurrently with this hearing relates to converting the Cochrane block to dairy platforms. No part of either application relates to the IWG of cows from WW1 and WW2 continuing on the Cochranes block.

- Bore E45/0622 does not have a secure wellhead and therefore requires consent under Rule 53(d) of the proposed Southland Water and Land Plan and Rule 22(d) of the Regional Water Plan.

4.1.8 The applicants currently hold Discharge Permit AUTH-20171278-01 and Water Permit AUTH-20171278-02 for WW2. The application states that WW2 operates under these consents. However, the applicants should currently be operating under Discharge Permit AUTH-300626-V2 and Water Permit AUTH-300627-V1. Condition 1 of AUTH-20171278-01 and AUTH-20171278-02 states that the consents cannot be exercised until the previous consents (AUTH-300626-V2 and AUTH 300627-V1 respectively) have been surrendered or are expired. At the time of writing this report the applicants have not surrendered either consent and neither of them have expired, therefore operating under AUTH-20171278-01 or AUTH-20171278-02 would be non-compliant with the conditions of those consents. While this is easily addressed through a surrendering the old permits and in my opinion does not change the current effects of the operation, it is a technical non-compliance which I noted while assessing the application for the existing environment.

---

[2] *Scholfield v Auckland Council* [2012] NZEnvC 68 and *Guilty As Ltd v Queenstown Lakes District Council* [2010] NZEnvC 191

4.2.0 *Issues relating to existing environment*

4.2.1 The application provides a lengthy, but basic, description of the receiving environment for the proposal, with what I consider to be a number of contradictions, inaccuracies to data, or omitted data. While most of these are minor in nature, the application also does not provide an evidential basis to back up the conclusions drawn about the receiving environment, and little to no analysis of available water quality data has been carried out. As such, I am not able to adopt the applications assessment of the receiving environment and instead rely on information contained in Council data bases and technical expert evidence detailed in the Lovett report[3]. The applicant has since provided a new "Water Quality Assessment" which further clarifies details provided in both applications. A further assessment of this document was completed and is detailed in the Lovett supplementary evidence report.

4.2.2 In updated versions of the application provided to me, concerns have been raised around poor wellhead protection of bores within the area of the properties as well as the bore on the WW1 platform. The application places emphasis on the fact that Bore E45/0622 is unsuitable for use as a monitoring bore and states: *"It is possible for birds or rodents to enter the well along the pipe, fall in and drown, which has happened in the past. Furthermore, the well's top pipe is flush with ground level, and soil in the vicinity has high organic matter content from long grass and woody shrubs in the area."*

4.2.3 The further information provided has used this point in order to effectively discount all groundwater monitoring in the area of the operation. This has been addressed by Lovett in her evidence and as such I will not go into further detail about that here. The updated information also provided an analysis bores in the area, however it is unclear which application it relates too. This report is also discussed by Lovett, and I adopt her findings on the matter for the purposes for my report.

4.2.4 Due to the above information, the use of the bore (and any maintenance) is illegal as the use (and/or maintenance of the bore) does not meet the permitted activity criteria of either the Regional Water Plan or the proposed Southland Water and Land Plan. On 19 July 2019, a (informal) request[4] was made for an additional consent for the use and maintenance (or decommissioning) of the bore, however at the time of the circulation of this report the additional consent was not received.

4.2.5 The updated information provided argues that due to the poor wellhead protection (and other matters), there is some uncertainty as to whether or not the groundwater quality data actually represents groundwater quality. Lovett again provides comment on this, and I will not repeat that here. It seems the application/ supplementary information has correctly identified that poor wellhead protection can lead to the contamination of groundwater, however it fails to note this as an adverse effect of the applicants proposed activities. The responsibility of ensuring the bore is suitable is on the applicant and should it not have been designed, constructed and/or maintained in a manner where the infiltration of contaminants is prevented, then the onus is on the applicant to apply for the appropriate consents in order to ensure the use of the bore is lawful.

---

[3] Lovett A., 2019. Review of Resource Consent Application by Woldwide One Ltd. and Woldwide Two Ltd. Earth & Environmental Science Report 2019/02, prepared for Environment Southland Regional Council.

[4] The request was ***not*** made under Section 91 of the Resource Management Act in respect of the applicants desire to keep the process moving and as such an informal request was made in good faith.

4.2.6 As contamination of the bore has been acknowledged in the application and there is no proposal to ensure maintenance on the bore is undertaken to prevent the infiltration of contaminants, consequently there is an adverse effect of the proposed activities that must be considered. Even if mitigation measures had been provided such as decommissioning the bore or undertaking maintenance no consent has been applied for to do this lawfully, it must be considered at face value that there is an adverse effect of the proposed activities that I can say with certainty will occur and will continue to occur unmitigated.

4.2.7 The application/ supplementary information also states that "*if bores with poor wellhead protection were rectified it is possible that groundwater quality in this area could be improved".* As such it is obvious that the applicant is aware that such measures would aide in reducing contaminant losses to groundwater, yet no steps have been taken to avoid, remedy or at least mitigate the effects.

4.2.8 Below I summarise the state of the receiving environment, including commentary on the nature of any disagreements relating to its status. The key areas of the description of the existing environment in dispute are summarised as follows:

- **The meaning of water quality data used to describe the existing environment**

4.2.9 A large volume of data is available for the area, over a considerable time period. The application references some of these datasets, however very little analysis of this data has been undertaken by the applicant in the original application. Further analysis was provided in a joint "water quality assessment" on 23 August 2019 which provided further discussion on the state of the water quality in the receiving catchments of both this proposal and related proposal APP-20191140. Despite this, the proposal draws conclusions regarding trends of key water health indicators and places a high degree of weight on these conclusions to inform the proposal's conclusion of effects. In comparison, evidence provided by the Lovett report analyses all available ground water and surface water data concludes the following:

> *"Although considerable surface water datasets exist, very little, if any analysis of data has been considered or undertaken, including more recent data. Very little consideration of groundwater data has been incorporated into the assessment. In all instances, only monitoring sites downgradient of the landholdings have been considered. Comparison to upgradient monitoring sites could have been shown for completeness to better understand variation in land use impacts through the catchment. In some instances, the application discards datasets as being invalid, which is supported by dubious reasoning (e.g. groundwater quality results from bore E45/0622). The assessment of effects regularly indicates that although the application is seeking additional cow numbers and increased FDE application volume, water quality will be maintained or improved through mitigation of farming practices. It is proposed that these statements have been made with a lack of supporting information, and rely heavily on Overseer analysis, for which the limitations are not adequately described. Overall, the analysis of potential effects on the receiving freshwater environments is not entirely robust."*

4.2.10 Having assessed all the evidence I consider that the evidence provided in the Lovett report is more helpful in providing me a basis to inform me of the existing environment and potential effects. As such, I have placed more weight on this when making my planning assessment.

- **Groundwater data collected from WW1 monitoring Bore (E45/0622)**

4.2.11 The application states that data collected over time from this bore should be disregarded due to poor wellhead protection and localised contamination. The Lovett report suggests that the data collected from this bore is still useful and, when analysed, contributes to the overall picture of groundwater quality in the catchment.

4.2.12 I also highlight that there is a best practice protocol for the collection of groundwater samples of which Environment Southland abides by when collecting samples. A key requirement of this is that the bore is purged until three times the storage volume has been removed. This effectively draws in freshwater from the aquifer and removes that “stagnant” water (and any animal carcasses) from the casing and ensures a representative sample is being taken. I have determined that it is appropriate to consider data gathered from this bore when making my assessment, and have utilised conclusions drawn from the Earth and Environmental Science Limited report in formulating my assessment. The use of this data, however remains a point of contention for the decision makers to consider.

- **Soil types on WW1**

4.2.13 The application states that the mapped areas of Braxton soils are, in reality, much smaller in area than what Topoclimate maps show.

4.2.14 An on-site investigation has been undertaken by Dairy Green Limited farm consultant, John Scandrett, however the application does not request that I adopt the soil types identified by Mr Scandrett, rather than those mapped by Topoclimate.

4.2.15 Expert evidence for general soil properties and contaminant pathways for the platforms has been provided in the PDP review, however this evidence has been produced without on-site investigations. A potentially defining factor for the decision makers to consider when weighing up these two pieces of evidence is that, while Mr Scandrett has been on-site, he would not be considered a suitably qualified person to undertake this type of work, and ideally an on-site soil assessment would have been undertaken by a qualified soil scientist and supplied with the application to give a higher degree of certainty.

4.2.16 For the purposes of this report and consideration against the relevant planning framework I consider the following about the soil types:

- Braxton soils are undisputedly present to some extent on all of the property blocks used for the dairy operations (they are not present at WRO);
- the "swell-crack" characteristics of Braxton soils are not considered nor adequately modelled by Overseer, and the presence of them provides added uncertainty to the accuracy of the model;
- one of the alternative soil types proposed by Mr Scandrett instead of Braxton is Glenelg, which also has a high risk for contaminant leaching;
- degraded groundwater quality below the property suggests, irrespective of the detailed specifics of the soil types, they are susceptible to contaminant leaching.

- **Quantity of groundwater available**

4.2.17 The applicants propose to increase their groundwater take, however they have not assessed the current status of the aquifer they propose to increase the take from, nor have they provided a stream depletion assessment or aquifer test assessment. While there is no contention that the allocation is available "on paper", the applicants have not adequately assessed the existing environment for this part of the proposal.

4.2.18 Actual and potential effects from the proposal are detailed further down this report at section 5. For clarity, I have split the receiving environment into the wider landholding, and block by block where appropriate as this is how I have structured the discussion on effects and causes.

4.3.1 Description of the receiving environment

4.3.2 The following section summarises what I consider to be the receiving environment for this proposal. For conciseness I have chosen to summarise the key points of the receiving environment and direct readers of this report to the technical evidence provided in the Lovett report for a detailed assessment of water quality data.

Catchment-scale environment

4.3.3 The landholding spans several sub-catchments, with the run off blocks located approximately 35 km west of the dairy platforms. The geographic setting of the landholding is well described in the application and all expert evidence and, aside from the disagreement about what factors make-up the landholding, the geographic setting is not in dispute so I have briefly summarised the catchment-scale environment below:

- **Dairy Platforms**

4.3.4 The dairy platforms detailed in this application sit adjacent to each other and span across two catchments – the Middle Creek catchment and Terrace Creek catchment. Middle Creek flows into the Waimatuku Stream which is in the Waimatuku River catchment. This flows directly into the sea at the Waimatuku Estuary within the Oreti Beach Embayment. Terrace Creek is a tributary to the Oreti River and is part of the wider Oreti River parent catchment.

- **Horner block**

4.3.5 The Horner block is located in the Aparima River and Middle Creek sub-catchments. The Aparima River catchment drains to the Aparima River, which subsequently flows in the Jacobs River

Estuary at Riverton. The Middle Creek sub catchment drains into the Waimatuku Stream which flows into the Waimatuku Stream within the Oreti Beach embayment. It is noted that the sole watercourse on the Horner block (Middle Creek) which flows into the Waimatuku River.

- **Run-off Blocks**

4.3.6 The run-off blocks spans across three catchments – Fenham Creek, Otautau Stream and Merry Creek catchments.

4.3.7 It is not expected that the Otautau Stream catchment will be affected by this proposal however, as only a very small portion of the Merrivale run-off is situated in the Otautau Stream catchment on the eastern boundary, with most overland flow of surface water largely expected to drain into the Fenham Creek catchment. Fenham Creek is a tributary of the Orauea River, which flows into the Waiau River. The run-off blocks sit in the Waiau River parent catchment. The Waiau River then flows into Te Wae Wae Lagoon.

4.3.8 Fenham Creek and Merry Creek both flow through the run-off blocks, with the Fenham Creek running through both of the blocks. Merry Creek is a tributary to Fenham Creek.

Existing Surface Water Quality

Dairy Platform and Horner block

4.3.9 The proposed dairy platform is situated in the Waimatuku Stream and Oreti River catchments. Surface water on the property largely flows into Terrace Creek, with some flowing into Middle Creek, making up the immediate receiving environment. From Terrace Creek, this eventually flows into the Oreti River, whilst Middle Creek flows into the Waimatuku Stream. The Oreti River flows into the New River Estuary, whilst the Waimatuku Stream flows into the sea at the Waimatuku Estuary within the Oreti Beach embayment.

4.3.10 There is one surface waterway that runs through the Horner block which flows into Middle Creek and subsequently into the Waimatuku Stream.

4.3.11 A portion of the Horner block sits within the Aparima River catchment. There are no surface waterways on this portion. The contaminant pathways in this portion are largely deep drainage to groundwater as such surface run-off of contaminants is not of a major concern. However any run-off or lateral flow of contaminants will discharge into the Aparima River.

4.3.12 The **application** describes the surface water quality in the area as:

- risks to surface water quality are classified as high in the area that the farm is located;
- there is significant degradation of water quality in Waimatuku Stream in relation to *E.Coli*, however this has a "*very likely improving ten year trend*";
- the total oxidised nitrogen is above ANZECC guidelines, but below New Zealand Drinking Standards Maximum Acceptable Level and when assessed against the NOF it is classified as Band C (suitable for the designated use), but there may be effects on growth of some sensitive fish species;
- the MCI score for the Waimatuku Stream is fair and algal growth is indicative of high nutrient levels;
- nutrient levels within the Waimatuku Estuary are elevated and makes the estuary susceptible to eutrophication;

- there has been no significant deterioration in water quality in the Oreti River;
- estimates show that current farming activity at WW1 and WW2 contribute a very small proportion of the nutrient loading to New River Estuary catchment and represents a very small proportion of total nutrient load in that catchment;
- due to a combination of nutrient loads and excessive sediment deposition, the nutrient enrichment condition of the New River estuary is poor and susceptible to eutrophication;
- in regards to the condition of the Jacobs River Estuary, there has been a significant decline in estuary quality since 2003, and especially over the past five years.

4.3.13 The **Lovett report** summarises the surface water quality in the area as:

4.3.14 For the Waimatuku Stream Catchment:

- surface water quality results show that land use processes in the catchment have had a considerable impact of the water quality of Waimatuku Stream;
- the Waimatuku Stream has been impacted by bacterial contamination and that the impact increases in a downstream direction;
- the Waimatuku Stream monitoring location regularly does not meet the national bottom line for *E.coli*;
- the Waimatuku Stream appears to be fed via groundwater flow derived from precipitation on the land surface, which infiltrates to the water table and then percolates to the stream.
- water quality in the Waimatuku Stream is predominantly controlled by land use processes in the catchment.

4.3.15 For the Oreti River Catchment:

- the upper Oreti River maintains much of its natural qualities;
- the mid and lower reaches of the Oreti have been modified via drainage, flood control and channel clearance work;
- impacts on water quality are likely due to tile drain and non-point source discharges, stock access to waterways, drainage maintenance and gravel extraction activities;
- water sampling data clearly indicate impacts from land use in the immediate catchment, particularly in regard to bacterial contamination;
- New River Estuary is in poor condition and a primary stressor is nutrient enrichment (e.g. from freshwater inflow).

4.3.16 For the Aparima River Catchment:

- headwaters of the Aparima catchment drain alpine, native tussock and forested land;
- agricultural development dominates the middle and lower reaches of the Aparima catchment;
- there are clear differences in observed water quality between the upstream and downstream monitoring sites;
- results demonstrate an increase in nutrient concentration through the catchment, likely due to land use within the catchment;
- primary pressures on water quality are associated with dairy farm intensification including the re-routing of water, increases in overland flow and nutrient loss, and drainage of wetlands.

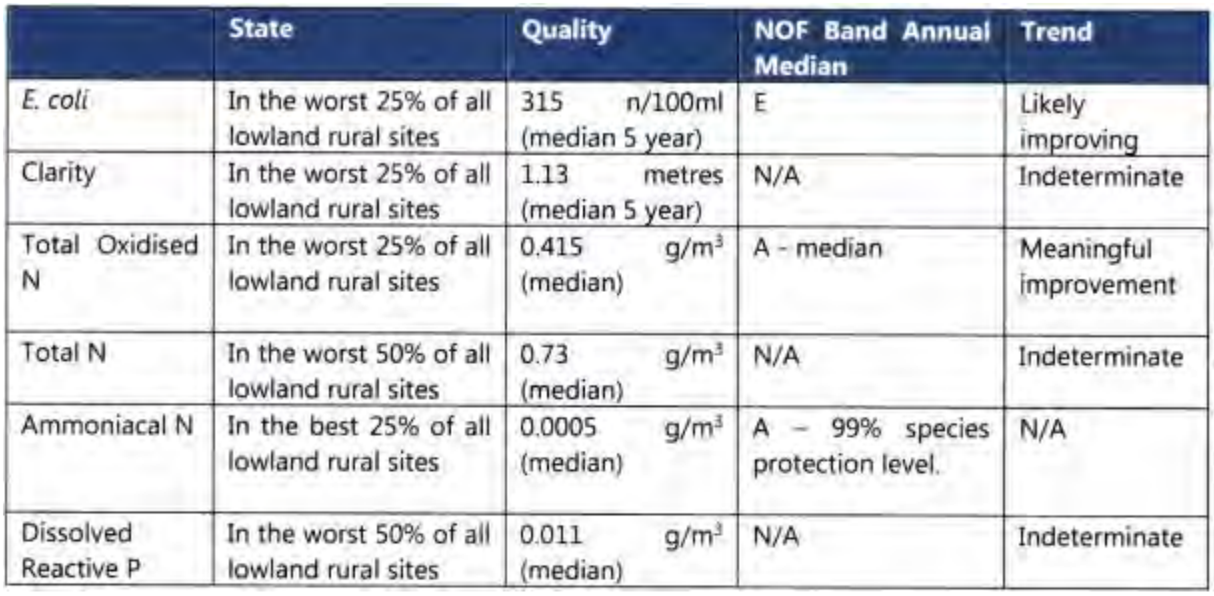
- Jacobs River Estuary is in poor condition, with estuary health being impacted by excessive mud, macroalgal growths, and poorly oxygenated sediments with toxic sulphides; meanwhile adversely affecting biodiversity, aesthetic, amenity and recreational values.

4.3.17 For the WRO – Waiau Catchment:

The **application** states:

- the run-off blocks sit within the Waiau River parent catchment with all surface water flowing into the Te Wae Wae Lagoon;
- both Fenham and Merry creeks are tributaries of the Orauea River;
- data used to inform the description of the existing environment has been gathered from State of the Environment water quality monitoring site at "Orawia Pukemaori Road" and retrieved from the Land and Water website;
- the most recent water quality data available has been used in the application;
- the water quality medians indicate that the Orauea catchment is degraded in regards to *E.coli*, however there is a definite trend of improvement;
- the median dissolved reactive phosphorus is below ANZECC guideline levels and is not showing an evident trend;
- raw data shows the dissolved reactive phosphorus is low on the majority of the sampling dates, with spikes most likely occurring during rainfall events where phosphorus can be transported to surfaces water bodies via run-off and erosion;
- overall impacts of the trends in nutrient concentrations is not clear at this stage, however the receiving water is considered low in relation to nitrogen and phosphorus concentrations overall;
- there is very limited published information on periphyton extent or macroinvertebrate community status in the Orauea River, so it is difficult to assess the current status or trend in biological quality of the stream;
- the below table summarises the surface water quality in the Orauea River at Orawia.

Table 4.3.18: Surface Water Quality Orauea River, taken from the application



	State	Quality	NOF Band Annual Median	Trend
E. coli	In the worst 25% of all lowland rural sites	315 n/100ml (median 5 year)	E	Likely improving
Clarity	In the worst 25% of all lowland rural sites	1.13 metres (median 5 year)	N/A	Indeterminate
Total Oxidised N	In the worst 25% of all lowland rural sites	0.415 g/m^3 (median)	A - median	Meaningful improvement
Total N	In the worst 50% of all lowland rural sites	0.73 g/m^3 (median)	N/A	Indeterminate
Ammoniacal N	In the best 25% of all lowland rural sites	0.0005 g/m^3 (median)	A – 99% species protection level.	N/A
Dissolved Reactive P	In the worst 50% of all lowland rural sites	0.011 g/m^3 (median)	N/A	Indeterminate

The **technical evidence** states:

- data from both available SOE monitoring sites in the catchment has been used to assess the current state of surface water quality;
- relevant water quality standards or guidelines including ANZECC 2008 and New Zealand Drinking Water Standards 2018 have been used to assess the water quality results and show that the Waimatuku water quality as being:
  - Total Nitrogen was above the ANZECC guidelines;
  - Total phosphorus was slightly below the ANZECC guidelines;
  - Dissolved reactive phosphorus was above ANZECC guidelines;
- the cumulative negative impact of land use on water quality in the Orauea and Waiau catchments is clearly demonstrated by the monitoring results, which high levels nutrients and bacterial contamination;
- water quality results clearly indicate nutrient concentrations and bacterial levels in the Orauea River are greater than background levels. Key factors that influence water quality in the Orauea catchment include land use intensification (including sheep, beef, and dairy farming), topography (moderate- to steep- in places), and soil characteristics. As a result, the most likely pathway for contaminants to enter surface waters is via overland flow during rainfall events;
- comparatively better water quality is observed in the Waiau River, likely due the extensive area of native forestry that it drains and a reduced level of land use intensification in the catchment above the monitoring site.

Summary
4.3.19 The surface waterbodies in the receiving environments, including Waimatuku Stream, Oreti River, Waiau River and Aparima River show impacts from land use processes and are already significantly degraded, with some ANZECC guidelines being exceeded. Both the application and the technical evidence conclude that the receiving water bodies are degraded, however there is dispute between the two as to what extent.

4.3.20 In reviewing all the evidence relating to surface water quality, I have placed considerably more weight on the technical evidence provided by Ms Lovett because:

- in most cases the application has only considered data from one monitoring site within the relevant catchment, even though more relevant data was available;
- data contained in the application does not correlate with what is presented on the Land and Water website, despite the application referencing this as the source of the data;
- very little analysis of the data has been provided in the application;
- in some cases, the application has omitted common water quality measurement parameters;
- descriptions and analysis of the Waimatuku Estuary and Te Wae Wae Estuary have been omitted;
- The data contained in the application has not been assessed against the most relevant water quality standards or guidelines (ANZECC 2008 and New Zealand Drinking Water Standards 2018).

4.3.21 In my opinion, the application assessment does not accurately present the condition of the receiving environment, and I consider that the water quality is significantly more degraded than what has been presented in the application.

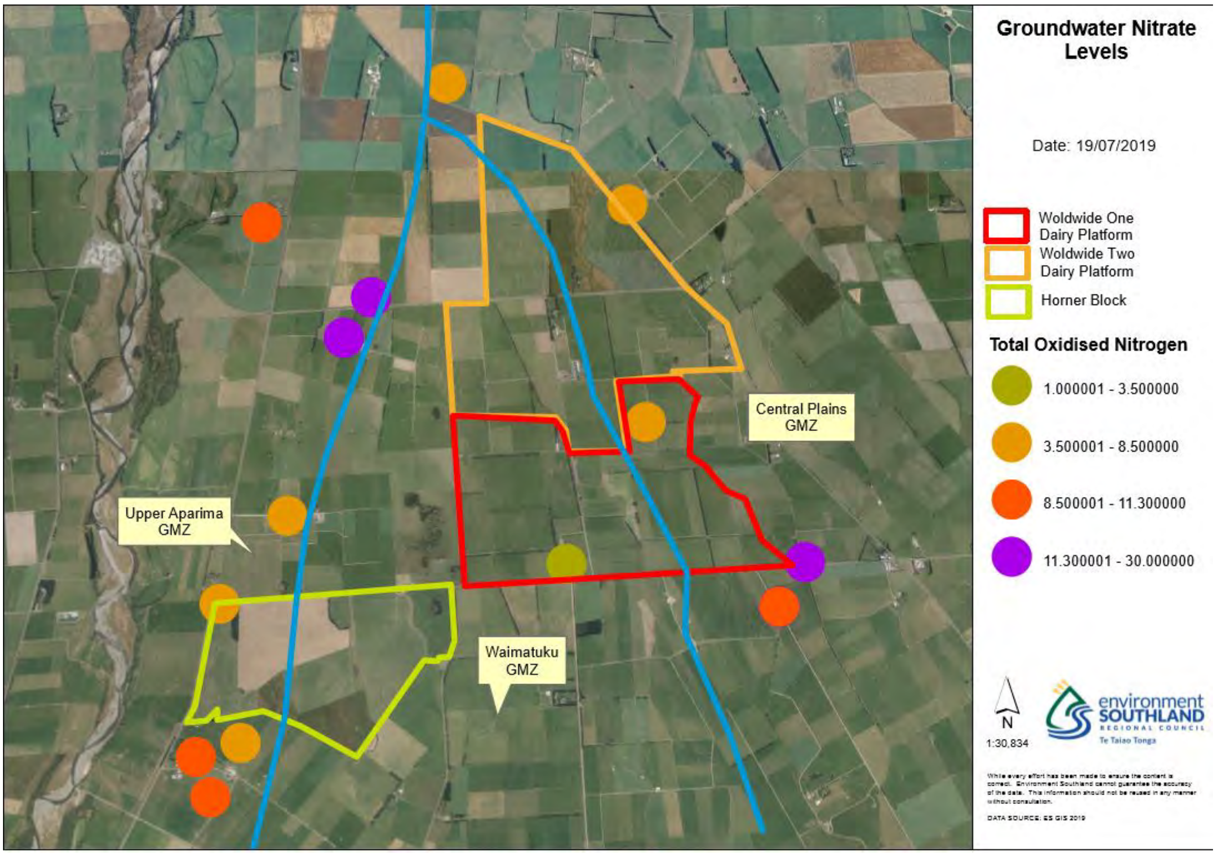
4.4.1 *Existing Groundwater Quality*

Dairy Platform

4.4.2 The proposed dairy platform sits in the Waimatuku and Central Plains groundwater management zones. The groundwater quality in the vicinity of the property is severely degraded, including three locations where groundwater nitrate levels exceed New Zealand Drinking Water Standards.

Horner block

4.4.3 The Horner block is located in the Waimatuku and Upper Aparima Groundwater Management Zones. There is a cluster of points with elevated nitrates on the Eastern boundary of the block where nitrate levels are at, or close to Drinking Water Limits (between 8.5-11.3 mg/L of N).



While every effort has been made to ensure the content is correct. Environment Southland cannot guarantee the accuracy of the data. This information should not be reused in any manner without consultation.

DATA SOURCE: ES GIS 2019

Figure 4.4.4: Groundwater Nitrate Levels; proposed dairy platform

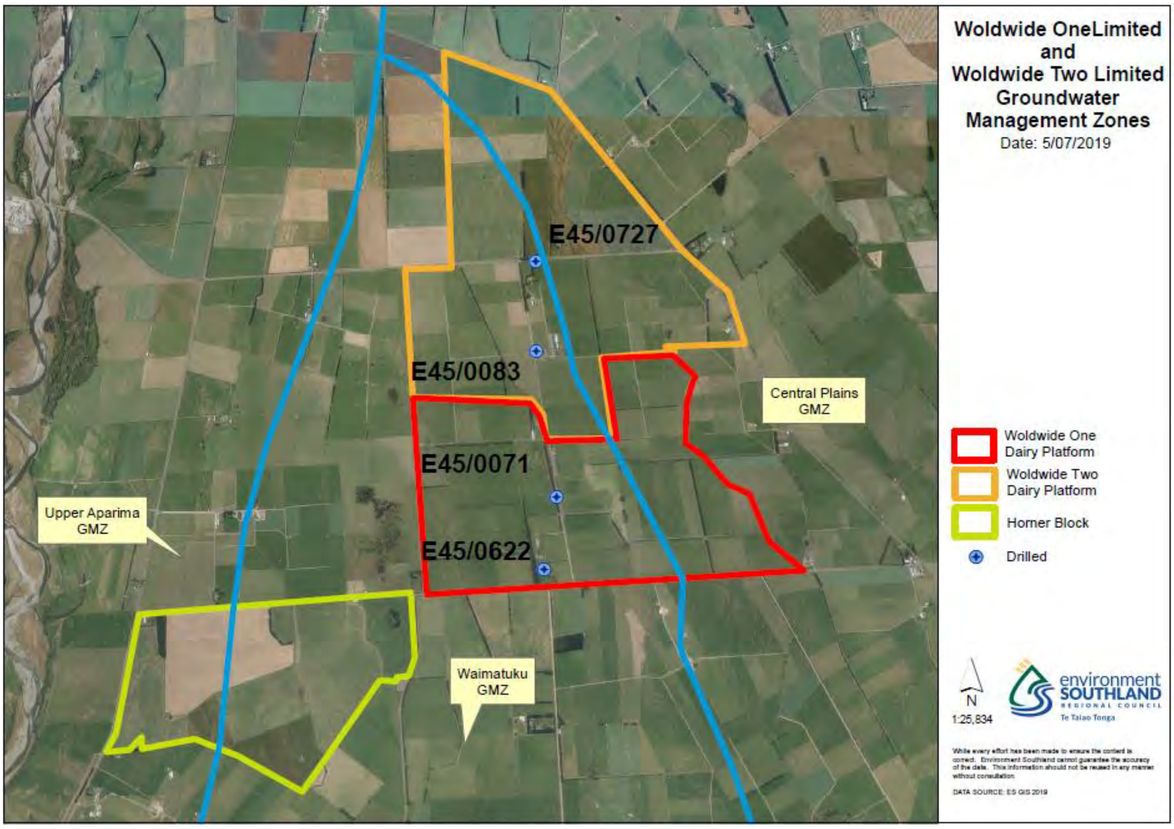


Figure 4.4.5: Location of WW1, WW2 and Horner block boundaries and groundwater management zones and selected bores

The **application** details groundwater receiving environment as:

4.4.6 For the Upper Aparima Groundwater Zone:

- groundwater quality is generally good, although does vary according to source aquifer and location;
- there are minimal "hotspot" areas where nitrate values are particularly high;
- there are no Upper Aparima Groundwater Zones registered drinking water supplies located within 35 kilometres of the property.

4.4.7 For the Waimatuku Groundwater Zone:

- the Waimatuku aquifer has low allocation status;
- recharge of the aquifer is principally derived from rainfall recharge;
- shallow groundwater makes a significant contribution to baseflow discharge in the Waimatuku catchment;
- groundwater circulation through deeper levels of the aquifer system is likely to be relatively slow and follow the more general southward topographic gradient;
- quality in the aquifer is generally good, although does vary according to source aquifer and location;
- some areas of elevated nitrate concentrations are observed in shallow groundwater reflecting infiltration from surrounding land use;

- groundwater nitrate levels south of WW1 and WW2, overlying the Waimatuku Groundwater Zone, are generally low, in the range of 0.01-8.5 g/m^3.
- the bore (E45/0622) on WW1 platform is frequently contaminated, unsuitable for use as a monitoring bore and data collected from the well may be unlikely to reflect wider groundwater quality;
- most groundwater underlying WW1 and WW2 has nitrate levels of 3.5–8.5 mg/L, indicative of moderate to high land use impacts;
- the applicants believe that their presence on the property at this location since 1992 (over 25 years) has not had a detrimental effect on the local environment.

4.4.8 For the Central Plains Groundwater Zone:

- the Central Plains Groundwater Zone has low allocation status;
- recharge occurs primarily through rainfall infiltration and some infiltration from run-off from the Tauringatura Hills;
- quality in the aquifer is generally good, although it does vary according to source aquifer and location;
- there ae some “hotspot” areas where nitrate values are particularly high;
- there are no Central Plains Groundwater Zone registered drinking water supplies within 10 kilometres of the property.

4.4.9 For the WRO groundwater:

- WRO sits outside of the mapped groundwater zones;
- groundwater nitrate levels in the vicinity of the property indicate groundwater nitrate levels consistent with Pristine, pre European.

The **Lovett report** summarises the groundwater quality for the receiving environment as:

4.4.10 For the Upper Aparima Groundwater Zone:

- monitoring sites show a general increase in concentrations of NO_2 – NO_3 over time;
- there was no observable trend in *E.coli* or total coliform concentration over time;

4.4.11 For the Waimatuku Groundwater Zone:

- four monitoring sites in the catchments show a decreasing trend in nitrate concentration over time;
- seven monitoring sites show an increasing trend in nitrates over time;
- water quality results indicate land use impacts on water quality, including elevated NO_3-N and bacterial contamination;
- Nitrate levels up to 8.5 mg/l are not able to be considered low, as they have been in the application;
- data gathered from bore (E45/0622) on WW1 is suitable to be used as a representative samples to determine land use impacts due to the protocol surrounding collection of samples.

4.4.12 For the Central Plains Groundwater Zone:

- extensive mole, tile and artificial drainage networks have been installed to intercept soil drainage and lower the water table;
- drainage is routed into small streams, along with local, shallow groundwater – this process results in relatively rapid transit of recharge through the surface water and shallow groundwater systems;
- groundwater in the Central Plains zone is generally of reasonable quality, although several nutrient "hotspots" areas occur with particularly high NO_3- N levels, which are often above the drinking water standard;
- there does not appear to be an overall declining trend in groundwater levels for the aquifer that this stage.

4.4.13 WRO Groundwater:

- WRO is located in the Waiau FMU, and the groundwater in the area is in an "unclassified" groundwater management zone;
- approximately 10 bores are located in the Merrivale area within the vicinity of WRO;
- several of these bores are located in trophic depressions in close proximity to stream beds and likely to abstract water that is connected to the surface waterways;
- very limited groundwater data exists for the Merrivale area;
- N concentration levels are very low one bore D45/0278, with a range of <0.002–0.053 mg/L, which is regarded as pristine to modern day background levels;
- In comparison, several other bores indicate increased N concentration levels including D45/0065 (3.8 mg/L), bore D45/0280 (6.01 mg/L), and bore D45/0108 (5.2–6.77 mg/L);
- Due to a combination of the topography, depth of groundwater and drainage channels it is thought that there is a low risk of nitrate accumulation in groundwater in this area;
- However, the limited number of groundwater quality results indicate that increased nutrient concentration is affecting water quality in several bores, none of which are located particularly close to surface waterways.

Summary

4.4.14 The groundwater in the receiving environments show impacts from land use processes and are degraded, with some ANZECC guidelines being exceeded. The application contained very little analysis of available groundwater monitoring results and did not provide a conclusion for the overall quality in each groundwater zone, and only provided basic descriptions of the hydrogeological context of zones.

4.4.15 In reviewing all the evidence relating to surface water quality, I have placed considerably more weight on the technical evidence provided by Ms Lovett because:

- for all groundwater zones the application has not assessed all available and relevant groundwater data. Had this assessment occurred, a more correct picture of the groundwater quality would have been presented;
- Of the little data that has been provided in the application, little analysis of it has been provided;
- Groundwater nutrient concentrations in the Merrivale area in particular were found to be higher than reported in the application.

4.4.16 In my opinion, the application assessment does not accurately present the condition of the receiving environment, and I consider that the water quality is significantly more degraded than what has been represented in the application. In the further "water quality assessment" provided by the applicant, the state of the water quality in the receiving environment is further clarified, but does not, in my opinion, change any of the conclusions I have reached regarding the state of the receiving environment.

4.5.1 *Groundwater Quantity*

For the proposed dairy platform:

4.5.2 Groundwater is proposed to be abstracted from three separate bores. All three bores are located in the Waimatuku Groundwater Management Zone under both the Regional Water Plan and the proposed Southland Water and Land Plan.

4.5.3 The application is for a maximum take of 91 m^3/day (an increase of 31 m^3/ day) from bore E45/0071 and maximum daily abstraction of 96 m^3/day (unchanged) from bores E45/0083 and E45/0727, combined. Groundwater abstraction is for use in the dairy shed and for stock drinking water.

4.5.4 Importantly, the total proposed abstraction of 187 m^3/day from bores E45/0071, E45/0083, and E45/0727 is greater than the Environment Southland guidelines (e.g. 120 L/cow/day = 180 m^3/day). As such this is not considered reasonable and efficient use of the water resource and the applicant has failed to demonstrate the efficiency of such an abstraction and why it is reasonable to do so.

4.5.5 The application also states *"The rate of take does not exceed 2 l/sec and should not result in more than minimal stream depletion and interference effects"*, however no evidence in the form of a stream depletion assessment or an aquifer test requirement have been supplied.

4.5.6 Furthermore, groundwater level monitoring from bore E46/0110 indicates lower groundwater levels in summer, likely as a result of increased abstraction and decreased rainfall recharge during this period.

4.5.7 While on paper there appears to be no quantity allocation issues for the groundwater zone related to the proposal, the application has failed to provide what I consider to be sufficient information regarding the effects associated with the proposed abstraction of groundwater, particularly in regards to stream depletion and bore interference.

Table 4.5.8: Groundwater availability and allocation for both the proposed Southland Water and Land Plan, and the Operative Water Plan

Groundwater Zone	Waimatuku (Regional Water Plan)	Waimatuku (proposed Southland Water and Land Plan)
Discretionary Allocation	18,800,000	22,270,000
Amount Currently Allocated	1,911,068	1,762,155
Mean Annual land Surface Recharge	125,600,000	N/A
Percentage Currently Allocated (%)	10.2	7.9

For WRO water take:

4.5.9 Woldwide run-off has a stock drinking water scheme that meets permitted activity rules and does not require consent.

4.6.0 *Existing Drinking water supplies*

4.6.1 There are four known public drinking water supplies downstream and/or down gradient of WW1, WW2, and Horner block farms. They are:

- Heddon Bush School supply, from groundwater Waimatuku groundwater zone;
- Drummond School, from groundwater in the Waimatuku groundwater zone;
- Otautau Township supply, from groundwater in the Upper Aparima groundwater zone;
- Invercargill City supply, from surface water in the Oreti River.

4.7.0 *Existing Local environment: the subject landholding*

Soils and Physiographic Zones on the subject landholding

4.7.1 Vulnerability of the subject land to effects of farming and effluent irrigation can be examined by reference to soil types, physiographic zones and to FDE land classifications. These are summarised in Table 4.10.2.

4.8.0 Soil classifications

Note: In the application there is dispute around the soil types present on the landholding, specifically on the dairy platforms. This will be addressed in Section 5.4.1 of this report.

4.8.1 There are a large number of soil types across the entire landholding with a range of vulnerability factors. The soil types within the proposed landholding have a slight to very severe risk of nutrient leaching. The soil types largely present a nil to slight vulnerability of waterlogging, with a section of soils on the run off blocks having a severe risk of waterlogging. The vulnerability for structural compaction across the landholding is slight to moderate. The soil types on the property also create a number of contaminant pathways including artificial drainage, overland flow and deep drainage. There are a number of areas of concern arising particularly from the soil types Glenelg, Braxton and Drummond which will be discussed in section 5.4.1 of this report.

4.8.2 Expert evidence provided in the PDP review describes soils on the landholding as the following:

> *"The soils across the WW1 and 2 are largely a silty loam or clay texture; these soils are common to the area. These soils have a large Profile Available Water (PAW) capacity (ranging from 100 – 149 mm, 0-60 cm) and a moderate to slow drainage profile. Examples of these soils are Braxton and Tuatapere soils, both are moderately deep soils, with a silty loam over clay and silty loam textures. There are also areas of soils which are lighter in nature, freer draining with sandy, silt textures. Because of the ability of the heavier soils to hold onto water, and the low permeability of the soil, they typically, as [sic] whole present a low nitrate nitrogen leaching risk. Instead, when waterlogged, the soils tend to facilitate denitrification of the soil nitrate nitrogen content, resulting [sic] gaseous losses to the atmosphere opposed to leaching to water (McLaren and Cameron, 1996).*
>
> *Clay rich soils, such as the Braxton series are inherently prone to shrink-swell behaviour. This characteristic often results in cracks and fissures forming at the soil surface and within the soil profile, forming during dry periods. The regularity of these cracks is highly situational and depends on a number of factors; such as the soil's texture, structure and pore characteristics."*

4.9.0 Physiographic zones

4.9.1 The proposed Southland Water and Land Plan introduced the concept of physiographic zones, which are spatial zones defined by their geological, topographical, soil, and climate characteristics. Physiographic zones provide an understanding of why land use impacts upon water quality vary between locations with similar land uses.

4.9.2 The physiographic zones for the landholding are:

- Gleyed;
- Lignite Marine Terraces;
- Oxidising;
- Central Plains;
- Bedrock/Hill Country.

4.9.3 The zones indicate that the main contaminant pathways for the proposed activity on the landholding will be via artificial drainage, deep drainage and overland flow. The proposal poses risks to both surface water and groundwater. This is an important point, as the receiving surface water and groundwater bodies are already significantly degraded.

4.9.4 The Gleyed and Lignite Marine Terraces physiographic zones both have denitrifying potential, and the Bedrock/Hill Country zone does not have any significant areas of groundwater. The bedrock/hill country, oxidising and lignite-marine terrace zones all have artificial drainage and overland flow variants whereby the main risk will be to surface water. These physiographic zones are found at the WRO part of the operations landholding.

4.9.5 The Oxidising zone consists of soil types that have little denitrifying potential and are well aerated which allows nitrogen to accumulate in soil water and groundwater. The main contaminant pathway for the Oxidising Zone is deep drainage to groundwater. Where the Oxidising Zone has no variant, there is little risk to surface water due to the deep drainage contaminant pathway. The Oxidising Zone however, has good phosphorous retention.

4.9.6 The Central Plains physiographic zone consists of clay-rich soils that shrink and crack when dry and swell when wet. Wet soils are prone to waterlogging in this zone, while when dry they are prone to cracking which allows for contaminants to bypass the soil to the underlying aquifer. The soils in this zone do also have denitrifying potential under the right conditions.

4.9.7 The proposed dairy platform is located on the Central Plains and Oxidising physiographic zones.

4.10.1 FDE land classification

4.10.2 The FDE risk categories for the discharge area are Category A, which identifies artificial drainage as the main contaminant pathway and Category E, where the main contaminant pathway is through the well-drained soils to underlying aquifers.

Table 4.10.2 : Soils, physiographic zones and FDE land classifications on the landholding showing vulnerability factors

	Soil Type	**Vulnerability Factors**		
		Structural Compaction	**Nutrient Leaching**	**Waterlogging**
	Braxton + Pukemutu$^{+\%}$	Moderate	Slight	Severe

	Glenelg^{+}	Minimal	Very Severe	Nil
	Glenelg + Drummond$^{+\%}$	Minimal	Very Severe	Nil
	Orawia*	Slight	Moderate	Nil to Slight
	Makarewa + Aparima$^{*\#}$	Moderate	Slight	Severe
	Aparima + Papatotara*	Moderate	Moderate	Moderate
	Unmapped*	Unknown	Unknown	Unknown
	Waimatuku$^{\#}$	Slight	Moderate	Slight
	Malakoff$^{\#}$	Slight	Severe	Slight
	Fairfax + Woodlaw$^{\#}$	Slight	Moderate	Slight
	Waiau + Tuatapere$^{\%}$	Moderate	Very Severe	Nil
Physiographic Zones	**Physiographic Zone**	**Variant Type**		
		No Variant	**Overland Flow**	**Artificial Drainage**
	Central Plains	√$^{+\%}$		
	Oxidising	√$^{+\%}$	√$^{*\#}$	√$^{\#}$
	Bedrock/Hill Country		√$^{*\#}$	√$^{\#}$
	Gleyed	√$^{*\#}$		
	Lignite-Marine Terraces		√$^{\#}$	√$^{\#}$
	Peat Wetlands	√$^{\%}$		
FDE Land Classification (Discharge Area – Dairy Platform and Horner block	Category A – Artificial Drainage or Coarse Soils Structure^{+} Category E - Other well drained but very stony flat land^{+}			

+ - Present on Dairy Platform
* - Present on Merriburn Run-off
# - Present on Merrivale Run-off
% - Present on Horner block

5. Effects and Causes

5.1.0 Effects to be considered

5.1.1 In assessing the application and making its decision, Council is required to consider all effects from a proposed activity. In the following sections of this report, I have considered all the effects of the proposal, but disregarded some later as they already form part of the existing environment or can be considered part of the permitted baseline. Other potential effects may be addressed through mitigations offered by the applicant.

5.1.2 Since the lodging of the original application, there have been many changes, additions and removals to aspects of the proposal, as has been detailed earlier in this report. I have assessed all changes in the various iterations for the application, however the changes have not provided me with any further certainty regarding the effects from the operation.

5.1.3 Due to the complexity of the application, I have separated out the effects from their likely causes and addressed each effect individually before assessing them against the proposed mitigations. This has allowed me to fully assess the likelihood of occurrence of these effects and their significance. Therefore, I have structured this part of the report as follows:

- my assessment of the actual and potential effects arising from the proposal that I consider are important for the decision makers to consider;
- my assessment of the cause of those effects;
- my assessment of the proposed mitigations to address the causes and effects;

- the relevant planning framework against the effects must be considered;
- my assessment of the applicants changes to the application;
- my assessment of the significance of the effects.

5.1.4 I found the applications assessment of effects inadequate to give me a complete picture of the likely effects from the proposal. Consequently, I commissioned evidence from subject matter experts to assist with my understanding of the proposal's effects. I have weighed up evidence from the following sources when considering the environmental effects of the proposal, their causes, and the effectiveness of mitigations:

- the application and related appendices;
- various updates, changes and removals of the application;
- supplementary reports provided in addition to the application;
- Earth and Environmental Science – technical review on surface and groundwater effects (Abigail Lovett);
- Pattle Delamore Partners Limited – technical memorandum on soils (Belinda Meares);
- Irricon Limited – Technical evidence on Overseer (Nicole Phillips);
- Updated versions and addendums to the above sources.

5.1.5 I have a number of concerns relating to the effects arising from proposal. These issues relate largely to effects on water quality, including potential for further contamination of groundwater and surface water, however there are also some minor concerns over soil health and groundwater quantity.

5.1.6 Consideration of all effects is required under Section 104(a) of the RMA. The relevant effects for the application are assessed below and include:

- effects on water quality, including potential for contamination of groundwater and surface water, and effects on sources of human drinking water;
- effects on water quantity (including stream depleting effects);
- cumulative effects;
- soil health; and
- odour.

5.2.0 Actual and Potential Effects – effects not in contention

Odour

5.2.1 Odour is a potential issue arising from discharges of agricultural effluent. Effluent and sludge produced in wintering barns are typically more potent than regular dairy shed effluent and, if stored for periods of time can turn anaerobic, resulting in a material with a stronger odour when spread. The relatively thick nature of the material means it can remain on the land surface for long periods releasing odours.

5.2.2 I consider that odour effects will likely be acceptable as the application details the use of modern technology slurry wagons for the discharge of effluent, which use a "dribble bar" application method which minimises the risk of odour occurring beyond the property boundary. This method applies the effluent at the soil surface, rather than aerating it as some other technologies do.

5.2.3 Provided the effluent is applied in accordance with the specified application rates and depths, and the buffers specified by recommended consent conditions are maintained, then there should little risk of adverse effects from odour and spray drift on surrounding land owners and occupiers.

5.2.4 Effluent storage facilities can also cause problems with odour, however, the closest dwelling on another property is located over 700 metres from the effluent storage facility and the facility is located more than 500 metres from the property boundary. A recommended condition of consent requires that there are no significant adverse effects on surrounding landowners and occupiers as a result of odour from the storage facility.

5.3.0 Actual and Potential Effects – effects in contention

5.3.1 The following effects are discussed below:

1. effects on surface water;
2. effects on groundwater;
3. effects on soil health;
4. effect on drinking water supplies;
5. cumulative effects.

5.3.2 *Effects 1 and 2: potential and actual effects on surface water and groundwater quality*

Please note the figures contained in this section have been replaced/ updated or deleted by the applicant multiple times and at the time of writing I am not certain of what figures they would like considered, so I have used the figures from the original application and compared them against the most recent updated version of these that I had available to me at the time of writing.

While the eventual figures may change slightly, I still consider that the discussion and conclusions I have drawn are relevant, even if the figures are differ slightly in the final application.

5.3.3 Contaminants in the form of N, P, sediment and microbials such as *E.coli* are lost through various farming activities. When intensification occurs, these losses can increase unless adequate mitigations and management practices are put in place. Nutrient loading calculations have been provided with the application to inform on total cumulative effects and I consider that they are useful in helping to estimate the scale of nutrients lost from the operation. As with any model there are limitations to be taken into account when considering these calculations, but they do provide a link to give an idea that:

- a load of contaminants from the proposal will be discharged into the environment, even if there is uncertainty around the accuracy of the number; and
- that the loading will result in environmental effects occurring or increasing.

5.3.4 The nutrient model loading is discussed in more detail in section 5.7.0 (Cumulative Effects) but for completeness I have summarised the nutrient loading from the application here too as it is relevant to both sections, to give an idea of the volume of nutrient losses to the receiving water bodies, both in the immediate vicinity of the operation and to the wider receiving environment. The original application details:

For losses into water bodies in the Oreti catchment:

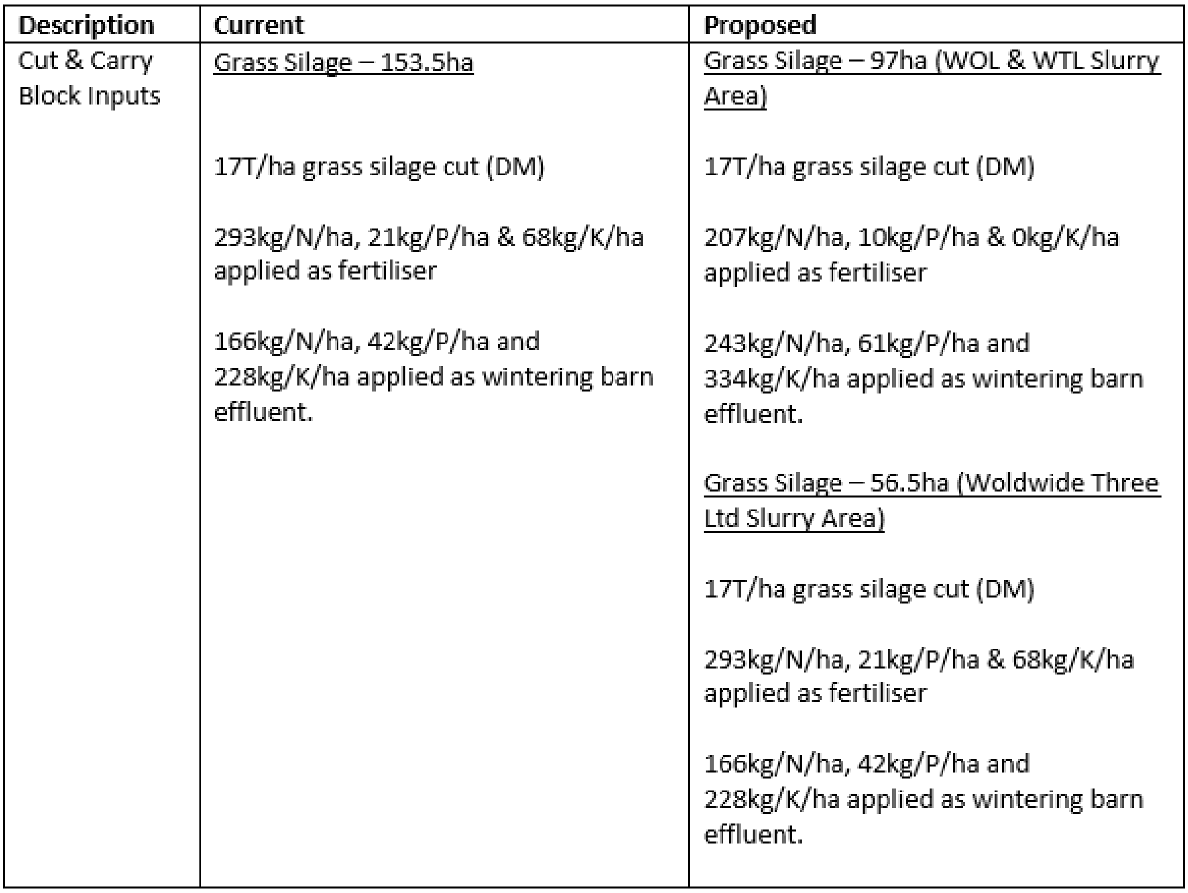
- approximately 8,959 kg/N per year may be lost from 94 ha at WW1and WW2;
- assuming an attenuation rate of 33% approximately 5,967 kg/N per year could reach receiving waters.

For losses into water bodies in the Waimatuku catchment:

- approximately 10,420 kg of N/year may be lost from 306 ha of land at WW1 and WW2;
- assuming an N attenuation rate of between 33% for the New River catchment and 39% for the Aparima catchment somewhere in the region of 6,775 kg of N/year may reach the Waimatuku, either directly from drainage to surface waters or via groundwater discharge;
- 230 kg of P may be lost annually from 306 ha of WW1 and WW2.

5.3.5 The original application does not provide an estimate of losses by way of nutrient load calculations for the Horner block and Aparima River catchment, however the original Overseer budget details N discharge (to land) from agricultural effluent of 250 kg/N/ha/yr. This load is significantly greater than good management practice guidelines of 150 kg/N/ha/yr.

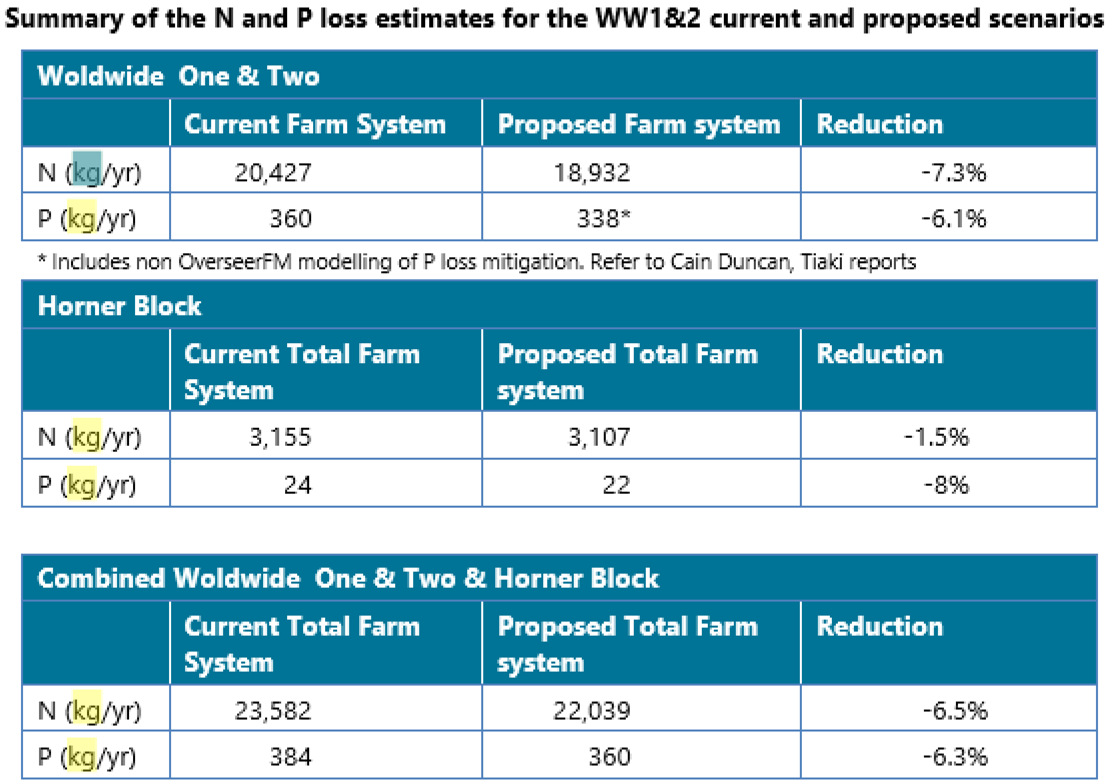
5.3.6 The updated nutrient budget reports for Horner Block details N discharge to land from agricultural effluent of 243kg/N/ha which is a slight decrease from the original (but still a 46.38% increase on N from effluent, while N from Fertiliser decreases by 29.35%). Proposed consent condition seeks to allow the discharge of N from effluent up to 250kg/N/ha despite the revised budget numbers. Further commentary about the new budgets has been addressed in technical evidence provided by Abigail Lovett and Nicole Phillips and I adopt their evidence in regard to the updated nutrient budgets. The information detailed below has been taken from the new nutrient budgets. *Note – the figures detailed below in the “current” column has been spread over the entire 153.5ha Horner block – so includes WW3’s portion, despite WW3’s portion being consented for 150kg/N/ha/year not 166kg/N/ha/year. The proposed portion of WW3 Horner Block discharge also details 166kg/N/ha/year. If this occurs, WW3 will be non-compliant with the current permit.*



Description	**Current**	**Proposed**
Cut & Carry Block Inputs	Grass Silage – 153.5ha 17T/ha grass silage cut (DM) 293kg/N/ha, 21kg/P/ha & 68kg/K/ha applied as fertiliser 166kg/N/ha, 42kg/P/ha and 228kg/K/ha applied as wintering barn effluent.	Grass Silage – 97ha (WOL & WTL Slurry Area) 17T/ha grass silage cut (DM) 207kg/N/ha, 10kg/P/ha & 0kg/K/ha applied as fertiliser 243kg/N/ha, 61kg/P/ha and 334kg/K/ha applied as wintering barn effluent. Grass Silage – 56.5ha (Woldwide Three Ltd Slurry Area) 17T/ha grass silage cut (DM) 293kg/N/ha, 21kg/P/ha & 68kg/K/ha applied as fertiliser 166kg/N/ha, 42kg/P/ha and 228kg/K/ha applied as wintering barn effluent.

5.3.6 The soils on the Horner block are either Braxton, which have swell/crack properties, and Drummond /Glenelg which are classified as "severe risk" of nutrient leaching. Due to these factors, the contaminant losses are likely to be significant and in turn, result in greater effects on water quality from this block compared to what is occurring currently. It should be highlighted that as well as the nitrogen loading being above good management practices, the applicant is proposing to increase the loading on this block from an average of 166 kg/ha/yr to a total of 250 kg/ha/yr.

5.3.7 In the "Water quality assessment" authored by Mike Freeman and provided on 23 August 2019 as an update or addition to the original application, the following figures for losses were provided:



Summary of the N and P loss estimates for the WW1&2 current and proposed scenarios

Woldwide One & Two

	Current Farm System	Proposed Farm system	Reduction
N (kg/yr)	20,427	18,932	-7.3%
P (kg/yr)	360	338*	-6.1%

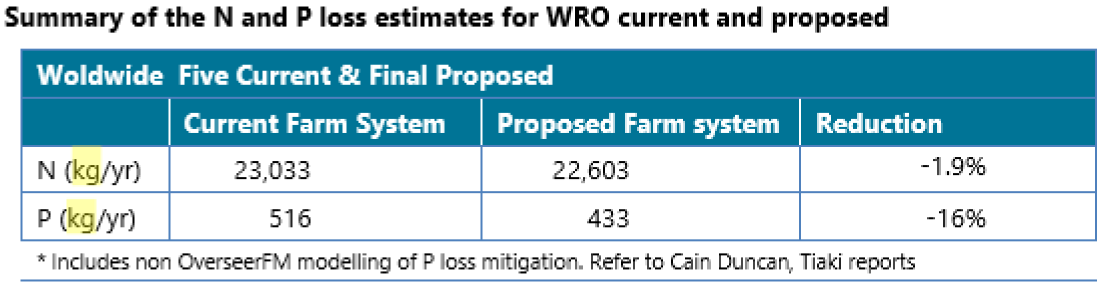
* Includes non OverseerFM modelling of P loss mitigation. Refer to Cain Duncan, Tiaki reports

Horner Block

	Current Total Farm System	Proposed Total Farm system	Reduction
N (kg/yr)	3,155	3,107	-1.5%
P (kg/yr)	24	22	-8%

Combined Woldwide One & Two & Horner Block

	Current Total Farm System	Proposed Total Farm system	Reduction
N (kg/yr)	23,582	22,039	-6.5%
P (kg/yr)	384	360	-6.3%



Summary of the N and P loss estimates for WRO current and proposed

Woldwide Five Current & Final Proposed

	Current Farm System	Proposed Farm system	Reduction
N (kg/yr)	23,033	22,603	-1.9%
P (kg/yr)	516	433	-16%

* Includes non OverseerFM modelling of P loss mitigation. Refer to Cain Duncan, Tiaki reports

5.3.7 The above losses do appear to show a decrease of losses when compared to those contained in the original application, and losses for the Horner block have also been included with the updated modelling. However, these have been provided in a different manner to the original calculations, using a different version of Overseer FM which makes a comparison difficult. Like the original calculations, these figures have also been calculated using mitigations and good management practices that either are unable to be implemented, do not form part of the existing environment or have since been removed from the original application.

5.3.8 Turning to the environmental effect of contaminant losses on surface and groundwater, the application considers these effects to be “less than minor”. This is argued because the nutrient budgeting for the proposal shows that overall losses will decrease overall, so while effects of the contaminant losses are discussed they have been disregarded as being no greater than what is already occurring from the current operation.

5.3.9 Conversely, the Lovett report details that the proposed activities will result in an increase in effects in the receiving environments. This is explained at length in her report from section 6.0 on page 37. The Lovett report details how the effects will come to occur is further explained in this report in section 5.8.0 “key causes”.

5.3.10 The application details actual and potential effects on pages 144–147, and I am able to adopt these effects in part (table 5.3.11). For clarity, I have summarised the key effects that various factors for the proposal may have on surface water receiving bodies below. The following section (5.8.0) then details how these effects are likely to occur.

Table 5.3.11: Potential environmental effects in receiving water bodies (paraphrased from the application)

Contaminant	Potential effect in receiving waterbodies
N,P	**Increased algal growth** in the water column, especially during low flow periods and/ or when temperatures are elevated. In turn, this can cause ecological effects such as: exclusion of macrophytes, reduced visibility for fish and other organisms, loss of habitat, loss of recreational values. **Increased turbidity** reduces light infiltration and reduces clarity **Increased Biological Oxygen Demand,** causes reduced dissolved oxygen which stresses aquatic organisms, and can result in loss of species and habitat. **Increased periphyton growth**, especially when temperatures are elevated or flows are low can cause smothering of streambeds, promotion of the growth of toxic mats of cyanobacteria (blue green algae). This in turn can lead to loss of habitat, effects on invertebrates and organisms in associated food webs, reduced biodiversity, toxic effects on biota including domestic animals, loss of recreational values, risk of human health effects. **Increased aquatic weed growth**, especially when temperatures are elevated or flows are low can cause choking of waterways. This in turn can lead to loss of habitat, effects on invertebrates and organisms in associated food webs, reduced biodiversity.
N	**Toxicity effects from high N concentrations,** can result in loss of habitat, fish kills, adverse animal health effects due to nitrate toxicity, ‘blue baby syndrome’ in humans.
P	**Increased nuisance plant growth on estuaries**, weed driven habitat modification and loss, smothering effects on invertebrates and organisms in associated food webs leading to reduced biodiversity .
Sediment	**Increased turbidity and increased water clarity**, resulting in exclusion of macrophytes, reduced visibility for fish and other aquatic organisms, loss of habitat, decreased suitability for recreational activity. **Deposition of sediment on streambed,** resulting in smothering, loss of habitats, increased anoxic conditions, reduction of food availability for invertebrates and organisms in associated food webs, reduced biodiversity.
Microbial contaminants	**Exposure to pathogens,** people using waterways for recreational activities and food gathering are at risk of adverse health effects.

5.3.12 Expert evidence provided by the Lovett report details how the above effects on surface and groundwater will be increased under the proposal, which I discuss more in the causes section below.

5.3.13 The Lovett report expands on the above effects detailed in the application at section 2.3 on page 8 of the evidence and discusses hydrological parameters and water quality indicators which I have summarised as follows:

- Nitrogen is found in several different forms in terrestrial and aquatic ecosystems, including ammonia (NH_3-N), organic and particulate nitrogen, nitrate (NO_3-N), and nitrite (NO_2-N);

- Nitrogen and phosphorous are essential plant nutrients. However, in excess these nutrients can cause significant water quality issues such as eutrophication, increase in aquatic plant growth and decrease in macroinvertebrate community;

- since natural levels of NH_3-N and NO_3-N in surface waters are typically low (e.g. <1 mg/L), these parameters are commonly used an indicator of the effects from land use processes;

- *E.coli* is the main indicator of the risk of getting sick from contact with surface waters, as high levels of *E.coli* can make people and animals sick. Primary contact involves activities such as swimming and water skiing whereas secondary contact includes activities such as boating and fishing. The compulsory national bottom line for secondary contact is 1,000 cfu/100 mL of *E.coli*, however limits for primary contact have not yet been established. In addition, faecal coliforms and total coliforms are additional parameters commonly used for reporting of water quality.

5.3.14 The Lovett report also details that the following effects from agricultural effluent are as follows:

- potential effects on groundwater and surface water quality include an increase in total amount of effluent discharged into the receiving environment, due to the increase in cow numbers;

- the applicants are proposing to house the current and additional cows in wintering barns. This operation results in the reduction of diffuse source contaminants (e.g. bacteria and nutrients from intensive winter grazing) since effluent (slurry) will now be collected at a point source (e.g. shed sump). Although collection of slurry (effluent) to a point source is an improved operational procedure likely to result in reduced effects on surface and groundwater quality, the applicant proposes to discharge this slurry (effluent) back onto land. Discharge of effluent and slurry creates a new diffuse source of potential nutrient and bacterial contamination and poses a risk to the shallow groundwater system and downstream surface water systems;

- Houlbrooke and Monaghan (2009) report that results from a literature review on land-application of FDE and its effects on water quality indicate between 2-20% of nitrogen and phosphorus applied in FDE is lost either in run-off or via leaching. Therefore, it is likely that (even if BMPs are followed) an increase in the nitrogen and phosphorus in the receiving environment is likely to occur. Since the total volume of effluent to be discharged will increase (with increase in number of cows), therefore likely increase in the total nutrients applied to the catchment with effects on surface and ground water. Groundwater quality of the Waimatuku and Central Plains aquifers show impacts from land use processes, including increased nutrients (e.g. NO_2-NO_3, TP) and bacteria (e.g. *E.coli*, faecal coliforms);

- FDE (effluent and slurry) discharge will increase cumulative effects on surface and groundwater quality in the receiving environments through predicted nitrogen losses of between 19–40 kg/N/Ha/yr (c. 23,400 kg/N/yr), and 0.1–0.7 kg/P/Ha/yr (380 kg/P) (Duncan, 2019);

- discharge of 150 kg/N/ha/yr to WW1 and WW2 discharge areas; and 250 kg/N/ha/yr on Horner block result in an estimated nutrient loss of 40 kg/ha/yr and 19 kg/ha/yr, respectively, of nitrogen to the receiving environment (Duncan, 2019). Due to limitations of Overseer, this value should be considered as conservative. It is unknown what proportion of N loading will contribute impacts on surface waters or groundwater, which will be a combination of effects of weather events (e.g. rainfall intensity, total rainfall, and land management).

5.3.15 I do not consider that there is any disagreement between the application and the expert evidence on the effects that contaminants have in receiving waterbodies in general, however there is dispute over the volume of contaminants that will be discharged into the receiving environment from the proposal, and the certainty of this occurring. This is a key factor to consider when weighing up the overall effect that the proposal will have on water quality. Further details on the limitations used to model losses are discussed in section 5.8.0 of this report, and in expert evidence provided by Ms Lovett, Ms Phillips and Ms Meares.

5.3.16 Having reviewed both the assessment of environmental effects in the application, the updated “water quality assessment”, and the expert evidence provided by Ms Lovett, I consider that there is a high probability that effects on surface and groundwater from the operation will increase, especially from specific blocks. While the overall losses from the proposed landholding may stay neutral or decrease in some areas, in others such as WW1 platform, WRO block and Horner block there will be a definite (isolated) increase. The causes of these increases are discussed further below in section 5.8.0.

5.4.1 *Effect 3: Soil health effects*

5.4.2 Effects on soils may occur during increased intensification of farming through agricultural effluent discharge, fertiliser inputs, compaction or pugging from additional cows on paddock, through cultivation, cropping and IWG. Land management practices within these activities can have a significant impact the effects that occur on the soils, and in particular on the preservation or enhancement of a soils structure. This, in turn influences hydraulic connectivity of the soil and water transportation methods.

5.4.3 In the case of this application, the soils across the landholding are largely a silty loam or clay texture. These soil types, identified as the Braxton and Tuatapere soils generally have a moderate to slow drainage profile and a large Profile Available Water capacity which defines the soils’ ability to hold water. The topography of the run-off block includes areas of steeper land, which can lead to the loss of sediment especially when there is little pasture cover and during adverse weather conditions, such as during periods where these blocks are intensively winter grazed.

5.4.4 The effluent disposal field will be 447 hectares, including the Horner block. Under the proposal, the total proposed effluent field will be covered by two discharge permits – 350 ha at WW1 and WW2 and 97 ha at Horner block. This is area greater than the area required to meet the minimum requirement for stocking rates of 4 hectares per 100 cows, which is calculated to achieve a maximum loading of 150 kg of nitrogen/hectare/year from effluent irrigation. It is also more than the 8 hectares per 100 cows as recommended in the Best Practice Guidelines Booklet[5] . As previously detailed, the Horner Block loading does not meet GMP practices.

---

[5] Farm Dairy Effluent, Best Practice Guidelines (2007), Environment Southland

5.4.5 There are several different soils in the disposal area with the predominant risks for contaminant losses to the environment being via artificial drainage, deep drainage and overland flow.

5.4.6 Provided the effluent is applied at the appropriate rate and depth effluent can act as a fertiliser providing nutrients to aid pasture growth and therefore soil health and available nutrients should be maintained and enhanced and the application concludes on page 132 of the AEE that *"there is little to no risk to the life supporting capacity of the soils at WW1&2 or the Horner block due to the effluent discharge activity"*.

5.4.7 Despite this conclusion, the AEE does not specifically address soil health separately in relation to effects from the proposed intensification, with the exception of nutrient budgets and the proposed mitigations.

5.4.8 The updated application and associated reports has only updated aspects of the proposal relating to water quality, rather than soil effects.

5.4.9 I consider that the explanation for soil health effects to be unclear in the application, and instead I have relied on the expert advice provided by the PDP review in forming my opinion on soil health effects.

5.4.10 Technical advice on the soils on the property from the review details that key effects relating to soil are as follows:

- *Possible increase to the Nitrogen surplus present in the soil, resulting from an increase in stocking rate and the associated inputs required.*
  The increased stocking rate and the associated feed demand, through pasture or supplementation, has the potential to increase the N surplus present in the soil. Nitrogen surplus is the amount of N input into the farm that is not converted to product; therefore, it is at risk of loss through leaching, volatilisation and gaseous loss. An increase in the N surplus, usually represents a reduction in the N efficiency on a property. DairyNZ (2018) report that Soil N in surplus is vulnerable to increased risk of loss from the system via leaching; the whole-farm risk of leaching increases by 0.2 to 0.4kg N/ha for every kg increase in the N surplus.

- *Potential for structural damage: Surface damage to the soil resulting in increased occurrence of run-off, or surface ponding which induces matrix flow through saturation of the soil.*
  Overland flow (run-off) occurs when the infiltration rate of the soil is exceeded and there is enough slope to enable lateral water movement. The energy generated by the run-off can pick up exposed sediment or contaminants sitting at the soil surface, the mobilised soil particulates typically will have soil nutrients, such as Phosphorus (P) bound to the colloids. As discussed, clay-rich soils tend to be prone to pugging, particularly with heavy stock classes; pugging can increase the occurrences of run-off by reducing infiltration rates.

5.4.11 Reduced infiltration rates then exacerbate any overland flow processes occurring and when coupled with an exposed soil surface after winter grazing there can be an increased susceptibility for nutrients bound to sediment to run-off. It is noted that in the documentation supporting the applications the topography is largely flat to very flat some depressions. Flat topography will reduce the risk of run-off, by allowing water time to pond and infiltrate down to groundwater through the soil profile.

- *Bypass flow of surface contaminants such as Farm Dairy Effluent, fertiliser or other surface contaminants and nutrients transmitted directly to the groundwater via the cracks.*
  The proposal will result in an increased generation of farm dairy effluent. The cracks and fissures created when the clay-rich soils are dry provide a more direct pathway for contaminants in FDE, fertilisers or any other surface contaminant to drain directly to the groundwater, without the natural filtration the soil matrix typically provides.

5.4.12 Drainage will naturally occur when rainfall increases soil moisture levels to beyond field capacity, and can also be induced by poor irrigation or FDE application practices. Induced exceedance of the soils field capacity will increase the probability of FDE applied to the surface of clay soils, prone to cracking, being transmitted rapidly through the profile. FDE or fertilisers applied to the soil surface in advance of a significant rain event will be at an increased risk of transmission.

5.5.0 *Effect 4: Effect on drinking water supplies*

5.5.1 The application details that no effect will occur on the respective drinking water supplies in the catchment of the WW1 and WW2 properties due to the land use intensification proposal, however expert evidence provided by the Lovett report contradicts this view.

5.5.2 The report describes that land use processes from WW1, WW2 and Horner block properties have the potential to effect water quality of the groundwater supply for Heddon Bush School due to the abstraction from an unconfined aquifer, the relatively shallow depth of the bore, and close proximity (2 km downstream) to the properties.

5.5.3 The report also concludes that operations on WW1, WW2, and Horner block properties have the potential to influence water quality at Drummond School and the Invercargill City Supply through cumulative loading as both these sites are in downstream groundwater and surface water environments, respectively.

5.5.4 It is worth noting that both Public Health South and the Ministry for Education have submitted in opposition against the proposal due to the potential effects on the schools drinking water supply, and wish to be heard on their position. Further details on these submissions are detailed in section 6.4 of this report.

5.5.5 Available water quality results for the Heddon Bush School water supply were analysed in the application to show the current trends in water quality for the school bore.

5.5.6 Concentrations of bacterial parameters were consistently reported as “absent” or below detection levels but the single sample provided to show groundwater quality indicated likely impact from land use processes including elevated nutrients. Additional groundwater quality results for Heddon Bush School would be required to provide a more reliable determination of groundwater quality at the site. Due to a lack of information or evidence provided with the application, there is also an increased level of uncertainty regarding the effects of the proposal on the Heddon Bush School water supply.

5.5.7 Despite the few samples from the bore I consider that the proposed intensification on the WW1 side of the proposed platform is likely lead to an increase in contaminants lost to the groundwater aquifer where the schools drinking water is sourced, due to the high risk soils for nutrient leaching and the increase in cow numbers carried on the land for the majority of the year.

5.5.8 Surface water quality results for the Invercargill Water Supply at Branxholme on the Oreti River showed impacts from land use within the catchment. In particular, there was high concentrations and high variability in bacterial presence, including 10–5,000 cfu/100 mL for *E.coli* and 10-7,000 cfu/100 mL for faecal coliforms. In comparison, nutrient concentrations were lower, and ranged from 0.36–3.10 mg/L NO_3-N and 0.53–4.8 mg/L for total nitrogen.

5.5.9 I consider that as the surface water quality in the Oreti River is already degraded, and that it is likely that losses will increase from the WW1 platform, the operation will have an effect on the cumulative loading in the Oreti River, and therefore, the water supply for ICC in a cumulative sense, however this is difficult to quantify to what extent.

5.5.10 I consider that land use on the properties is unlikely to influence water quality of the Otautau supply since the bore is located in the Upper Aparima groundwater zone, on the opposite side of the Aparima River to the dairy platforms, and is not located down-gradient of the properties.

5.6.0 *Effect 5: effects on groundwater quantity*

5.6.1 The effects of increased abstraction from the aquifer under the proposal should be considered in the context of effects on other users, effects on the groundwater system, and, since groundwater from the aquifer discharges as baseflow into Waimatuku Stream, the effects of abstraction on surface water quality and quantity of the stream should also be considered.

5.6.2 Insufficient information was provided in the application to provide an adequate picture of the actual effects of this part of the proposal. Further information was requested from the applicants on this point.

5.6.3 The application proposes that *"The rate of take does not exceed 2 l/sec and should not result in more than minimal stream depletion and interference effects"*.

5.6.4 I consider that the take does slightly exceed 2l/sec, and as such further investigation into potential or actual effects is required.

5.6.5 While I do not consider that currently there will be any cumulative effects on allocation from the proposed increased water take, nor will it result in over-allocation as the aquifer is within the allocation as set in the relevant plans. However, due to lack of supporting evidence provided I cannot say if there will be any localised effects from this activity.

5.7.0 *Effect 6: cumulative effects*

5.7.1 The granting of the application would authorise the following increases in inputs into the environment, from which environmental effects cumulatively would likely occur:

- 30% increase in cow numbers from 540 cows to 700 cows at WW1;
- 10% increase of cows to be held in wintering barns over the winter months to 1,250 (from 1,140);
- 1.1% increase in total cows in the Middle Creek sub catchment from 12,622 to 12,782;
- an increase in agricultural effluent generated and discharged to land from 1,500 cows (an increase of 160 cows), and to discharge agricultural effluent from 1,250 cows to the Horner block;

- an increase in fertiliser used, to enable additional grass to be grown to support the additional cows;
- an increase in IWG on WRO from 50 ha to 100 ha on WRO.

5.7.2 When considering cumulative effects from a proposal I am required to assess the effects upon the wider receiving environment while also considering all other factors that have an impact on water quality in the respective catchments. As detailed in the description of the existing environment earlier in this report the affected catchments are already significantly impacted by other farming land uses in the area due to cumulative loading of contaminants.

5.7.3 The assessment of cumulative effects contained in the application largely relies on modelled outputs from Overseer. As discussed further below in this report, while Overseer is a useful tool in estimating losses from an activity, it does not inform actual effects.

5.7.4 The budgets have included IWG modelled on SH96/M in the present situation which is not part of the existing environment, as this activity on this block of land was removed as a mitigation for the land conversion in 2017 from support block to dairy platform.

5.7.5 The budgets provided with the application only detail operations until 2017. The updated nutrient budgets detail that the 2017-2018 and 2018-2019 farming years have not been modelled or provided, as the applicant has already bought and is farming the additional cows over what is allowed by the farms discharge permit, and this would mean that the losses would be inflated (see page 7 paragraph 1 of WW1&WW2 nutrient budget).

5.7.6 From a planning perspective, this places a far greater uncertainty on the modelled results reflecting actual losses from the proposed activities, and makes it more difficult to determine the cumulative effects of the proposal. The modelling also effectively gives the application the opportunity to “double dip” for activities that are not in the existing environment by showing increased losses that are not legally allowed to occur.

5.7.7 The results from the nutrient budgets have been used to calculate the proportional percent of loading from the proposal into the affected estuaries, and I accept that the use of these calculations is a helpful addition to the application and follow a reasonable method.

5.7.8 The application concludes that there will be “minimal” effects, however this is not supported in regards to consideration of the current (very poor) condition of the New River Estuary, Jacobs Estuary or the Waimatuku Estuary. As previously discussed, the calculation of loading to Waimatuku catchment is based on Overseer outputs, which have a high level of uncertainty. The conclusion that there will be ‘minimal effect or improved water quality’ is not factually supported in the application.

5.7.9 A significant omission from the applications cumulative effects assessment is that there is no consideration of the effects from proposed activities at the Horner block. A considerable amount of effluent/sludge is discharged at this landholding (243 kg/N/Ha/yr), which is likely to have significant impact on surface and groundwater environments.

5.7.10 In addition, there is no assessment of cumulative effects mentioned regarding the proposed increase in groundwater abstraction.

5.7.11 Overall, I consider that the cumulative effects of the proposal will have a significant effect on the receiving environment, due to the already degraded nature of the waterbodies and estuaries, the likelihood of losses increasing from the proposal on WW1 platform, and the increase in IWG on the WRO blocks.

5.8.0 Actual and potential causes

5.8.1 I consider that the key causes from the proposed operation will all contribute in some way to the effects that have been discussed above. Most of them are either currently consented, or are currently permitted activities under the plan rules. Either way, they are allowed to occur within the exiting environment and do currently influence the receiving environment. In other words, these effects are expected to some extent and the relevant planning framework anticipates them, if the activities causing them meet permitted activity criteria. If an effect is related to a consented activity, it is expected that that effect has been adequately assessed through the consenting process, and the Council has deemed it acceptable, usually subject to conditions.

5.8.2 Through an application to intensify the current operation, Policy 39 of the proposed Southland Water and Land Plan needs to be applied which directs me to consider all effects on water quality from an activity, whether or not the proposed Plan permits an activity with that effect.

5.8.3 All potential or actual causes are summarised as follows:

1. increased cow numbers on the dairy platforms and support blocks, in particular from the operational block of the WW1 platform, causing an increase in contaminant losses;
2. increased incidental discharges from farming;
3. an increase in agricultural effluent discharge, causing increased losses;
4. an increase in groundwater take, causing aquifer depletion;
5. the suitability of the effluent systems;
6. the grazing, including intensively on crop over the winter months, of dry stock, including young stock, breeding stock and replacement cows at WRO;
7. the application of fertiliser to pasture;
8. Cropping and cultivation of pasture;
9. Silage storage and leachate.

5.8.4 I have not discussed all of the above points in further detail below, instead I have only discussed the main causes of effects from the proposal. Others are discussed more generally in the GMPs and mitigations section at section 6.

5.9.0 *Cause 1: increase in cow numbers on the dairy platforms and support blocks*

5.9.1 The application seeks to increase their herd size of milking cows by 160 additional stock. The nutrient modelling has spread these cow numbers over both dairy platforms. Operationally, the increased cows will be located solely on WW1's platform. There are no changes proposed on WW2's platform. However, the dairy platforms have been modelled as a sole landholding, which allows (in a theoretical sense) the losses resulting from the increased cows on WW1 to be distributed over both platforms. In reality, these losses will not be distributed over both platforms and will solely occur from WW1. No additional land is proposed to be added to the operation.

5.9.2 The additional cows increase the size of WW1's operational milking herd by 30% and increase the combined WW1 and WW2 herd size by 11% over the whole landholding.

5.9.3 While the modelling of the nutrient budgets has been completed with the two dairy platforms modelled into a conjoined platform, in reality, I do not consider that it is appropriate to essentially "spread out" the cows on paper. Furthermore, this is not what will operationally occur as the additional cows are proposed to be located entirely in WW1.

5.9.4 I consider effects caused by the additional cows the main issue with the proposal because it forms a key point of difference between what is currently occurring in the existing environment compared to what is proposed to occur.

5.9.5 Intensification of cows grazing on land will mean there is an increase in urine and dung deposited on paddocks during the milking and shoulder seasons.

5.9.6 Simply put, more cows on paddocks, especially when intensively farmed, generate contaminants which can cause localised and widespread contamination of receiving waterbodies. Nitrogen, phosphorus, sediment and microbial losses all enter receiving environments through various pathways. Due to the soil's types, topographic and geological settings of the properties related to this proposal, the main contaminant pathways, as detailed above in the "receiving environment" section mean that both groundwater and surface water bodies are at risk of contamination.

5.9.7 The actual effects that these contaminants have on the receiving environment depend on the volume and length of time which they are discharged to a receiving environment.

5.9.8 Additional cows on land can also have effects on soil health, through structural damage. Structural damage through compaction or pugging, can affect moisture infiltration and result in increased surface run-off and loss of fertile topsoil.

5.10.0 *Cause 2: an increase in agricultural effluent discharged to land*

5.10.1 The application details that cows of milking age will be housed in barns over the winter months and during adverse weather events. During these times, there will be an increase in agricultural effluent generated to be disposed of from the wintering barns. Over the summer months, there will be an increase in effluent collected in WW1's milking shed, due to the additional effluent generated by more cows moving through the milking shed.

5.10.2 The application details that slurry wagons with trailing shoe technology will be utilised to discharge on the Horner block, and travelling irrigators on the dairy platforms. Low rate pods are also proposed to be installed in future, but it is not clear when or where these will be installed. I consider that the slurry wagon discharge method is suitable for discharging the effluent and the applicants are to be commended for this, however I do not think, with the proposed loading to the Horner block, the use of them will mitigate all the effects from the discharge.

5.10.3 Compliance history for the dairy platforms suggests that there have been several instances of non--compliance with the current discharge permit, and that they have not always operated in accordance with GMP. Careful operation of the travelling irrigators will be required to avoid over application, especially when more effluent is generated and will be required to be discharged.

5.10.4 In my opinion, the application does not adequately assess the impact from the increase in volume of effluent proposed to be discharged across the entire platform and the Horner block. This is especially important on the Horner block, as the discharge here is likely to have increased effects due to the increased loading. Due to the lack of analysis and evidence in the application regarding the actual and potential effects from the increased effluent discharge, (which is detailed in the application from page 120 of the application), I have instead relied on evidence provided in the Lovett report to form my opinion.

5.10.5 Due to the additional effluent generated, and the significant loading rates proposed for the Horner block, I consider that the effects of the discharge will be more than are currently consented, particularly as the proposed loadings are in excess of the current loadings authorised by the applicant's respective consents.

5.11.0 *Cause 3: an increase in groundwater take*

5.11.1 The proposal seeks to increase the amount of water taken from bore E45/007, on WW1 platform, to support the increase in cow numbers here. The application provides insufficient information on aquifer drawdown effects or stream depletion effects for me to make an overall determination on what the possible effects could be from this activity. A further information request has been issued on this point.

5.11.2 Expert evidence provided in the Lovett report detailed that groundwater monitoring in the area indicated lower groundwater levels in summer, likely as a result of increased abstraction and decreased rainfall recharge during the summer period. It is not known what, if any effects the proposal will have on aquifer levels.

5.12.0 *Cause 4: Intensive winter grazing*

5.12.1 While the proposal is to house the majority of the milking herd and some young stock in the wintering barns over the winter months, the proposal still includes a significant amount of IWG. It is widely accepted that IWG is a key cause of sediment and other contaminant loss to waterbodies due to the complete devegetation and exposure of bare soil over the winter months, when adverse weather events occur. GMPs can reduce these losses, however the impact of this specific activity is still significant and difficult to mitigate without removing completely.

5.12.2 Under the proposal IWG on the WRO block will increase from 52 ha to a maximum of 100 ha or 72ha depending on what version of updates is considered. The application also details that "intensive winter grazing is responsible for more than 90% of the water quality issues in Southland". While I do not have specific evidence to adopt this figure, I do agree with the applicant that IWG is a key cause of losses of contaminants in Southland, and I consider that the IWG that will increase in intensity under this proposal is a key cause of additional effects which will arise.

5.13.0 *Cause 5: uncertainty regarding suitability of effluent storage pond on WW2*

5.13.1 WW2 uses a soil/ clay lined pond for the collection and storage of wintering and dairy shed effluent. This is a key mitigation in the application for the effluent discharge.

5.13.2 The effluent storage pond on WW2 is in poor condition and I have significant concerns around the structural integrity of the pond in its current form. The pond was subject to a separate consent application to legalise its use, which had also been publicly notified and was to be heard concurrently with the hearing for this application. This application has since been withdrawn and the applicants have indicated that they will apply for a further consent for the reconstruction of the effluent pond, which will include relining the pond with a HDPE synthetic liner. At the time of writing this report a new application has been received by council but not yet accepted under S88.

5.13.3 A number of concerns were raised with the testing undertaken to demonstrate the suitability of the pond for storing effluent. The pond was signed off by Dairy Green Limited as having no visible cracks, holes or defects, in spite of the assessor noting defects in the lining of the pond during a previous visit to the site. Similar defects were noted during my site visit on 20 June 2019.

Figure 5.13.4: Rocks visible protruding from pond liner indicating erosion of the liner

5.13.5 At this stage a subsequent application to reline the pond with a synthetic liner has been received but not yet processed and as such the effects of storing effluent in an unsuitable effluent pond need to be considered. Due to the condition of the pond accompanied with the inadequacy of the testing and assessments undertaken on behalf of the applicants and the age of the pond itself, I consider that the effects from the ongoing use of the pond will likely be more than minor. There are obvious defects in the integrity of the liner and there is no guarantee the structure is not leaking. Consequently, there is no certainty or evidence provided to indicate that groundwater is not being affected.

5.14.0 Other factors

5.14.1 In this section I describe other relevant influential factors that need to be considered as they form an essential part in understanding the likely and actual effects arising from the proposed activity. Should the proposal be granted, these factors also need to be considered to formulate conditions of consent.

Factor 1: Uncertainty around the relevance and accuracy of modelled losses shown by Overseer

5.14.2 While modelled contaminant losses do not tell us what the effects of the proposal will be, they are useful in providing some context towards understanding the effects, both quantitatively and qualitatively. The nutrient budgets for the proposal have been reviewed in the Irricon review.

5.14.3 Limitations of the model with relevance to the accuracy of the assumed output have been detailed in the nutrient budgets for the dairy platforms and I am able to adopt these limitations from the application. The budgets state the key limitations of the Overseer model are:

- Overseer does not predict transformations, attenuation or dilution of nutrients between the root zone or farm boundary and the eventual receiving water body;
- Overseer uses long-term average climate data and therefore does not account for climatic extremes;
- Overseer does not calculate the impacts of a conversion process, rather it predicts the long term annual average nutrient budgets for the changed land use;
- Overseer is not spatially explicit beyond the level of defined blocks;
- not all management practices or activities that have an impact on nutrient losses are captured in the Overseer model.

5.14.4 Overall, I consider that the budgets completed for the proposal have a high degree of robustness and have been modelled in accordance with best practice using the inputs provided to the CMNA, using five years of evidence in the form of fertiliser receipts and Fonterra milk output data. The Horner block budgets and WRO budgets have not been completed using five years of actual data.

5.14.5 The nutrient budgets contained in the application detail that the key drivers affecting nitrogen loss under the proposal are:

- removal of winter and summer crop;
- removal of cows wintered outside on crop or grass;
- expansion of the size and use of the wintering barns facilities;
- more efficient use of nitrogen fertiliser.

5.14.6 The nutrient budgets contained in the application detail that the key drivers affecting phosphorus loss under the proposal are:

- decrease in winter crop area;
- maintaining Olsen P at a target of 30;
- expansion in the size and use of wintering barn facilities (less wintering).

5.14.7 While I consider that the budgets have been calculated correctly, the proposed scenario has been modelled for what the applicants consider to be the “landholding” – WW1 and WW2 combined, minus the Horner block and WRO – and shows a slight reduction in losses overall across these combined blocks. This approach to the modelling means it is not possible to examine any change in contaminant losses that may occur on WW1, where the proposal’s additional cows will be located. In my opinion the environmental effects of localised losses on WW1 are important to consider, but the approach taken in the nutrient modelling frustrates this to some extent.

5.14.8 In regard to the existing environment modelled in Overseer, key drivers that have been detailed in the budgets do not actually make up the “existing environment”. An example of this is the applicants' proposal to remove IWG and crop from WW2 M/SH96 block. Legally, IWG and cropping ceased on these blocks when WW2's consent for intensified dairying was exercised in 2017, as the conditions of that consent precluded these activities. As such those activities do not cannot form part of the existing environment and cannot legitimately be used to transfer greater losses from another part of the operation. This is detailed further in the mitigations section (6) of this report.

5.14.9 As detailed in my planning assessment and in expert evidence[6] [7] [8] calculated losses for the operation are unlikely to be accurate. The main reasons these losses are unlikely to be depicted accurately above the standard Overseer limitations are:

- the combined modelling across the two platforms, despite increases only occurring on WW1;
- the past two years of farming operations has not been modelled;
- the modelling of IWG on WW2 SH96/M blocks, which does not form part of the existing environment;
- swell crack properties of the Braxton soils and the uncertainty of the ability of the model to assess these;
- the baseline losses are missing the most recent two years and older inputs have been calculated in an older model of Overseer, so the two are not comparable.

5.14.10 Despite these issues, I do not think that there is likely to be an increase in contaminant losses or environmental effects arising from the WW2 operational platform, as there are no proposed changes on this platform.

5.14.11 Further uncertainty exists with the modelled losses and effectiveness of the applicants' proposed and existing GMPs and mitigations. This is because some of the GMPs and mitigations incorporated in the modelling are not currently occurring.

5.14.12 Overseer assumes that GMPs are in place when modelling losses, both for the status quo or existing environment modelling and future proposed scenarios. On my site visit I saw that some GMPs and mitigations incorporated by the applications Overseer modelling were not occurring. This is an additional factor that adds uncertainty to the calculated losses.

5.14.13 Further, some practices occurring on the property and modelled in Overseer are presently being undertaken illegally. As such, losses are overstated compared to what should have, and could have been legally occurring. Then when compared to the modelling for the proposed scenario, the calculated decrease in losses may not be correct. As such, solely relying on the modelled losses to argue that an improvement in water quality will occur (as argued in the application) would not be appropriate as this will effectively give the applicant credit for proposing to operate lawfully without introducing any actual mitigations. Simply removing unlawful practices is not a mitigation.

5.14.14 Expert evidence provided by Ms Lovett, Ms Meares and Ms Phillips provide further detail on the shortcomings of Overseer and the possible implications for this application.

---

[6] Lovett A., 2019. Review of Resource Consent Application by Woldwide One Ltd. and Woldwide Two Ltd. Earth & Environmental Science Report 2019/02, prepared for Environment Southland Regional Council.

[7] Phillips N., 2019. Technical Review of Overseer Nutrient Budgets, prepared for Environment Southland Regional Council

[8] Meares B., 2019 Review of Resource Consent Application by Woldwide One Limited and Woldwide Two Limited, prepared for Environment Southland Regional Council

5.15.0 *Factor 2: What makes up the proposal's "landholding"*

Landholding summary

5.15.1 In order to determine what effects from the proposed activity will be controlled by the land use consent for farming (if granted), the commissioners will need to make a determination regarding what constitutes the operation's "landholding".

5.15.2 In this section I have detailed the various companies that are in play for this operation, what their roles are and what effects are transferred as I understand it. I have then drawn a conclusion for what I believe to be the applicants' landholding from a planning perspective under the pSWLP.

5.15.3 When assessing this proposal, I have determined that the following constitutes the applicants' landholding:

- dairy platforms at WW1, WW2, WW3, WW4 and WW5;
- the Gladfield block;
- the Horner block;
- WRO – Merrivale and Merriburn.

These properties are shown on Figures 5.15.10 and 5.15.11 below.

5.15.4 What has been applied for in this application, and related application APP-20191140 for WW4 and WW5, differs from the conclusion I have reached for the entirety of the landholding. This is because, despite the fragmented approach that the both applications take to the operations, I have found that when assessed through a planning lens using the definition of landholding in the pSWLP that the entire of the WW operation goes beyond the fragments that have been applied for in this application and are all inextricably linked. Breaking the platforms into separate landholdings as has been applied for, in my opinion does not meet the intention of the pSWLP when accounting for landholdings. I do note that the application contradicts itself in several places, as in some areas it does detail that the WRO block and Horner block will form part of the landholding (see page 48 of the application).

5.15.5 It is important to note that all effects from the proposed operation are required to be considered, regardless of what is determined to be within the landholding. Despite where I have arrived with my view of the landholding from a planning perspective, I acknowledge the applicants' right to apply for aspects of their farming activity separately, and as such I have assessed the applications and their associated effects as presented to me in the respective applications.

5.15.6 I consider that most of the activities applied for under the application operation could conceivably be consented as outlined in the consent applications for the respective dairy platforms, such as land use for wintering barns and effluent storage.

5.15.7 The issue arises when considering how the conditions of consent (if granted) will ensure that the activities of land use for "farming" are appropriately controlled, especially in the absence of an application for the farming activity for WW3. I consider that if resource consent for land use for farming is granted, the commissioners have the following options available to them:

- consider the applications as presented by the applicants, with three fragmented land use consents "farming activities" on three separate "landholdings". This approach would exclude the WRO block from being part of the landholding and may limit the ability to impose conditions relating to effects on the environment from the WRO block. In my opinion this option would not achieve the intention of the pSWLP when considering the definition of "landholding";

- consider the applications as presented but determine that the landholding is the entirety of the WW operation including the farms that I have outlined above. In essence, this would require the two current applications to be considered together. If they are minded to grant consent, the commissioners could grant the separate consents sought for the "farming activities" described in the applications, but impose consent conditions relating to the entire "landholding".

5.15.8 The second of these options, in my opinion, is the most appropriate for these applications. However, in the absence of the inclusion of WW3 into this proposal, it would require the construction of conditions that allow for the inclusion of those activities at such a time as a proposal is made.

5.15.9 I consider that in this instance, not considering the two applications together would be inappropriate, as the effects of exercising the two land use for farming consents (should they be granted) would overlap and would have consequential or flow-on effects that are not distinct from each other.

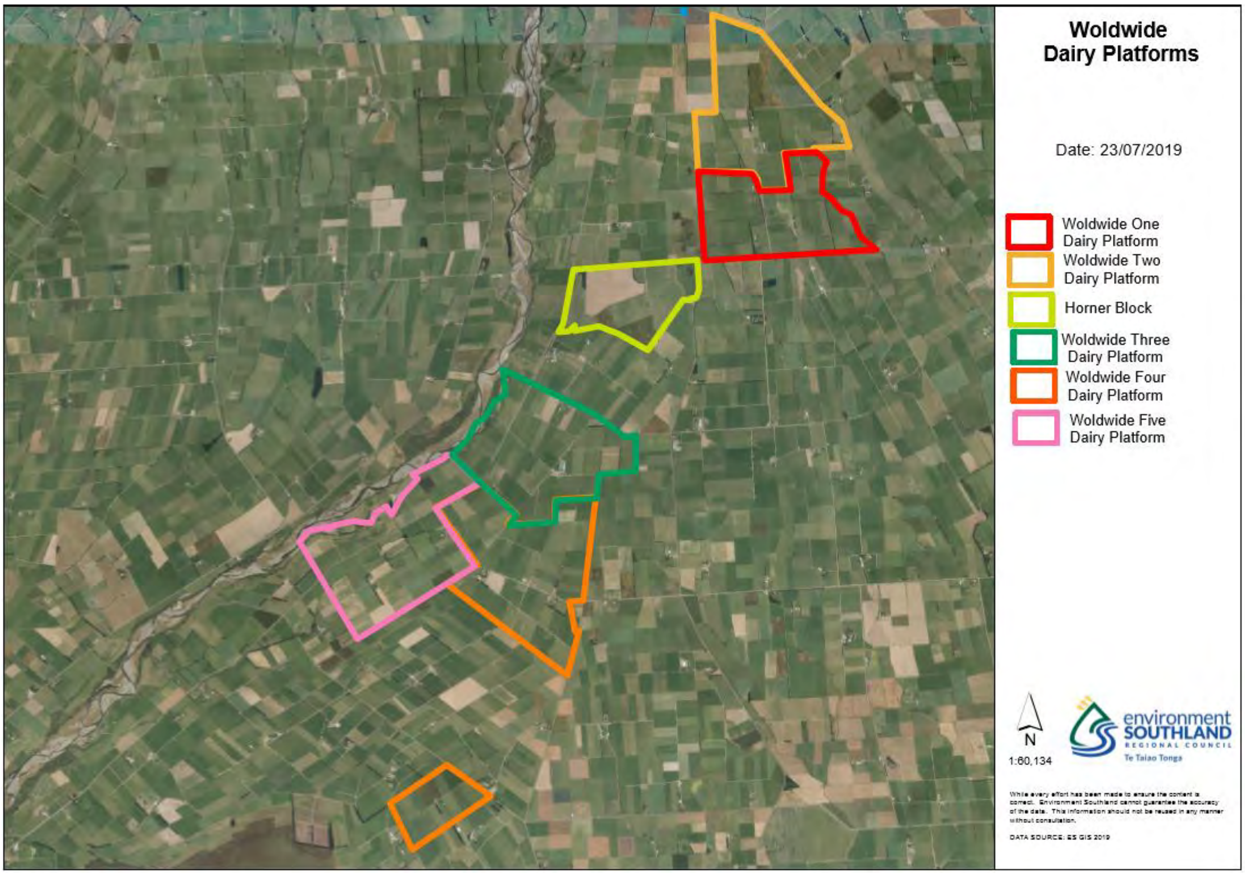


Figure 5.15.10: Location of WW3, WW4, WW5 and Gladfield block property boundaries and surface water catchments. I consider that these three blocks that are pictured, together with WRO blocks make up the landholding for this proposal

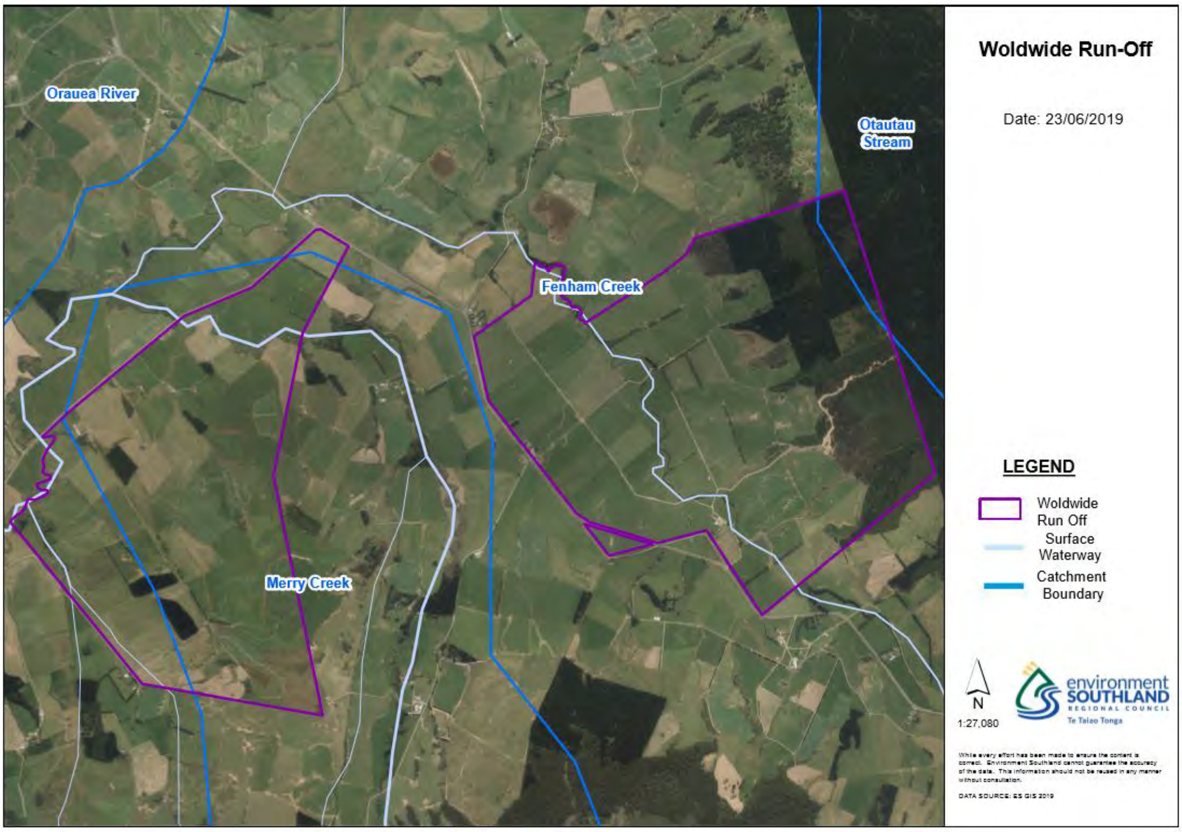


Figure 5.15.11: Location of the WRO block

Analysis

5.15.12 My reasoning for my conclusions on the landholding is as follows:

Landholding is defined by the proposed Southland Water and Land Plan as (my emphasis added in underlined areas):

(a) any area of land, including land separated by a road or river or modified watercourse, held in one or more than one ownership, that is utilised as a single operating unit, and may include one or more certificates of title; except

(b) for land with a residential, commercial, industrial, infrastructural or recreational zoning or designation in the relevant district plan means any area of land comprised wholly of one Certificate of Title or any Allotment as defined by Section 218 of the RMA.

The definition is accompanied with a note which states (my emphasis added in underlined areas):

Note: *For the purposes of this definition, a "single operating unit" may include, but is not limited by, the following features:*

(a) it has effective control by any structure of ownership of the same group of people (for example, land that is controlled by a family trust, or beneficiaries of that family trust or a related group of companies, or an estate, or partner, or individual/s or a combination of); and

(b) it is operated as a single business entity.

5.15.13 The key issue is whether each application relates to a “single operating unit” or whether the whole operation is a single operating unit. As the note above indicates, two considerations for determining if an area of land is a single operating unit are shared ownership or control and whether the land is operated as a single business entity. In my opinion, other helpful considerations include whether operating units can function separately without a material change to the farming system and whether the effects generated by operating units are transferred between different areas. I address these considerations below.

Company structure and roles

5.15.14 Below I have attempted to break down the ownership structure of the related groups of companies, and the roles that all of the related companies offer to the proposal:

Table 5.15.15: Company structure

Company	Directors	Role of company to the proposal
Woldwide One Limited	Albert De Wolde Janita De Wolde	Provides dairy platform, effluent to platform and Horner block, young stock to WRO and owns WW3.
Woldwide Two Limited	Albert De Wolde Janita De Wolde	Provides dairy platform, effluent to platform and Horner block, young stock to WRO.
Woldwide Three Limited	Albert De Wolde Janita De Wolde	Not applied for, but transfers effects between all other related properties.
Woldwide Four Limited	Albert De Wolde Janita De Wolde	Covered by related application APP-20191140.
Woldwide Five Limited	Albert De Wolde Janita De Wolde	Covered by related application APP-20191140.
Woldwide Farm Limited (Horner block)	Albert De Wolde Janita De Wolde	Provides wintering of stock from WW1, WW2, WW3, WW4, WW5. Provides additional area to discharge agricultural effluent produced on the dairy platforms from WW1, WW2 and WW3. Provides fresh grass and silage to feed WW1, WW2 and WW3 stock.
Woldwide Run-off Limited (Owned by Woldwide Farm Limited)	Albert De Wolde Janita De Wolde	Provides IWG of stock from WW1, WW2, WW3, WW4, WW5. Provides grazing of young stock, dry stock and supplementary stock from WW1, WW2, WW3, WW4, WW5.

Company	Directors	Role of company to the proposal
		Provides cut and carry of feed to support collective stock on the platform.

5.15.16 As detailed in the application, the argument to exclude certain blocks from the landholding is that the blocks are under different ownership by different companies. These companies then buy, sell and offer goods and services to the other companies for their farming operations on those blocks. The view is that this model does not operate as a "single operating unit".

5.15.17 While I respect the applicants' view on this matter, all of the companies have the same ownership and control structure (i.e. all have the same directors and shareholders). While the companies are all strictly separate legal entities, Mr and Mrs De Wolde control and benefit from all of the related companies.

5.15.18 In terms of whether each company operates as a single business entity, I acknowledge that there is some differentiation between the companies as to the activities each undertakes, however, from the information provided to me I do not consider that they are independent businesses. From the evidence that has been presented, the various companies work together to undertake the overall farming enterprise for Mr and Mrs De Wolde, rather than providing grazing, feed etc to the open market.

5.15.19 Below I have only detailed the components that each company offers to the operation, based on what currently occurs within the farm system, and what is proposed moving forward. I have not detailed other services provided by the companies as I do not consider them relevant to this proposal.

5.15.20 As can be seen from the tables above and below, the related companies all add an essential component to the current and proposed operation. Without all of these components, the application would be materially different.

5.15.21 The table below also shows that environmental effects of each of the related companies and land areas are shared – supplement feed, effluent and stock grazing is transferred between all of the various farm components. This is important given the focus of the pSWLP's objectives and policies on "holding the line" on water quality. To achieve the objectives and policies, all actual and potential adverse effects on water quality must be considered and (if consent is granted) be appropriately managed by conditions. Such an approach is not possible if resource consents are considered in a fragmented way.

Breakdown of land ownership and use for this application

Table 5.15.22: Breakdown of land use for this application

Land and ownership	Use	Link to other parts of operation/effect transferred?	Essential to proposed farm system?	Part of proposed landholding?	Justification for inclusion to landholding
Horner block – owned by WWFL	Cut and carry operation of fresh grass and silage. Used as a discharge area for agricultural effluent from WW1, WW2, WW3	Nutrients are transferred between Horner block and the dairy platforms, through feed fed to cows, and back in the form of effluent spread on the block.	Yes	Yes	Without the Horner block the entire operation would not be able to operate as stated in the application. The application relies on nutrients to be spread on this block, without it, the losses would increase on the dairy platforms. The operation also relies on the feed generated on the block to sustain cows on the dairy platforms. WWFL is under the same ownership structure and control as WW1, WW2, WW3 with the same directors and shareholders. The Horner block is already consented as part of WW2 land use consent for dairy farming and has conditions restricting activities here.
Merrivale and Merriburn blocks – Owned by Woldwide Run-off Limited	Grazing and IWG of stock from WW1 WW2 WW3 WW4 WW5	Young stock are raised on WRO blocks up to the age of rising two years olds. This includes IWG. Dry stock are also grazed on the blocks.	Yes	Yes	Without the WRO the operation would not be able to operate as stated in the application. The application relies on stock being grazed on the block to keep losses lower on the dairy platform.

Land and ownership	**Use**	**Link to other parts of operation/effect transferred?**	**Essential to proposed farm system?**	**Part of proposed landholding?**	**Justification for inclusion to landholding**
					WRO is under the same ownership structure and control as WW1 and WW2, with the same directors and shareholders.
WW1	Dairy platform	*Effect transferred out:* Winter barn effluent – to Horner block *Effect transferred in:* Supplement – from Horner block *Effects transferred in and out:* Young and dry stock – to/from WRO	Yes	Yes	The proposal will see additional milking cows added to the dairy platform, which subsequently triggers Rule 20 in the proposed SWALP.
WW2	Dairy platform	*Effect transferred out:* Winter barn effluent – to Horner block *Effect transferred in:* Supplement – from Horner block *Effects transferred in and out:* Young and dry stock – to/from WRO.	Yes	Yes	The proposal relies on combining the two dairy platforms into one landholding. No additional cows will be milked through WW2's milking platform.
Cochranes Block – Owned by Woldwide Farm Limited	IWG of stock from WW1 and WW2	Milking aged cows from WW1 and WW2 (and other platforms) that do not currently fit in the wintering barns are grazed on this block. Young stock and support stock are also IWG on this block.	Yes	Yes	To be converted to dairy platform.
WW3	Dairy platform	*Effect transferred out:* Effluent – to Horner and WW5 (area overlaps with effluent from WW5) *Effect transferred in:* Supplement – from Horner Young stock and dry stock	Yes	Yes	See discussion further down this report.

Land and ownership	Use	Link to other parts of operation/effect transferred?	Essential to proposed farm system?	Part of proposed landholding?	Justification for inclusion to landholding
		Effects transferred in and out: Young stock – to/from WRO, and displaced from Cochranes to elsewhere? Dry stock – to/from WRO, and displaced from Cochranes to elsewhere? Cows IWG (some) – to WRO, displaced from Cochranes to elsewhere?			

Breakdown of land use for related application APP-20191140

Table 5.15.23: Breakdown of land use for APP-20191140

Land and ownership	Use	Link to other parts of operation/ Effect transferred?	Essential to proposed farm system?	Part of landholding?	Justification for inclusion to landholding
WW3	Dairy platform	*Effect transferred out:* Effluent – to Horner and WW5 (area overlaps with effluent from WW5) *Effect transferred in:* Supplement – from Horner Young stock and dry stock *Effects transferred in and out* Young stock – to/from WRO, and displaced from Cochranes to elsewhere? Dry stock – to/from WRO, and displaced from Cochranes to elsewhere? Cows IWG (some) – to WRO, displaced from Cochranes to elsewhere?	Yes	Yes	See discussion below this table.
WW4 (including Gladfield)	Dairy platform	*Effect transferred out:* Winter barn effluent – to Gladfield *Effect transferred in:* Supplement – from Gladfield	Yes	Yes	The proposal will see additional milking cows and land added to the dairy platform, which subsequently triggers Rule 20 in the proposed

Land and ownership	Use	Link to other parts of operation/ Effect transferred?	Essential to proposed farm system?	Part of landholding?	Justification for inclusion to landholding
		(part of WW4 platform under proposal) WW1&WW2 youngstock housed in barns *Effects transferred in and out:* Young and dry stock – to/from WRO Phase 1, Cows IWG (some) – to/from WRO Phase 2, WW1&WW2 youngstock housed in barns			SWALP. The proposed barns for WW4 will house youngstock from WW1&WW2.
WW5	Dairy platform	*Effect transferred in:* Effluent – from WW3 Supplement – from Gladfield *Effects transferred in and out* Young stock – to/from WRO Dry stock – to/from WRO Young stock – to/from WRO Dry stock – to/from WRO Phase 1, Cows IWG (some) – to WRO and Gladfield (modelled) Phase 2, WW1&WW2 youngstock housed in barns	Yes	Yes	The proposal will see additional milking cows and land added to the dairy platform, which subsequently triggers Rule 20 in the proposed SWALP. The proposed barns for WW5 will house youngstock from WW1&WW2.
Merrivale and Merriburn blocks – Owned by Woldwide Run-off Limited	Grazing and IWG of stock from all dairy platforms	Young stock are raised on WRO blocks up to the age of rising two years olds. This includes IWG. Dry stock are also grazed on the blocks.	Yes	Yes	Without the WRO the operation would not be able to operate as stated in the application. The application relies on stock being grazed on the block to keep losses lower on the dairy platform.
Cochranes Block – Owned by Woldwide Farm Limited	IWG of stock from WW1, WW2, WW3, WW4, WW5	Milking aged cows from all WW platforms are IWG here currently. Young stock and support stock are also IWG on this block.	Yes	Yes	To be converted into dairy pasture and split between WW4 and WW5 dairy platforms

5.15.24 Given the above, in my opinion, the landholding in terms of Rule 20 of the pSWLP is the entire Woldwide farming operation. It has common ownership, works together for a single business purpose, its individual farms cannot function without the others and there is a transfer of environmental effects between the various farms. Simply put, stepping back and looking at the operation as a whole, it is not realistic to separate out the individual farms. As such, I consider that excluding the other blocks from the landholding for this application would not be consistent with the objectives and policies of the pSWLP, the intent of Rule 20, nor the definition of “landholding”.

5.15.25 WW3 does not form part of this proposal, however the farming operations occurring under the “WW3” umbrella appear to be inherently linked with the farming activities which are subject to this proposal. Due to these factors, I have found it impossible to consider WW3 as separate from the other WW operations and therefore conclude it is part of the landholding for this proposal. My reasons for this determination are as follows:

- there is a clear transfer of effects between the landholding subject to this application and the operations occurring on WW3, with three key practices that make it difficult to argue that WW3, WW4 and WW5 are not operating as a “single operating unit” as defined in the pSWLP;

- WW3 holds discharge permit AUTH-301665-V2, which permits the discharge of dairy shed effluent to land from 1,000 cows. The discharge area for this platform is extensive and spans several properties including the WW3 dairy platform (owned by WW1), the WW5 dairy platform (owned and/or leased by WW5) and the Horner bllock (owned by WWFL and subject to a separate application);

- the discharge area authorised by AUTH-301665-V2 (held by WW3) overlaps with the discharge area for WW5 on the WW5 dairy platform. The activity requires the transfer of effluent, and by virtue nutrients from the WW3 to the WW5 platform, and consequently a transfer of effects from WW3 to WW5. WW5 can then utilise the additional nutrients to support pasture growth and supplement fertiliser requirements;

- the discharge of effluent on WW5 will also attribute to the contaminant loss from the property and hence the farming activity for WW5 also. A clear distinction cannot be made that would provide a valid reason for WW3 to be excluded from the same landholding as WW5 (and as a consequence WW4 and WRO) and the application is completely silent on this matter and does not attempt to provide any form of evidence;

- WW3 also utilises WRO for the grazing, including intensive winter grazing of young stock and dry stock and has utilised Cochrane’s block (although unlawfully) for the same. The stock from WW3 are not kept separate from those from any of the other WW farms when located at WRO. WW3 relies on WRO to provide grazing largely for their young stock and without this land would either have to employ a third party grazier or purchase replacement stock. As such, this practice inherently forms part of their farming activity. As the stock from the various Woldwide properties at WRO are not kept separate there is no separation of goods and services offered by WRO to all the properties, nor is there a separation of effects from each “individual” farming activity. Consequently, this practice forms a single activity, and as such WRO is not utilised as a “single operating unit”.

- It is also prudent to note that WW3 has the same ownership structure as WW4 and WW5, specifically at the director level and as such is under the same effective control by a structure of ownership such as a related group of companies, as the rest of the landholding subject to this application.

- finally, in relation to WW3, Rule 20(a)(2)and(3) of the pSWLP only permits farming if:
  - the dairy platform had a dairy effluent discharge permit on 3 June 2016 that specified a maximum number of cows; and
  - cow numbers have not increased beyond the maximum number specified in the dairy effluent discharge permit that existed on 3 June 2016;

- due to WW3 utilising WW5's platform, and the cows proposed to increase on WW5, WW3 inadvertently trips this part of the rule;

- in addition to rule 20, cows from WW3 are currently illegally IWG on Cochrane's block without the required GMPs, so in turn triggers consent under Rule 20.

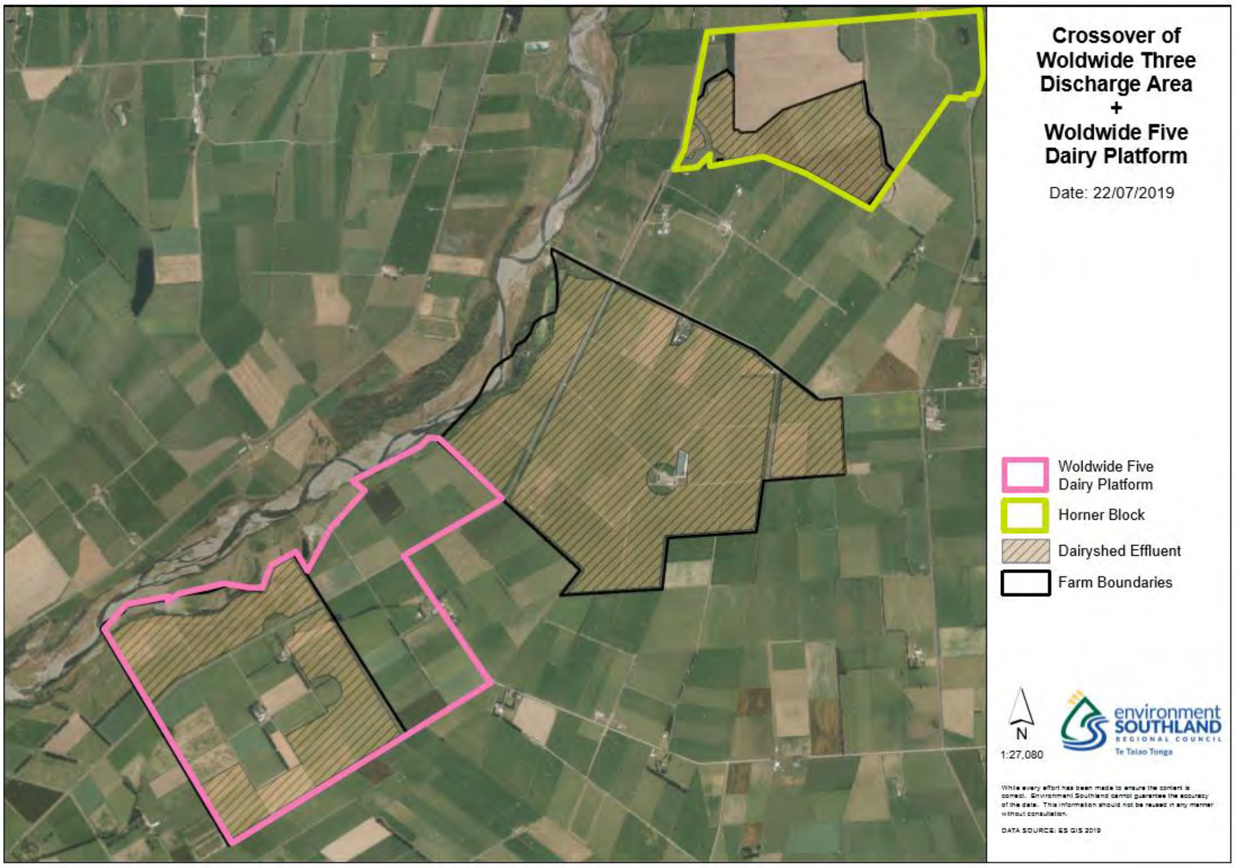


Figure 5.15.26: Woldwide Three Discharge Area

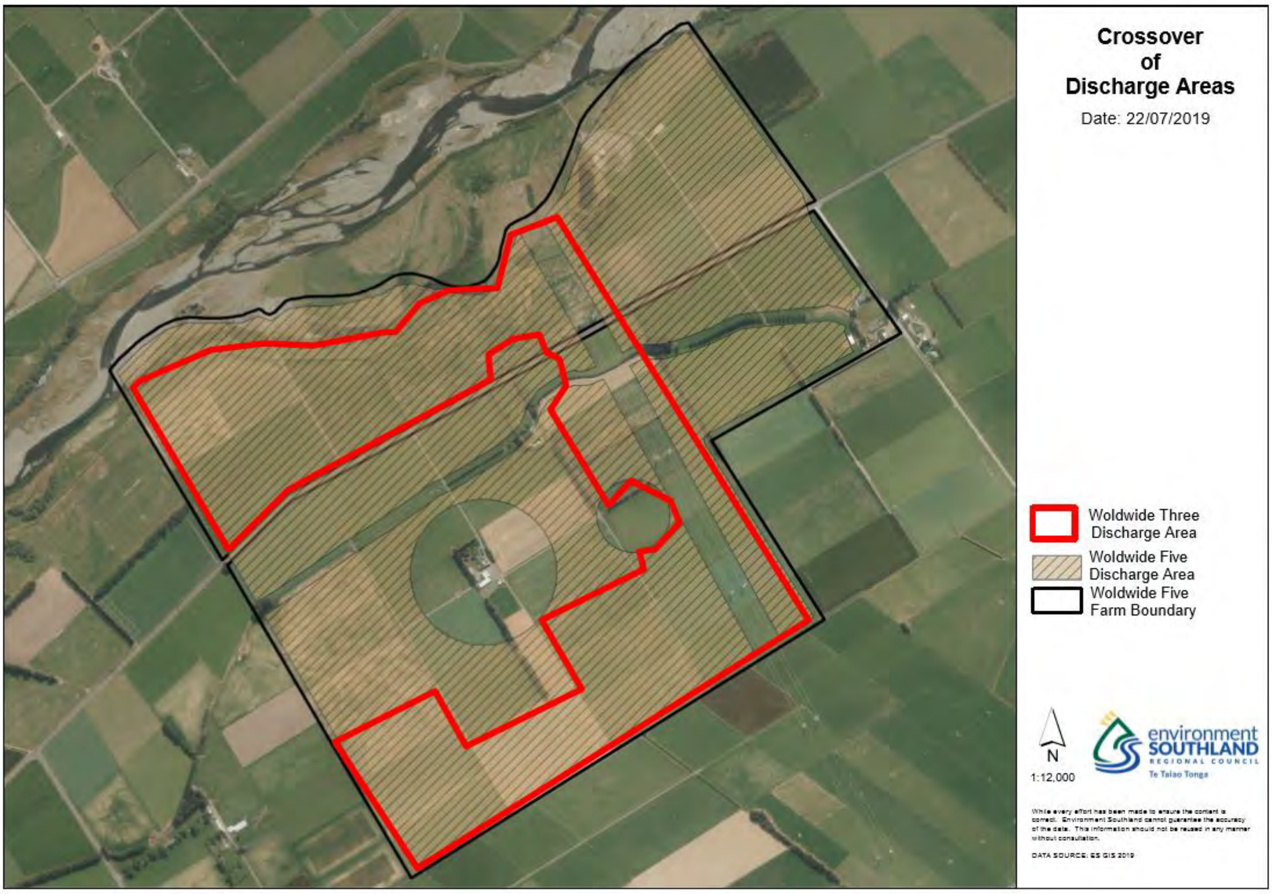


Figure 5.15.27: Overlap of WW3 and WW5 discharge areas

5.15.28 Aside from the other activities that are offered by WFL, there is no difference in links between all of the WW companies – for example, the links between WW1, WW2 and Horner block (subject to a separate but related application) and WW3, WW4, WW5 and WFL.

5.15.29 The application uses the same argument for joining WW1 and WW2 dairy platforms together into one landholding (despite the additional cow numbers only being added to WW1's side of the proposed operation), as it does to dismiss the other related blocks from the landholding. The proposed joining of WW1 and 2 platforms allows the applicants to "even out" and distribute losses over the two platforms (when the increased losses will only occur on one platform from the increase in cows) so the nutrient budgets show neutral or a decrease in losses, however, the application details that the two platforms that will be joined will still remain in separate ownership and at an operation level, will run completely independent of each other, with no transfer of effects between the two.

5.15.30 I also note that despite the majority of the application details that it is considered that WRO and Horner block are not in the landholding, the Horner block is considered part of WW2's farming platform under the current land use consent for "dairy farming" and the nutrient budget report for this application also considers the Horner block as part of the landholding.

5.15.31 In my view, it is not appropriate to effectively "pick and choose" when and how the "landholding" definition is able to be applied in this manner and when it is not, especially with such a high level of inconsistency within a single application. Aside from the other activities that are offered by WWFL, there is no difference in links between all of the companies – for example, the links between WW1 and WW2 and WW1 and WWFL. Using the applicants viewpoint on the landholding, if WWFL and WRO do not form part of the landholding for this operation, then WW1 and WW2 could not make up part of the same landholding either and the operations would need to be separated out into different land use applications for each dairy platform.

5.15.32 Further to the above, and to address additional matters that have arisen recently during the processing of the application, I detail the following:

5.15.33 I raised the above interpretation of "landholding" with the applicant at the informal prehearing meeting held on 9 August 2019. In response, Duncan Cotterill has provided a legal opinion on behalf of the applicant dated 22 August 2019. The opinion argues for a different interpretation of the definition of landholding and says that my interpretation is no reason for delaying the hearing. To be clear, the reason for raising the landholding issue was to give the applicant and its consultants an opportunity to consider my interpretation, not to delay the application. I do not consider it necessary to respond to all of the arguments raised in the legal opinion but address some key points below.

5.15.34 The Duncan Cotterill legal opinion relies on a narrow reading of the words "any area of land" to mean referring to a single area of land in the same location and reading the words "including land separated by a road or river or modified watercourse" as an exclusive list.

5.15.35 In my opinion, the words "any area of land" are not intended to refer to a "single" area of land in the same location. I do not consider that those words limit the definition only to adjoining or adjacent parcels land, as Duncan Cotterill seems to suggest. Instead, I consider that the definition includes any land (whether adjacent, adjoining or not) – the key issue is whether the area of land is utilised as a single operating unit. I note at paragraph 8.1 the Duncan Cotterill opinion argues its interpretation is reinforced by the words "single" and "unit" – however, those words relate to the operation, not to the area of land.

5.15.36 The definition of "landholding" is generally used by the proposed Plan to ensure that certain limits are fairly applied (and not taken advantage of). For example, the IWG conditions in Rule 20 of the proposed Plan allow IWG on no more than 15% or 100 hectares of the landholding, whichever is the lesser. If the definition of "landholding" were limited to "single" areas of land, applicants could structure their farming systems to maximise the amount of land available for IWG without a resource consent by having nearby, but non-adjacent blocks making up a farm. This would jeopardise the intent of the proposed Plan, including Objective 7 which seeks to avoid further overallocation for freshwater quality.

5.15.37 In my opinion, the words "including land separated by a road or river or modified watercourse" do not provide an exclusive list, such that land separated by other land does not fall within the definition. The definition of "landholding" expressly says "any area of land, including land separated by a road or river or modified watercourse" – that is an inclusive list and, in my opinion, cannot be read as excluding land separated by things not included in the list.

5.15.38 The Duncan Cotterill legal opinion refers to other rules or definitions that use the landholding definition and argues that they show my interpretation as unworkable. I disagree. For example, rule 49 provides for surface water takes as a permitted activity, providing that the take does not exceed $40m^3$ per landholding per day. I consider it is intended that each farming unit (regardless of whether the blocks are adjacent) are subject to that limit, rather than enabling each piece of land to take up to $40m^3$ per day without resource consent.

5.15.39 Overall, the Duncan Cotterill legal opinion does not change my opinion regarding the application of the definition of “landholding” to the WW farming enterprise

5.16.0 *Factor 3 – permitted baseline and S20A rights*

5.16.1 Further complexity arises when considering the relationship between S20A rights and the permitted baseline in regards to the Woldwide operation.

5.16.2 The operation holds multiple discharge permits for each of the WW platforms, which allows FDE to be discharged to land from a specified number of cows (with the exception of WW2 which also holds a consent for land use for dairy platform over the WW2 and Horner block platforms). It is important to recognise that a discharge permit authorises the effects from discharging effluent, not the effect of “cows on paddock”. Despite this, the application argues that currently the discharge permit in combination with Rule 20, allows for the dairy farming of cows and the incidental discharges from them are currently permitted under the current operation, until such time as the proposed additional cows and land are added to the operation.

5.16.3 The difficulty with this argument, which the application does not discuss, is that the other conditions of Rule 20 of the pSWLP apply to the existing farming operation and must be complied with if the cows are to be permitted and legally entitled to be present there. However, as has previously been detailed in this report, the operation has not complied with permitted activity rules because:

- the IWG is new, of a different scale and scope as has been carried out by the operation previously, and in a different location that the budgets specify will result in higher losses if IWG;
- all of the dairy platforms are affected by this as stock from all platforms are being illegally IWG on the Cochranes block; and
- More cows are on the platforms than are allowed by the discharge permits, also adding to the scale and intensity of the operation.

5.16.4 Therefore in my view protection under s20A of the RMA does not apply for the land use for farming under rule 20 of the PSWLP.

5.16.5 This essentially means that none of the entire Woldwide operation for the land use for farming is legally occurring (with the exception of WW2 platform). Case law directs that illegal activities cannot make up part of the existing environment.

5.17.0 Effects that must be Disregarded (Section 104(2))

5.17.1 Policy 39 of the proposed Southland Water and Land Plan states:

> *“When considering any application for resource consent for the use of land for a farming activity, the Southland Regional Council should consider all adverse effects of the proposed activity on water quality, whether or not this Plan permits an activity with that effect”.*

5.17.2 As such, all effects related to the use of land for farming and the associated activities undertaken as part of the entire farming operation have been considered, and no effects have been disregarded in terms of Section 104(2) of the RMA.

6. Mitigations

6.1.0 Mitigations and good management practices

6.1.1 The application details a number of good management practices and mitigations that are proposed to be implemented to address the effects arising from the operation. All detailed mitigations are to control the losses of N, P, sediment and microbial contaminant loss arising from additional intensification.

6.1.2 Good management practices are required by the pSWLP in order for any farming activity to remain a permitted activity under Rule 20. As such, to provide further description, GMPs can be considered compulsory and a "minimum operating standard" that all farming operations in Southland must implement to "hold the line" on water quality in the region as they are a requirement of the proposed rule. This is important to keep in mind when assessing the application as some GMPs have been defined as mitigations in the proposal and are practices that the operation should be implementing anyway under the pSWLP, not as a mitigation for wanting to increase intensification.

6.1.3 The plan defines GMP as "*Include, but are not limited to, the practices set out in the various Good Management Practices factsheets available on the Southland Regional Council's webpage"*[9].

6.1.4 Comparatively, I consider that when assessing mitigations for a consent application, where there is an additional effect(s) on the existing environment above what is currently occurring, mitigations are considered as "going above and beyond" good management practice to mitigate that specific effect.

6.1.5 The pSWLP is silent on defining "mitigations" specifically but does define "mitigate" as *"to reduce or moderate the severity of an effect".* It is common for GMPs and mitigations to be used interchangeably, and in some cases, they can be both, but in other cases mitigation goes well above and beyond what is considered GMP.

6.1.6 The application defines mitigations as distinct from GMP and I agree with this approach. Mitigations are usually considered actions that will have a measurable effect when implemented – for example, the moving of a laneway adjacent to a waterway to reduce phosphorus loss or the installation of a wintering barn.

6.1.7 Good management practices can be defined as practices that are applied to the management of an operation in order to reduce contaminant loss and improve water quality and can be considered different to mitigations when assessing an application. Industry agreed good management practices have been developed throughout New Zealand with input from DairyNZ, farmer-led industry groups, NGOs and authorities. In assessing the applications proposed mitigations

---

[9] https://www.es.govt.nz/services/land-sustainability/Pages/Good-management-practices.aspx

and GMPs, I have referred to the industry agreed set of GMPs - which I have appended to this report, along with a comparison of the GMPs detailed in the application against the industry agreed GMPs.

6.1.8 The proposal details proposed GMPs and mitigations at pages 109,113, 140, 141 of the application for the dairy platform. GMPs are also proposed to be implemented "where practical" in the FEMPs for both WW1 and WW2 platforms.

6.1.9 The applicant withdrew details of GMPS and mitigations for the WRO in the sharepoint 4 update, however I have left the discussion regarding these in this section in anticipation for them to be revised and for discussion at the hearing.

6.1.10 For conciseness, I have opted not to discuss all GMPs that are proposed by the applicants, as these are required as a minimum baseline anyway, and only discuss the ones that I have determined through my analysis of the application to be an issue, or that have not currently been implemented "on the ground". These have been included below the proposed mitigations in the table below.

6.1.11 The application details additional mitigations that will be implemented for this proposal to ensure losses do not increase from the proposal. These mitigations are detailed on page 140 of the application. Below, I have taken the suggested mitigations and assessed both the applicants view and the expert's views of the effectiveness of these. These mitigations have been split up to mirror the causes discussed above:

Table 6.1.12: Mitigations for additional cows

#	Proposed mitigation measure	Applications view on effectiveness	Council's view on effectiveness
1	Removal of fodder crop rotation on WW1 and WW2 platforms	High level of effectiveness – over time this leads to less mineralisation of N, increased soil organic matter, water holding capacity, improved soil structure and less run-off/ leaching.	In theory and on paper, this may be a mitigation that would go towards mitigating effects of additional cows. This would only be the case if the cropping was directly being swapped with where the additional cows were going to be added. However, the removal of fodder crops were offered as a mitigation for WW2's current permit for farming and have not been in place on the M/SH96 block since the granting of that consent. If the current proposal is not granted, they would still not be able to crop on the M/SH96 block. Crops are detailed in the nutrient budgets as only having been grown on WW2's platform. WW1, in the evidence that has been provided in the proposal has not been in crop at any stage. Essentially, the application is utilising a mitigation which has already been implemented for the past conversion of M/SH96. In the existing environment, there are no crops to remove to use as a mitigation. Budgeting of these crops in the nutrient budgets has helped show a decrease of nutrients, even though they have already been accounted for under another proposal when the platforms were considered separate. The conclusion could be reached that the mitigation is already being implemented, regardless of legality, however it is what has been proposed by the application rather than is what is currently occurring that is the defining factor in a planning sense.
2	No land cultivated into fodder crop and intensively summer/ winter grazed: Fodder crop/ IWG by R2 heifers and summer grazing on turnips by cows have been carried out annually at WW1 and WW2 landholding.	High	As above, this mitigation is not available to be considered for this proposal as it does not exist in the existing environment – IWG is not able to occur on M/SH96 as its removal was offered as a mitigation under WW2's Land use for expanded dairy farming consent in 2017. AUTH-20171278-03 controls the land use on WW2, and condition 2 of this consent details the currently consented activity must be carried out "as per the application". IWG has not occurred on either current WW1 or WW2 platforms in the evidence provided by the applicant, nor should it have occurred on M/SH96 since the granting of AUTH-20171278-03.

#	Proposed mitigation measure	Applications view on effectiveness	Council's view on effectiveness
3	Expansion of the size and use of the wintering barn facilities	High level of effectiveness – an additional 225 cows will be wintered in the WW1 wintering barn. Both barns will be used more in the shoulders of the season (May, August and September) than they have been in the past. This reduces additional dung and urine on the paddocks, and will also reduce soil damage, compaction and run-off risk.	Wintering barns can be considered a significant mitigation, and the use of the existing barns in the current farming system is to be applauded. However in the case of the proposal moving forward, the two wintering barns make up part of the existing environment – so what can be considered as the mitigation here is the extension to allow for additional cows to be housed during winter. While I consider that cows housed in barns is better than IWG over the winter months, it does in turn generate additional effluent, which will be deposited on the Horner block at almost twice the volume that is considered GMP. The decision-makers on the proposal will need to consider if the housing of the additional cows over the winter months will adequately balance the effects of additional cows on the WW1 block over the milking season and the additional effluent disposal occurring. In my opinion, these factors greatly discount this proposed mitigation. The application details that along with the extension the winter barns will be utilised for longer periods of time and during adverse weather events. Provided that this is carried out as has been modelled in the nutrient budgets (e.g. the entire milking herd indoors over the detailed times) then I consider this could be a meaningful mitigation.
4	More efficient use of fertiliser	Moderate – this is effective at reducing N loss to water in drainage events following fertiliser application.	I consider that this is a GMP and should be being implemented on farm regardless of the proposal.
5	Low depth application of agricultural effluent with the trailing shoe slurry tanker	Moderate – in order to recognise the higher strength effluent and to avoid overloading the soils with N and microbes the application proposes an auger condition on depth of application.	I do not consider this as a mitigation, or even a GMP, as while this depth has been offered, the application is also applying to discharge 250 kg/N/ha on the block where the trailing shoe irrigation is used, which is well in excess of 150 kg/N/ha considered to be GMP. In areas where the travelling irrigators are used, they are not capable of achieving low depths. I consider that on its own, without the additional N loading on the block, low depth irrigation is generally considered GMP.
6	Lane adjacent to WW1 wintering barn will be	Moderate – This will be effective in addressing a point source discharge of P and other run-off into the stream. Good grass	I do not consider this to be a mitigation or GMP – point source discharges to land where it may enter water are an offence under S15(1)(b) of the RMA unless

#	Proposed mitigation measure	Applications view on effectiveness	Council's view on effectiveness
	contoured to drain away from the stream	cover will always be maintained on the stream bank to further protect the stream.	authorised by consent or a relevant plan rule. No such authorisation exists for discharge from this laneway, so the recontouring would be required regardless to ensure illegal discharges do not occur. The application also offers that good grass cover will be maintained at all times to further protect the stream, however at the time of the site visit this vegetation had been sprayed off and removed.
7	Eliminate direct contamination of a house bore (E45/0622)	Minor – this will prevent localised contamination of groundwater in the Waimatuku groundwater zone with N, P and microbes.	I do not consider this to be a mitigation or GMP – this bore does not meet permitted activity rules due to the insecure wellhead allowing periodic contamination and a consent is required.
8	Olsen P levels are slightly below optimum level. Once target Olsen P levels are achieved, P fertiliser will be applied to maintain Olsen P levels within the optimum range. Olsen P levels are 30.	Moderately effective for mitigating P loss to surface waters across farm. This will avoid the loss of excess P to water in artificial drainage and run-off following prolonged wet periods.	This can be considered a GMP, not a mitigation. I note that in soil test results provided in the application, Olsen P levels are currently sitting above optimum levels for much of the dairy platforms, with a range between 22–42 on WW1, and 25-54 on WW2. Of this range, only 3 paddocks are below 30 on WW1, and only 1 paddock under 30 on WW2. The rest are at or over optimum level of 30 offered in the application. What is not detailed in the application is that the optimum level of Olsen P can range between 30 and 40 depending on the individual farm. Also, as the application does not state what range they will maintain Olsen P at it is hard to determine whether or not this is in fact achieving the desired outcome.
9	Tracks/lanes management and layout to reduce run-off to streams	Highly effective as mitigating P, sediment and microbial contaminant loss to surface water across the landholding.	I consider this to be a GMP rather than a mitigation. Laneways are already on place on the property, with several located in close proximity to waterways/crossing over waterways. In some areas, run-off from the lane ways would not currently meet GMP, as lane culverts lack nibbing to stop flow to waterways and run-off is able to collect on top of tile drain outlets. To be considered a GMP, at the bare minimum tracks and lanes should be managed to prevent run-off to streams not just to reduce the run-off, and ensure run-off is to vegetated areas. To be considered a mitigation all run-off, to either water or land, would be completely removed.

6.1.12 The applicants must be commended for some aspects of their farming operation (such as the use of wintering barns), however due to the factors listed above I am unable to place much weight on overall effectiveness of GMPs and mitigations concluded in the application to adequately address actual and potential effects for this proposal.

6.1.13 Further amendments made to the application detail that IWG on WRO will be reduced to 72ha from the originally proposed 100ha, however this mitigation doesn't detail when this will occur. This mitigation also would require the housing of youngstock belonging to WW1&2 being housed in wintering barns on WW4&5 which has an impact on the landholding discussion.

7. Planning assessment

7.1.0 This section details my assessment of the application against relevant planning matters. I have first discussed the relevant rules from each of the three applicable plans for the proposal.

7.1.1 As Southland is currently operating under multiple plans, plan weighting is discussed, followed by further information requests on the application and a summary of the submissions received on the application.

7.1.2 I then detail my planning assessment against the relevant policies and objectives from the regional plans.

7.1.3 For conciseness, I have discussed only the policies and objectives that I consider relevant. I have also separated the key polices that I consider the application is contrary to. These are detailed in section 7.7.5.

Overall activity status

7.1.4 When bundled, I consider that the proposal is a **discretionary** activity.

7.2.0 Regional Plan rule framework

7.2.1 Resource consents for the above activities are required under the Regional Effluent Land Application Plan (1998) (RELAP), the Regional Water Plan (2010) (RWP) and the proposed Southland Water and Land Plan (Decisions Version) (2018) (proposed Southland Water and Land Plan).

Regional Effluent Land Application Plan rules

7.2.2 The Regional Effluent Land Application Plan was notified in 1996 and became operative on 30 May 1998.

- The discharge of agricultural effluent to land is a discretionary activity under Rule 5.4.6.

Discussion

7.2.3 Rule 5.4.6 applies in this instance because the applicant is seeking to discharge agricultural effluent multiple sources, including dairy shed effluent, winter barn effluent, under pass effluent and silage leachate. The discharge does not fit within the definition of farm dairy effluent under the operative Regional Water Plan, and therefore elements of the discharge are not subject to Rule 50 of that plan.

7.2.4 Rule 5.4.6 also applies to the winter barn slurry effluent discharge on the Horner block.

Regional Water Plan rules

7.2.5 The Regional Water Plan for Southland was notified in 2000 and became operative in January 2010.

- the abstraction and use of up to 180,000 litres per day of groundwater from three bores in the Waimatuku groundwater zone for dairy farm use is a discretionary activity under Rule 23(d)(ii);
- the discharge of farm dairy effluent to land is a restricted discretionary activity under Rule 50(d);
- the use, maintenance and decommissioning of a bore is a discretionary activity under Rule 22(d); and
- the discharge of winter barn effluent is not covered by this plan.

Discussion

7.2.6 The Waimatuku groundwater zone is listed as a lowland groundwater zone under Appendix H of the plan. The application is for 180,000 litres per day, up to 55,296 m^3/year. The allocation limit (which is based on 15% of the estimated mean annual land surface recharge) for the Waimatuku groundwater zone is 18,800,000 m^3/year. Total allocation, including this application, from the groundwater zone is 1,911,068 m^3/year, which is 10.2 % of the limit.

7.2.7 Due to the applicants proposing to increase cow numbers and land area, the discharge permit application is restricted discretionary as it was not lawfully being undertaken as at 17 July 2010. The RWP solely focuses on the discharge of farm dairy effluent which does not include wintering barn effluent.

7.2.8 Bore E45/0655 requires resource consent for its ongoing use and maintenance or decommissioning as the headworks do not prevent the infiltration of contaminants.

Proposed Southland Water and Land Plan rules

7.2.9 The proposed Southland Water and Land Plan (pWLP) was notified by Council on 3 June 2016 and submissions received. Following a hearing the decision on the plan was released on 4 April 2018. Appeals are being heard by the Environment Court on:

- the use of land for a farming activity that includes a dairy platform where the cow numbers are increased is a discretionary activity under Rule 20(e)*;
- the discharge of incidental discharges from farming is a permitted activity under Rule 24 provided the land use is authorised under Rule 20;
- the take and use of up to 180,000 litres per day of groundwater from three bores in the Waimatuku groundwater zone for dairy farm use is a discretionary activity under Rule 54(d)*;
- the discharge of agricultural effluent to land is a discretionary activity under Rule 35(c)*;
- incidental discharges from farming to land is a non-complying activity under Rule 24(b);

- the use of land for a feedpad/lot (winter barn) is a discretionary activity under Rule 35A(b)*;
- the use, maintenance and decommissioning of a bore is a discretionary activity under Rule 53(d).

The provisions marked with an asterisk (*) have been appealed.

Discussion

7.2.10 The application is for the use of land for dairy farming under Rule 20(e), as it proposes to increase cow numbers beyond what was consented on the dairy effluent discharge permit on 3 June 2016, and as such, does not meet permitted activity criteria. The application does not meet the criteria for a restricted discretionary activity as the assessment made for contaminant losses discharged from the landholding does not detail five years of data for all components of the landholding.

7.2.11 There has been five years of data supplied for the modelling of the dairy platforms, and if the decision makers consider that the landholding is only made up of the dairy platforms, minus WRO and Horner blocks, then I consider that this component of the application would then be of restricted discretionary status, prior to bundling occurring.

7.2.12 The current operation triggers Rule 24 – incidental discharges from farming. This has not been applied for in the application but I consider that consent would be required currently. This is because the current farming operation is IWG cows from both WW1 and WW2 on land that has not previously been used for IWG, without the required Rule 20 GMPs in place. There are no S20A rights in place for this activity. To remain a permitted activity under Rule 24, the land use activity associated with the discharge must:

- be authorised under Rules 20,25 or 70 of the plan; and
- any discharge of a contaminant resulting from any activity permitted by Rules 20, 25 or 70 is managed to ensure that after reasonable mixing it does not give rise to any of the following effects on receiving waters:
    1. any conspicuous oil or grease films, scums or foams, or floatable or suspended materials; or
    2. any conspicuous change in the colour or visual clarity; or
    3. the rendering of fresh water unsuitable for consumption by farm animals; or
    4. any significant adverse effects on aquatic life.

7.2.13 The operation as it is currently run is not permitted under Rule 20, and IWG activities do not meet Rule 24(a)(ii)(1) and (2), the incidental discharges from farming are currently an unconsented non-complying activity.

7.2.14 I consider that the activity class awarded to this rule sends a clear message that any farming operation in Southland needs to be operating in accordance with Rule 20 GMPs in order for a collective “hold the line” approach to be effective. While the current operations are a compliance matter which is under investigation, and Rule 24 will not be applicable to the proposal moving forward if consent for farming is granted, I consider it appropriate to discuss briefly as Rule 24 does currently apply “on the ground”.

7.2.15 The application is for 180,000 litres per day, up to 55,296 m^3/year. The allocation limit for the Waimatuku groundwater zone under Appendix L.5 of the proposed plan is 22,270,000 m^3/year. Total allocation, including this application, from the groundwater zone is 1,762,155 m^3/year, which is 7.9% of the limit.

7.2.16 Bore E45/0655 requires resource consent for its ongoing use and maintenance or decommissioning as the headworks do not prevent the infiltration of contaminants.

Definitions from the proposed Water & Land Plan

7.2.17 Feedpad/lot* is defined in the plan as "a fenced in or enclosed area located on production land used for feeding or loafing of cattle or deer to avoid damage to pasture when soils are saturated, and which can be located either indoors or outdoors. It includes 'sacrifice paddocks', wintering pads, stand-off pads, calving pads, loafing pads, and self-feed silage storage facilities."

7.2.18 Landholding is defined in the plan as:

"(a) Any area of land, including land separated by a road or river or modified watercourse, held in one or more than one ownership, that is utilised as a single operating unit, and may include one or more certificates of title; except

(b) For land with a residential, commercial, industrial, infrastructural or recreational zoning or designation in the relevant district plan means any area of land comprised wholly of one Certificate of Title or any Allotment as defined by Section 218 of the RMA.

*Note: **F**or the purposes of this definition, a "single operating unit" may include, but is not limited by, the following features:*

(a) it has effective control by any structure of ownership of the same group of people (for example, land that is controlled by a family trust, or beneficiaries of that family trust or a related group of companies, or an estate, or partner, or individual/s or a combination of); and

(b) it is operated as a single business entity."

Summary

7.2.19 Overall, the application is considered to be a ***discretionary*** activity.

7.3.0 Weight given to the regional plans

7.3.1 When assessing this application, I consider that the operative RWP merits less weight because it predates, and therefore does not give effect to, the NPSFM 2014 or the RPS. In contrast, while it is still at the appeals stage, additional weight has been given to the pSWLP as it better reflects Part 2 RMA imperatives, and relevant provisions in the NPSFM 2014 that relate to tangata whenua and water quality.

7.4.0 Further information request

7.4.1 Apart from a formal request to provide a hydrologic connection assessment and aquifer drop down test for the increased water take on WW1, information was not formally requested during the processing of this application. Due to the background of this application, this was done to avoid hold times being placed upon the applications. Multiple informal clarifications to matters were made.

7.5.0 Notification and Submissions

7.5.1 The application was publicly notified on 3 April 2019. This was for the following reasons:

- the applicants requested public notification of the application;
- the effects of the proposal was likely to be more than minor.

7.5.2 The above decision to publicly notify the application was made under Section 95A(3)(a) of the RMA.
Six submissions were received. These are included in the appendices, and are summarised as follows:

Submitter	**Oppose/ Support**	**Issues/comments** ***Decision/Changes sought***	**To be Heard?**
Te Ao Marama Inc on behalf of Te Rūnanga o Oraka Aparima	Oppose	– The Papatipu Runanga has recognised status as kaitiaki and manawhenua of the natural resources within their takiwā boundaries. The proposal is within the takiwā boundaries of Te Rūnanga o Oraka Aparima. – The submission is opposed to the proposed increase in cow numbers. – The submitter is concerned about the degraded state of water quality; both groundwater and surface water. – Proposal poses risk to the environment, particularly water quality, and Ngāi Tahu values. – Avoid risk of further deterioration of the environment, and to Ngāi Tahu values and cultural well-being • *Decline application*	Yes

Submitter	**Oppose/ Support**	**Issues/comments** ***Decision/Changes sought***	**To be Heard?**
Public Health South on behalf of Southern District Health Board	Oppose	– A 30% increase in cow numbers is a significant increase in load to an already degraded catchment. – The proposal is likely to adversely impact the environment. – The application does not adequately consider effects on domestic drinking water supplies in the area with regard to increased nitrate concentrations in water. – The shrinking and cracking characteristics of the Braxton soils during dry periods will allow nitrates and other contaminants to directly leak into groundwater. – Overseer does not readily assess the losses associated with cracking of the Braxton soils. – There are already elevated nitrate concentrations in groundwater in the vicinity. Groundwater in 81% of bores within 2-4 km exceed more than 50% of the maximum allowable value (MAV) for drinking water. The current drinking water standards may not provide sufficient protection to human health. A Danish study has shown that there is increased risk of colon cancer associated with elevated nitrate concentrations in drinking water. – Agricultural intensification is contributing significantly to degraded environments in lowland Southland. – The Waimatuku catchment discharges to coastal waters on Oreti Beach. There is strong correlation between eutrophication of coastal waters and the incidence of shellfish poisoning, fish mortality, loss of submerged vegetation and marine mammal mortality. – The Oreti River is categorised as being in the worst 25% of rivers with regard to total nitrogen, total oxidised nitrogen, phosphorous and E. coli. Nitrogen levels mean that there is an increased risk of Harmful Algal Blooms (HAB). E. coli levels, which are a good indicator of risk associated with contracting Campylobacter and other enteric diseases, are getting worse in lowland Southland in general.	

Submitter	**Oppose/ Support**	**Issues/comments** **Decision/Changes sought**	**To be Heard?**
		– More cows will increase loads of micro-organisms, including pathogenic organisms, which may leach into aquifers and contaminate drinking water supplies. The proposed increased cow numbers will add pathogens to the ecosystem, which will add to the increasing burden of illness. There is also a high probablility that there will be bacteria arising from the proposal that will have developed resistance to antimicrobial residues. – If approved the application will set a precedent that will allow other applicants to increase herd sizes with consequent increases in contaminant discharges. – The application is contrary to the objectives of the proposed Water and Land Plan, the National Policy Statement for Freshwater Management and to the purpose of the Resource Management Act. • *Pathogens should be removed from effluent prior to discharge to pasture* • *Dedicated bores should be established and monitored for nitrate, nitrogen and E. coli as a minimum.* • *No discharge when soils are saturated or in dry conditions when there are obvious cracks* • *Herd numbers should be reduced, or only increased in stages if monitoring data supports the AEE.*	Yes

Submitter	Oppose/ Support	Issues/comments *Decision/Changes sought*	To be Heard?
Mid-Aparima Catchment Group	Support	– The applicants farming business has a huge focus on environmental sustainability. Their environmental commitment was recognised in the 2013 Southland Balance Farm Environmental Awards. – The proposal will have a positive impact on the surrounding environment, especially lowland rivers and estuaries. – The proposal will avoid intensive winter grazing, a practice that has high nutrient and sediment losses, on Woldwide 1 or Woldwide 2. – The wintering barns can be utilised as stand-off pads during inclement weather. Strategic use of stand-off pads can reduce nitrogen leaching by 20%. – Changes to cropping operations will reduce nutrient losses and improve uptake of nutrients. – Improved systems will offset the small increase in cow numbers as shown by the nutrient budgets. The Overseer results are backed up by scientific research the wintering and cropping practices. – The applicants have made a significant capital investment for this application. – The application should be determined on the effects of the proposal, rather than the inputs to the farm system. Use of technology and management practices to offset potential effects needs to be encouraged. – The proposal fits with the catchment group's vision and its key value, which is to improve water quality in the area.	Yes
		– The application will result in reduced losses of phosphorous, nitrogen, sediment and indicator organisms to the environment. The overall effect on water quality will be positive. • *Approve the application.* • *Grant a 15 year term*	
Ivan Graham Walter Lines	Support	– The applicants have an exceptional farming operation and are early adaptors of technology and improved management practices. They are highly values leaders in the Southland farming community and have won several awards for farming and environmental stewardship. – The applicants have made significant capital investment, including wintering barns, in order to keep their adult stock indoors over winter, with only younger stock outside. This would reduce annual winter crops from over 100 hectares to less than 35 hectares. A significant reduction in nitrogen losses, as indicated by Overseer budgets, is projected. – To justify the investment, and to utilise the additional feed produced, the applicants are seeking a small increase in cow numbers. – The nutrient budgets show a significant improvement in nitrogen losses, even with the increased cow numbers.	Yes

Submitter	**Oppose/ Support**	**Issues/comments** *Decision/Changes sought*	**To be Heard?**
		– The proposal will result in less damage to soil structures by stock over winter, and so reduced contaminant losses associated with run-off. – The system will return nutrients to the soil at a time when contaminant losses to water will be significantly less. – There will be reduced need for artificial fertilisers – An increase in cow numbers is not a valid reason to reject an application if environmental standards are improved. • *Approve the application*	
Joanne Flett & Susan Flett	Neutral	– They own the Merriburn block which is leased to Woldwide Run-off until October 2021. – The submitters are concerned if the decision on the application may jeopardise their position in future. – The submitters are happy with the applicants' environmental practices on the leased block, which include winter-crop rotation, direct drilling of kale crops, waterways are fenced off and placement of baleage before winter to avoid soil damage in wet conditions. • *Exclude the Merriburn block from the landholding and the applicant's land use consent for farming.*	Initially Joanne Flett & Susan Flett did not wish to be heard. However, on 19 August 2019 they indicated they would now like to be heard due to the amendments to the application[10].
Ministry of Education	Oppose	– The Ministry operates a drinking water supply bore at Heddon Bush School, approximately 2.3 km downgradient of the applicant's site. – There is potential for the proposal to adversely affect the safety and wellbeing of students and teachers using drinking water from the supply well at the school. – There is a lag time between nutrients applied to land and when they enter groundwater. That means that impacts on groundwater are not known immediately, and may take 10-20 years to become apparent. – The application does not provide information on the location, depth, monitoring frequency and parameters, and trigger levels, for the proposed monitoring bore. – The effect of the proposed water take on nearby bores, particularly the Heddon Bush School bore, has not been adequately assessed. • *Refuse the application*	Yes

---

[10] Email received on 19 August 2019 from Joanne and Susan Flett;

In light of the recent amendments to the Woldwide consent applications we would like to change our position to be heard. The amendments under the Woldwide Runoff include significant changes from the original proposal for the Merriburn property and as such our position to be heard has changed. We now wish to be heard in support of our submission.

Submitter	**Oppose/ Support**	**Issues/comments** **Decision/Changes sought**	**To be Heard?**
		• *If approved, water quality at the Heddon Bush School bore must not be adversely affected by the discharge of contaminants from the proposed operation.* • *the location, depth, monitoring frequency and parameters, and trigger levels, for the proposed monitoring bore must be specified* • *A quantitative interference effects assessment be provided to ensure that the Heddon Bush School bore is not adversely affected by drawdown from the applicants water take.*	

7.6.0 Statutory Considerations

7.6.1 Section 104 of the Act sets out the matters to be considered when assessing an application for a resource consent. Section 104(1) of the Resource Management Act, 1991, states:

> *(1) When considering an application for a resource consent and any submission received, the consent authority must, subject to Part 2, have regard to:*
> *(a) any actual and potential effects on the environment of allowing the activity; and*
> *(b) any relevant provisions of:*
> *(i) a national environmental standard:*
> *(ii) other regulations:*
> *(iii) a national policy statement:*
> *(v) a regional or proposed regional policy statement:*
> *(vi) a plan or proposed plan; and*
> *(c) any other matter the consent authority considers relevant and reasonably necessary to determine the application.*

7.6.2 Those matters which are relevant for this application are discussed in the following sections as follows:

- relevant provisions of the Regional Water Plan and the Proposed Southland Water and Land Plan and the Regional Effluent Land Application Plan;
- relevant provisions of the Southland Regional Policy Statement;

- relevant provisions of the National Policy Statements and National Environmental Standards;
- Part 2 of the RMA.

7.6.3 The following matters relevant for this application were discussed previously in this report, and have not been covered again in this section:

- description of the receiving environment;
- assessment of the actual and potential effect of the activity on the environment;

7.6.4 Sections 108 and 220 provide for consent to be granted subject to conditions and sets out the kind of conditions that may be imposed.

7.7.0 Relevant provisions of the relevant regional plan objectives, policies and rules (Section 104(1)(b)(v))

7.7.1 Council is currently operating under three Regional Plans – the Regional Effluent Land Application Plan (RELAP), Regional Water Plan (RWP) and the proposed Southland Water and Land Plan (proposed Southland Water and Land Plan).

7.7.2 The proposed Southland Water and Land Plan was notified by the Consent Authority on 3 June 2016 and decisions on the proposed Plan were notified in June 2018. The proposed Southland Water and Land Plan is subject to appeal, however, it has legal effect under Section 104(1)(b) regard must, subject to Part 2 of the Act, be had to the provisions of any proposed plan. The relevant provisions of both plans are detailed below and are considered in turn.

7.7.3 The objectives and policies of the Regional Water Plan and the proposed Southland Water and Land Plan that are relevant to this application have been grouped according to topic.

7.7.4 The provisions marked with an asterisk (*) have been appealed.

7.7.5 *Key Policies: Proposed Southland Water and Land Plan*

7.7.6 I consider that the policies below are of the most significance in relation to the proposed activities.
I have separated them from the groupings below in order to highlight their significance.

Policy 5* *In the Central Plains physiographic zone, avoid, remedy, or mitigate adverse effects on water quality from contaminants, by:*

1. *requiring implementation of good management practices to manage adverse effects on water quality from contaminants transported via artificial drainage and deep drainage;*
2. *having particular regard to adverse effects on water quality from contaminants transported via artificial drainage and deep drainage when assessing resource consent applications and preparing or considering Farm Environmental Management Plans; and*
3. *decision makers generally not granting resource consents for additional dairy farming of cows or additional intensive winter grazing where contaminant losses will increase as a result of the proposed activity.*

Discussion
7.7.7 Much of the land subject to the application is in the Central Plains physiographic zone. Therefore, Policy 5 of the pSWLP is a key policy for this proposal and provides clear direction to decision makers to generally not grant resource consents for additional cows where contaminant losses will increase. Importantly, the policy also requires the implementation of GMP to manage effects on water quality, regardless of if an activity is being assessed for a resource consent or to remain a PA.

7.7.8 When weighing up the two parts of this policy against the proposal, I consider that the application will result in additional losses on WW1 platform, if not over the whole landholding, given the uncertainty of the modelled losses. The application seeks to capitalise on offering to largely implement GMPs rather than actual mitigations in exchange for additional cows, and as such I question the appropriateness of this given they are required to be implemented by this policy regardless. I consider that the proposal is contrary to Policy 5 of the pSWLP.

Policy 10* *In the Oxidising physiographic zone, avoid, remedy, or mitigate adverse effects on water quality from contaminants, by:*

1. *requiring implementation of good management practices to manage adverse effects on water quality from contaminants transported via deep drainage, and overland flow and artificial drainage where relevant;*
2. *having particular regard to adverse effects on water quality from contaminants transported via deep drainage, and overland flow and artificial drainage where relevant when assessing resource consent applications and preparing or considering Farm Environmental Management Plans; and*
3. *decision makers generally not granting resource consents for additional dairy farming of cows or additional intensive winter grazing where contaminant losses will increase as a result of the proposed activity.*

Discussion
7.7.9 The land subject to the application is made up in part of the Oxidising physiographic zone. Therefore, Policy 10 of the pSWLP is a key policy for this proposal and provides clear direction to decision makers to generally not grant resource consents for additional cows where contaminant losses will increase. Importantly, the policy also requires the implementation of GMP to manage effects on water quality, regardless of if an activity is being assessed for a resource consent or to remain a PA.

7.7.10 When weighing up these two parts of this policy against the proposal, I consider that as the intensification will result in additional losses on WW1 platform, if not over the whole landholding given the uncertainty of the modelled losses. The application seeks to capitalise on offering to largely implement GMPs rather than actual mitigations in exchange for additional cows, and as such I question the appropriateness of this given they are required to be implemented by this policy regardless. I consider that the proposal is contrary to Policy 10 of the pSWLP.

Policy 15B* *Where existing water quality does not meet the Appendix E Water Quality Standards or bed sediments do not meet the Appendix C ANZECC sediment guidelines, improve water quality including by:*

1. *avoiding where practicable and otherwise remedying or mitigating any adverse effects of <u>new discharges</u> on water quality or sediment quality that would <u>exacerbate the exceedance</u> of those standards or sediment guidelines beyond the zone of reasonable mixing; and*

2. *requiring any application for replacement of an expiring discharge permit to demonstrate how and by when adverse effects will be avoided where practicable and otherwise remedied or mitigated, so that beyond the zone of reasonable mixing <u>water quality will be improved</u> to assist with meeting those standards or sediment guidelines.*

Discussion

7.7.11 Policy 15B applies to this application, in both parts 1 and part 2 of the policy. The application triggers the need for a new discharge permit through Rule 24, as has been discussed earlier in this report, and due to this, part 1 of Policy 15B needs considered. In this case, I consider that the incidental discharge from farming will exacerbate the exceedance of the water quality standards, due to the receiving waterbodies already being significantly degraded and losses from the activity will increase.

7.7.12 Part 2 of the policy applies to the proposed replacement discharge permits, including the discharge on the Horner block. The application has not demonstrated how water quality will be improved through the discharge of additional effluent beyond what the current discharge permits cover. I consider that the application is contrary to both parts of Policy 15B.

Policy 16* 1. *Minimising the adverse environmental effects (including on the quality of water in lakes, rivers, artificial watercourses, modified watercourses, wetlands, tidal estuaries and salt marshes, and groundwater) from farming activities by:*

- *(a) discouraging the establishment of new dairy farming of cows or new intensive winter grazing activities in close proximity to Regionally Significant Wetlands and Sensitive Waterbodies identified in Appendix A; and*
- *(b) ensuring that, in the interim period prior to the development of freshwater objectives under Freshwater Management Unit processes, applications to establish new, or further intensify existing, dairy farming of cows or intensive winter grazing activities will generally not be granted where:*
  - *(i) the adverse effects, including cumulatively, on the quality of groundwater, or water in lakes, rivers, artificial watercourses, modified watercourses, wetlands, tidal estuaries and salt marshes cannot be avoided or mitigated; or*
  - *(ii) existing water quality is already degraded to the point of being over-allocated; or*
  - *(iii) water quality does not meet the Appendix E Water Quality Standards or bed sediments do not meet the Appendix C ANZECC sediment guidelines; and*
- *(c) ensuring that, after the development of freshwater objectives under Freshwater Management Unit processes, applications to establish new, or further intensify existing, dairy farming of cows or intensive winter grazing activities:*
  - *(i) will generally not be granted where freshwater objectives are not being met; and*
  - *(ii) where freshwater objectives are being met, will generally not be granted unless the proposed activity (allowing for any offsetting effects) will maintain the overall quality of groundwater and water in lakes, rivers, artificial watercourses,*

> *modified watercourses, wetlands, tidal estuaries and salt marshes.*

Discussion

7.7.13 Policy 16 provides very clear direction to Council when assessing applications, and in my opinion the proposal does not meet the tests required by parts of this policy for the following reasons.

7.7.14 Point 1(b) of Policy 16 I consider is a policy that holds some of the greatest planning significance when assessing this proposal. In my opinion, it provides decision-makers with a clear direction on how applications such as this proposal should be approached by detailing that applications to further intensify existing dairy farms or intensive winter grazing should <u>“generally not be granted”</u> where the adverse effects, including cumulatively, on the quality of groundwater, or water in lakes, rivers, artificial watercourses, modified watercourses, wetlands, tidal estuaries and salt marshes <u>cannot be avoided or mitigated</u>, or existing water quality is already degraded to the point of being over-allocated, or where water quality <u>does not meet</u> the Appendix E Water Quality Standards or bed sediments do not meet the Appendix C ANZECC sediment guidelines (my emphasis added).

7.7.15 In forming my viewpoint that the application is inconsistent with Policy 16(1)(b), it is helpful to consider my emphasised parts in the policy excerpt above from a plain reading viewpoint, which I detail my interpretation below:

- I consider that ‘”generally not grant” means that applications for further intensification, where effects are not avoided or mitigated should be declined, especially in areas where water quality is already degraded. The policy only details “avoid” or “fully mitigate” and, I note, does not allow for transferring or the balancing of, as is the case in this proposal, effects caused by IWG in the winter months for more cows “on the paddock” during the wider part of the year, as those additional effects will still be occurring over the time that the additional cows are not housed in barns. The applicants have also relied on rectifying unlawful practices to demonstrate effects are being avoided or fully mitigated, which is not an appropriate approach;

- I consider that it is clear, from the evidence provided by the applicants and Council experts, that the water quality in the receiving environment is degraded. Given the significantly degraded quality of the receiving environment, I conclude that the water quality could be considered as over-allocated;

- Point 1(b) is the proposed Southland Water and Land Plan’s key method for giving effect to the National Policy Statement for Freshwater Management 2014 in respect of farming activities in Southland. This is a directive policy that dictates a clear outcome.

7.7.16 Point 1(a) is not relevant to this application, as the proposed site is not in close proximity to sensitive waterbodies. However, the cumulative effects from the proposed activity may affect such waterbodies present in the receiving environment. The proposed activities are consistent with point 2 of the policy, and I consider that the application satisfies the requirements of this part of the policy.

7.7.17 In my opinion, the mitigations provided do not fully mitigate nor avoid the adverse effects of the proposal. As mentioned earlier in the report, the directives of the policies in the Plan take a “hold the line" approach in respect of freshwater quality, where the onus is on the applicants to ensure their operations do not further degrade their receiving environments. I will note that "offsetting of effects" is provided for in Policy 16(1)(c)(ii), where freshwater objectives are being met, which, in regards to this proposal, are clearly not being met. As such, I interpret that a transfer or balancing of effects must be interpreted in the same way, and I have treated this as such.

7.7.18 I would interpret this hold the line approach to clearly anticipate that any further intensification should be declined, unless the adverse effects, including cumulatively are fully avoided or mitigated. In respect of this application, the actual and potential adverse effects on freshwater quality are not. While I accept that the applicants have implemented/proposed a number of measures to mitigate and/or avoid effects, I consider that the application does not avoid or mitigate all adverse effects on freshwater quality. The proposed activities are contrary to the directives of the policy.

Policy 17*

1. *Avoid significant adverse effects on water quality, and avoid, remedy, or mitigate other adverse effects of the operation of, and discharges from, agricultural effluent management systems.*
2. *Manage agricultural effluent systems and discharges from them by:*
    - *(a) designing, constructing and locating systems appropriately and in accordance with best practice; and*
    - *(b) maintaining and operating effluent systems in accordance with best practice guidelines; and*
    - *(c) avoiding any surface run-off or overland flow, ponding or contamination of water, including via sub-surface drainage, resulting from the application of agricultural effluent to pasture; and*
    - *(d) avoiding the discharge of untreated agricultural effluent to water.*

Note: Examples of best practice referred to in Policy 17(2)(a) for agricultural effluent include IPENZ Practice Note 21: Farm Dairy Effluent Pond Design and Construction and IPENZ Practice Note 27: Dairy Farm Infrastructure.

Note: Examples of best practice guidelines referred to in Policy 17(2)(b) for agricultural effluent include DairyNZ's guidelines A Farmer's Guide to Managing Farm Dairy Effluent – A Good Practice Guide for Land Application Systems, 2015 and A Staff Guide to Operating Your Effluent Irrigation System, 2013.

Discussion

7.7.19 The effluent pond on WW1 is relatively new, was suitably designed and constructed with a resource consent.

7.7.20 The applicants have proposed to match the management of effluent to the level of risk aids in mitigating adverse effects on the dairy platforms. The size of the proposed discharge area is sufficiently sized on the dairy platforms to ensure that the effluent can act as a fertiliser, with the nutrients being available for uptake by vegetation cover, ensuring soil health and sufficient pasture production.

7.7.21 The application is not consistent with Policy 17 when considering the N loading on the Horner block from agricultural effluent discharge, as the proposal includes discharging 250 kg/N/ha/year, which is significantly higher than the maximum N loads set out in the explanation for Policy 42.

7.7.22 This application proposes to discharge of effluent over a large area, therefore using the nutrients from the effluent and applying it to land to be used as a fertiliser. This reduces the chance of run-off when effluent is discharged appropriately. The effluent system was appropriately constructed, however no evidence has been provided to show that the clay lined pond is structurally sound or is not leaking.

7.7.23 Furthermore, due to all the factors that have been discussed previously in this report regarding the effectiveness of the mitigations offered, the additional volumes of effluent that will be generated and discharged, and the conclusion that I have reached that the increase in losses will be significant, I consider that the proposal is contrary to Policy 17(1), which directs significant effects on water quality from effluent discharge are avoided.

Policy 39* *When considering any application for resource consent for the use of land for a farming activity, the Southland Regional Council should consider all adverse effects of the proposed activity on water quality, whether or not this Plan permits an activity with that effect.*

Discussion

7.7.24 This policy provides direction to Council for assessing applications. The interpretation taken is that when considering the proposed activities, all adverse effects on water quality are to be considered, and activities that are permitted to be occurring in the environment are not considered as part of the existing environment. This provides a wide scope for assessing applications and draws in the off-site activities and does not provide for the transfer of effects. When considering the application through the lens of this policy, as previously mentioned, the adverse effects especially cumulative effects will be more than minor.

Regional Water Plan

7.7.25 Policies from the Regional Water Plan and proposed Southland Water and Land Plan which have less relevance to this application or that align with the proposal are discussed further below.

Water Quality

Policy 1

(a) Recognise the different characteristics of the following surface water body classes when managing discharges:
  - *(i) Natural State Waters*
  - *(ii) Lowland (hard bed)*
  - *(iii) Lowland (soft bed)*
  - *(iv) Hill*
  - *(v) Mountain*
  - *(vi) Lake-fed*
  - *(vii) Spring-fed*
  - *(viii) Mataura 1*
  - *(ix) Mataura 2*
  - *(x) Mataura 3*
  - *(xi) Lowland/coastal lakes and wetlands*
  - *(xii) Hill lakes and wetlands*
  - *(xiii) Mountain lakes and wetlands*

(b) Apply water quality standards established under any Water Conservation Order.

Policy 3 *Notwithstanding any other policy or objective in this plan, allow no discharges to surface water bodies that will result in a reduction of water quality beyond the zone of reasonable mixing, unless it is consistent with the promotion of the sustainable management of natural and physical resources, as set out in Part 2 of the Resource Management Act 1991, to do so.*

Policy 4 *For surface water bodies outside Natural State Waters, manage point source and non-point source discharges to meet or exceed the water quality standards referred to in Rule 1 and specified in Appendix G "Water Quality Standards", unless it is consistent with the promotion of the sustainable management of natural and physical resources, as set out in Part 2 of the Resource Management Act 1991, to do so and so avoid levels of contaminants in water and sediments that could harm the health of humans, domestic animals including stock and/or aquatic life.*

Policy 7 *Prefer discharges to land over discharges to water where this is practicable and the effects are less adverse.*

Policy 13 *Avoid the point source discharge of raw sewage, foul water and untreated agricultural effluent to water.*

Policy 13A

- *(a) Recognise that the establishment of new dairy farms poses risks to water quality, including the quality of water in coastal lakes, lagoons, tidal estuaries, salt marshes and coastal wetlands, that need to be addressed when establishing a new dairy farm.*
- *(b) Manage the risk posed by the establishment of new dairy farms by requiring resource consent and requiring the documentation of risks and measures to avoid or mitigate them in a Conversion Environmental Plan.*
- *(c) Consideration should be given to, but not be limited to, the following matters;*
  - *(i) the assimilative capacity and drainage characteristics of the soil and consequential effects on water quality;*
  - *(ii) the risks posed by the establishment of a new dairy farm to the water quality of water bodies, coastal lakes, lagoons, tidal estuaries, salt marshes and coastal wetlands;*
  - *(iii) the extent to which those risks can be avoided or mitigated through measures proposed in the Conversion Environmental Plan;*
  - *(iv) the likely effectiveness of the measures contained in the Conversion Environmental Plan;*
  - *(v) how, and within what timeframe, those measures will be implemented.*
- *(d) Where the risks to the water quality of water bodies, coastal lakes, lagoons, tidal estuaries, salt marshes and coastal wetlands cannot be avoided or mitigated, the Council may decline consent for the establishment of a new dairy farm.*

Policy 25 *To avoid, remedy or mitigate the adverse effects arising from point source and non-point source discharges so that there is no deterioration in groundwater quality after reasonable mixing, unless it is consistent with the promotion of the sustainable management of natural and physical resources, as set out in Part 2 of the Resource Management Act 1991, to do so.*

Discussion

7.7.26 The above policies from the RWP all seek to maintain or improve water quality from point source or non- point source discharges. The application is consistent with the Policy 1, as the application has given consideration to different characteristics of surface water bodies. It is also consistent with Policies 7 and 13 as all discharges proposed by the activity are to land. Policy 13 does not apply, as this is for the establishment of new dairy farms.

7.7.27 I consider that the proposal is inconsistent with Policies 3, 4 and 25, as the incidental discharge from farming and the effluent discharge from the proposal will result in adverse effects on water quality above what is already occurring, due to the addition of more cows and more effluent being generated.

Water Quantity

Policy 21 *To ensure that the rate of abstraction and abstraction volumes specified on water permits to take and use water are no more than reasonable for the intended end use.*

Policy 23 *Impose a condition enabling the review of consent conditions in accordance with Sections 128 and 129 of the Resource Management Act 1991 on all new permits to take and use water.*

Policy 28 *To manage groundwater abstraction to avoid significant adverse effects on:*

- *long-term aquifer storage volumes;*
- *existing water users;*
- *surface water flows and aquatic ecosystems and habitats;*
- *groundwater quality.*

Policy 29

(a) Manage the stream depletion effect of any groundwater abstraction with a rate of take exceeding 2 litres per second as follows:

  (i) where there is a direct hydraulic connection between the groundwater source and an adjacent surface water body, the stream depletion effect will be determined as the maximum instantaneous rate of take and will be managed in the same manner as a surface water abstraction for flow and allocation purposes. The abstraction will therefore be subject to any relevant minimum flow regime;

  (ii) where there is a high degree of hydraulic connection between the groundwater source and an adjacent surface water body, the stream depletion effect will be determined as the greater of:

    1. the effect of 150 days pumping at the continuous pump rate required to deliver the seasonal volume;

    2. the effect of continuous pumping at the maximum permitted pump rate over the period required to deliver the seasonal volume.

  The calculated rate of stream depletion will be managed in the same manner as a surface water abstraction for allocation purposes with the remainder of the abstraction included in the allocation volume for the relevant groundwater zone. Where the calculated rate of stream *depletion exceeds 2 litres per second, the abstraction will be subject to any relevant minimum flow regime;*

(iii) where there is a moderate degree of hydraulic connection between the groundwater source and an adjacent surface water body, the stream depletion effect will be determined as the effect of 150 days of pumping at the continuous pump rate required to deliver the seasonal volume. The calculated rate of stream depletion will be managed in the same manner as a surface water abstraction for allocation purposes with the remainder of the abstraction included in the allocation volume for the relevant groundwater zone;

(iv) where there is a low degree of hydraulic connection between the groundwater source and an adjacent surface water body, the stream flow effect is considered to be minor and the individual abstraction will not be taken into account in determining surface water allocation but will be included in the allocation volume for the relevant groundwater zone.

Policy 30

(a) Use a staged management approach to allocate groundwater for abstraction in Southland to allow the knowledge gained by the progressive development of the region's groundwater resources to be built into its future management.

(b) Recognise the different characteristics of the following aquifer types when managing groundwater abstraction:
  (i) riparian aquifers;
  (ii) terrace aquifers;
  (iii) lowland aquifers;
  (iv) confined aquifers;
  (v) fractured rock aquifers.

(c) …

(d) …

(e) Require resource consent applications for groundwater abstractions to be supported by a level of information that corresponds to the level of risk of adverse environmental effects. Information to be supported by a conceptual hydrogeological model that corresponds to the level of allocation from the aquifer.

(f) …

(g) Impose monitoring on resource consents for groundwater abstractions that corresponds to the level of risk of adverse environmental effects.

(h) Where monitoring shows adverse environmental effects are occurring in a specific groundwater zone, remedy or mitigate those effects using one or more of the following methods:
  (i) reviewing the conditions of existing groundwater abstraction consents for that groundwater zone in accordance with Section 128 of the Resource Management Act 1991;
  (ii) ceasing any further allocation of groundwater from that groundwater zone; and
  (iii) temporarily restricting the abstraction of water from that groundwater zone by issuing a water shortage direction under Section 329 of the Resource Management Act 1991.

(i) Ensure that groundwater abstractions that have a high risk of adverse environmental effects will not result in:
  - *(i) a long-term decline in groundwater levels;*
  - *(ii) surface water allocation regimes being exceeded*

Discussion

7.7.28 The application is not from an over-allocated groundwater zone and the proposed groundwater take will not result in any over-allocation when assessed against the planning framework. Consent conditions will require that the water take is metered, and abstraction records provided to Council. However, the water take is not in line with reasonable and efficient use of water, is for more than 2 l/s, and it is not known what the stream depletion effects will be under the proposal. Due to these factors, I consider that the application could be inconsistent with Policies 29 and 30(e), as these factors were not adequately assessed in the application.

Land and Soils

Policy 31A *Match the level of management that is required for discharges of contaminants onto or into land to the level of environmental risk posed by the following risk factors:*
- *(a) Nature and quantity of contaminants in the discharge*
- *(b) Sloping land*
- *(c) Soils with artificial drainage or coarse structures*
- *(d) Soils with impeded drainage or low infiltration rates*
- *(e) Well drained soils*
- *(f) Climate*
- *(g) Proximity to groundwater*
- *(h) Proximity to surface water*
- *(i) Soil's current physical, chemical and biological characteristics and its potential to leach nutrients*
- *(j) Natural hazards (for example, flooding and erosion).*

Policy 31C *Manage discharges of contaminants onto or into land to avoid, remedy or mitigate adverse effects, including on:*
- *(a) soil quality;*
- *(b) amenity values;*
- *(c) habitats, ecosystems and indigenous biological diversity;*
- *(d) historic heritage, cultural and traditional values;*
- *(e) natural character;*
- *(f) outstanding natural features.*

Policy 31D *Encourage the beneficial reuse of materials where this is appropriate, and promote discharges of these materials onto or into land to maximise the potential reuse of the nutrients and water contained in the discharge.*

Discussion

7.7.29 Overall, the application is largely consistent with the above polices.

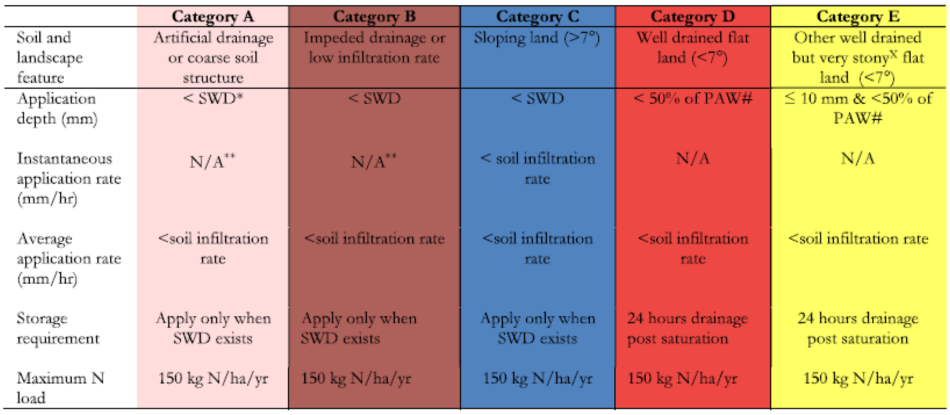
Agricultural Effluent

Policy 41 *Avoid adverse effects on water quality, and avoid as far as possible other adverse environmental effects, associated with the location, design, construction, operation and maintenance of agricultural effluent ponds.*

Policy 42 *Avoid adverse effects on water quality and other adverse environmental effects associated with the application of farm dairy effluent to land by matching farm dairy effluent management to receiving environment risk.*

From the explanation to Policy 42:
The following table defines minimum management criteria for the five soil/landscape categories identified in Map 1 of Appendix N based on the inherent risk for each soil/landscape category:

Table 1: Minimum management criteria for a land applied effluent system to achieve



	Category A	Category B	Category C	Category D	Category E
Soil and landscape feature	Artificial drainage or coarse soil structure	Impeded drainage or low infiltration rate	Sloping land (>7°)	Well drained flat land (<7°)	Other well drained but very stony^X flat land (<7°)
Application depth (mm)	< SWD*	< SWD	< SWD	< 50% of PAW#	≤ 10 mm & <50% of PAW#
Instantaneous application rate (mm/hr)	N/A**	N/A**	< soil infiltration rate	N/A	N/A
Average application rate (mm/hr)	<soil infiltration rate	<soil infiltration rate	<soil infiltration rate	<soil infiltration rate	<soil infiltration rate
Storage requirement	Apply only when SWD exists	Apply only when SWD exists	Apply only when SWD exists	24 hours drainage post saturation	24 hours drainage post saturation
Maximum N load	150 kg N/ha/yr	150 kg N/ha/yr	150 kg N/ha/yr	150 kg N/ha/yr	150 kg N/ha/yr

* SWD = soil water deficit (The amount of water (mm) required to restore a soil to field capacity from its current moisture status)

\# PAW = Plant available water (The state of top 300mm of soil after rapid drainage has effectively ceased and the soil water content has become relatively stable)

X Very stony= soils with > 35% stone content in the top 200 mm of soil

** N/A = Not an essential criteria, however level of risk and management is lowered if using low application rates

If all the criteria in the above table are met, the valuable nutrients contained within farm dairy effluent will be kept in the root zone so they can be taken up by plants, instead of being lost into groundwater or surface waterways. Similarly, compliance with these criteria is necessary to prevent the loss of harmful faecal microbes to water. A high level of management will be required on some soils, and at some times of the year to ensure full compliance with consent conditions.

Discussion

7.7.30 The effluent pond on WW1 is relatively new, was suitably designed and constructed with a resource consent.

7.7.31 The applicants have proposed to match the management of effluent to the level of risk aids in mitigating adverse effects on the dairy platforms. The size of the proposed discharge area is sufficiently sized on the dairy platforms to ensure that the effluent can act as a fertiliser, with the nutrients being available for uptake by vegetation cover, ensuring soil health and sufficient pasture production.

7.7.32 In regards to these aspects, the proposal is largely consistent with the above policies.

7.7.33 The application is not consistent with Policy 42 when considering the N loading on the Horner block from agricultural effluent discharge, as the proposal includes discharging 250 kg/N/ha/year, which is significantly higher than the maximum N loads set out in the explanation for Policy 42.

Proposed Southland Water and Land Plan

Ngai Tahu

Objective 3 *The mauri of waterbodies provide for te hauora o te tangata (health and mauri of the people), te hauora o te taiao (health and mauri of the environment) and te hauora o te wai (health and mauri of the waterbody).*

Objective 4 *Tangata whenua values and interests are identified and reflected in the management of freshwater and associated ecosystems.*

*Objective 15** *Taonga species, as set out in Appendix M, and related habitats, are recognised and provided for.*

*Policy 1** *Enable papatipu rūnanga to effectively undertake their kaitiaki (guardian/steward) responsibilities in freshwater and land management through the Southland Regional Council:*

1. *providing copies of all applications that may affect a Statutory Acknowledgement area, tōpuni (landscape features of special importance or value), nohoanga, mātaitai or taiāpure to Te Rūnanga o Ngāi Tahu and the relevant papatipu rūnanga;*
2. *identifying Ngāi Tahu interests in freshwater and associated ecosystems in Murihiku (includes the Southland Region); and*
3. *reflecting Ngāi Tahu values and interests in the management of and decision-making on freshwater and freshwater ecosystems in Murihiku (includes the Southland Region), consistent with the Charter of Understanding.*

Policy 2 *Any assessment of an activity covered by this Plan must:*

1. *take into account any relevant iwi management plan; and*
2. *assess water quality and quantity, taking into account Ngāi Tahu indicators of health.*

*Policy 3** *To manage activities that adversely affect Taonga species identified in Appendix M.*

Discussion

7.7.34 Te Tangi a Tauira, and the views of Te Runanga o Ngai Tahu and Te Ao Marama Inc have been taken into account in assessing the application. Te Ao Marama Inc has submitted on the application.

Physiographic Zones

*Policy 5** *In the Central Plains physiographic zone, avoid, remedy, or mitigate adverse effects on water quality from contaminants, by:*

1. *requiring implementation of good management practices to manage adverse effects on water quality from contaminants transported via artificial drainage and deep drainage;*
2. *having particular regard to adverse effects on water quality from contaminants transported via artificial drainage and deep drainage when assessing resource consent applications and preparing or considering Farm Environmental Management Plans; and*
3. *decision makers generally not granting resource consents for additional dairy farming of cows or additional intensive winter grazing where contaminant losses will increase as a result of the proposed activity.*

*Policy 6** *In the Gleyed, Bedrock/Hill Country and Lignite-Marine Terraces physiographic zone, avoid, remedy, or mitigate adverse effects on water quality from contaminants, by:*

1. *requiring implementation of good management practices to manage adverse effects on water quality from contaminants transported via artificial drainage, and overland flow where relevant; and*
2. *having particular regard to adverse effects on water quality from contaminants transported via artificial drainage, and overland flow where relevant when assessing resource consent applications and preparing or considering Farm Environmental Management Plans.*

*Policy 10** *In the Oxidising physiographic zone, avoid, remedy, or mitigate adverse effects on water quality from contaminants, by:*

1. *requiring implementation of good management practices to manage adverse effects on water quality from contaminants transported via deep drainage, and overland flow and artificial drainage where relevant;*
2. *having particular regard to adverse effects on water quality from contaminants transported via deep drainage, and overland flow and artificial drainage where relevant when assessing resource consent applications and preparing or considering Farm Environmental Management Plans; and*
3. *decision makers generally not granting resource consents for additional dairy farming of cows or additional intensive winter grazing where contaminant losses will increase as a result of the proposed activity.*

Policy 12A *Where site specific information is available that better identifies or delineates the relevant physiographic zones or contaminant loss pathways for a landholding or site, that information must be taken into account when undertaking activities, preparing Farm Environmental Management Plans or when determining resource consent applications for that landholding or site.*

Discussion

7.7.35 The physiographic zones relate to the classification of land and risks to water quality based on factors including soil types, landscape classification, climate, and topography and water chemistry. These have been developed to better understand Southland's water and why it is better quality in some areas than others.

7.7.36 Policies 5 and 10 are key policies for this application and have already been discussed further up this report.

7.7.37 Policy 6 also applies to the application as the WRO blocks are located within the Gleyed physiographic zone.

7.7.38 The applicants have implemented good management practices and have proposed a wide range of good management practices to mitigate adverse effects. The application proposes to have regard to the contaminant pathways, in particularly artificial drainage and overland flow associated with the Gleyed physiographic zone.

7.7.39 The proposed activities within the Gleyed physiographic zone are generally consistent with Policy 6 and have given regard to the direction of this policy. The effectiveness, however, of the good management practices and mitigation measures to avoid, remedy or mitigate adverse effects on water quality is hard to quantify.

Water Quality

Objective 1 *Land and water and associated ecosystems are sustainably managed as integrated natural resources, recognising the connectivity between surface water and groundwater, and between freshwater, land and the coast.*

*Objective 2** *Water and land is recognised as an enabler of primary production and the economic, social and cultural wellbeing of the region.*

*Objective 6** *There is no reduction in the overall quality of freshwater, and water in estuaries and coastal lagoons, by:*

- *(a) maintaining the quality of water in waterbodies, estuaries and coastal lagoons, where the water quality is not degraded; and*
- *(b) improving the quality of water in waterbodies, estuaries and coastal lagoons, that have been degraded by human activities.*

Objective 8

- *(a) The quality of groundwater that meets both the Drinking Water Standards for New Zealand 2005 (revised 2008) and any freshwater objectives, including for connected surface waterbodies, established under Freshwater Management Unit processes is maintained; and*
- *(b) The quality of groundwater that does not meet Objective 8(a) because of the effects of land use or discharge activities is progressively improved so that:*
  - *(1) groundwater (excluding aquifers where the ambient water quality is naturally less than the Drinking Water Standards for New Zealand 2005 (revised 2008)) meets the Drinking Water Standards for New Zealand 2005 (revised 2008); and*
  - *(2) groundwater meets any freshwater objectives and freshwater quality limits established under Freshwater Management Unit processes.*

*Objective 13B** *The discharges of contaminants to land or water that have significant or cumulative adverse effects on human health are avoided.*

*Objective 18** *All activities operate in accordance with "good management practice" or better to optimise efficient resource use, safeguard the life supporting capacity of the region's land and soils, and maintain or improve the quality and quantity of the region's water resources.*

Policy A4

1. *When considering any application for a discharge the consent authority must have regard to the following matters:*
   a. *the extent to which the discharge would avoid contamination that will have an adverse effect on the life-supporting capacity of fresh water including on any ecosystem associated with fresh water; and*
   b. *the extent to which it is feasible and dependable that any more than minor adverse effect on fresh water, and on any ecosystem associated with fresh water, resulting from the discharge would be avoided.*
2. *When considering any application for a discharge the consent authority must have regard to the following matters:*
   a. *the extent to which the discharge would avoid contamination that will have an adverse effect on the health of people and communities as affected by their contact with fresh water; and*
   b. *the extent to which it is feasible and dependable that any more than minor adverse effect on the health of people and communities as affected by their contact with fresh water resulting from the discharge would be avoided.*
3. *This policy applies to the following discharges (including a diffuse discharge by any person or animal):*
   a. *a new discharge; or*
   b. *a change or increase in any discharge – of any contaminant into fresh water, or onto or into land in circumstances that may result in that contaminant (or, as a result of any natural process from the discharge of that contaminant, any other contaminant) entering fresh water*.”

*Policy 13**

1. *Recognise that the use and development of Southland’s land and water resources, including for primary production, enables people and communities to provide for their social, economic and cultural wellbeing.*
2. *Manage land use activities and discharges (point source and non-point source) to enable the achievement of Policies 15A, 15B and 15C*.

*Policy 15A**

Where existing water quality meets the Appendix E Water Quality Standards or bed sediments meet the Appendix C ANZECC sediment guidelines, maintain water quality including by:

1. *avoiding, remedying or mitigating the adverse effects of new discharges, so that beyond the zone of reasonable mixing, those standards or sediment guidelines will continue to be met; and*
2. *requiring any application for replacement of an expiring discharge permit to demonstrate how the adverse effects of the discharge are avoided, remedied or mitigated, so that beyond the zone of reasonable mixing those standards or sediment guidelines will continue to be met.*

*Policy 15B**

Where existing water quality does not meet the Appendix E Water Quality Standards or bed sediments do not meet the Appendix C ANZECC sediment guidelines, improve water quality including by:

1. *avoiding where practicable and otherwise remedying or mitigating any adverse effects of new discharges on water quality or sediment quality that would exacerbate the exceedance of those standards or sediment guidelines beyond the zone of reasonable mixing; and*

2. *requiring any application for replacement of an expiring discharge permit to demonstrate how and by when adverse effects will be avoided where practicable and otherwise remedied or mitigated, so that beyond the zone of reasonable mixing water quality will be improved to assist with meeting those standards or sediment guidelines.*

*Policy 16**

1. *Minimising the adverse environmental effects (including on the quality of water in lakes, rivers, artificial watercourses, modified watercourses, wetlands, tidal estuaries and salt marshes, and groundwater) from farming activities by:*
    - *(a) discouraging the establishment of new dairy farming of cows or new intensive winter grazing activities in close proximity to Regionally Significant Wetlands and Sensitive Waterbodies identified in Appendix A; and*
    - *(b) ensuring that, in the interim period prior to the development of freshwater objectives under Freshwater Management Unit processes, applications to establish new, or further intensify existing, dairy farming of cows or intensive winter grazing activities will generally not be granted where:*
        - *(i) the adverse effects, including cumulatively, on the quality of groundwater, or water in lakes, rivers, artificial watercourses, modified watercourses, wetlands, tidal estuaries and salt marshes cannot be avoided or mitigated; or*
        - *(ii) existing water quality is already degraded to the point of being overallocated; or*
        - *(iii) water quality does not meet the Appendix E Water Quality Standards or bed sediments do not meet the Appendix C ANZECC sediment guidelines; and*
    - *(c) ensuring that, after the development of freshwater objectives under Freshwater Management Unit processes, applications to establish new, or further intensify existing, dairy farming of cows or intensive winter grazing activities:*
        - *(i) will generally not be granted where freshwater objectives are not being met; and*
        - *(ii) where freshwater objectives are being met, will generally not be granted unless the proposed activity (allowing for any offsetting effects) will maintain the overall quality of groundwater and water in lakes, rivers, artificial watercourses, modified watercourses, wetlands, tidal estuaries and salt marshes.*
2. *Requiring all farming activities, including existing activities, to:*
    - *(a) implement a Farm Environmental Management Plan, as set out in Appendix N; and*
    - *(b) actively manage sediment run-off risk from farming and hill country development by identifying critical source areas and implementing practices including setbacks from waterbodies, sediment traps, riparian planting, limits on areas or duration of exposed soils and the prevention of stock entering the beds of surface waterbodies; and*
    - *(c) manage collected and diffuse run-off and leaching of nutrients, microbial contaminants and sediment through the identification and management of critical source areas within individual properties.*

3. *When considering a resource consent application for farming activities, consideration should be given to the following matters:*
    (a) *whether multiple farming activities (such as cultivation, riparian setbacks, and winter grazing) can be addressed in a single resource consent; and*
    (b) *granting a consent duration of at least 5 years.*

*Policy 39** *When considering any application for resource consent for the use of land for a farming activity, the Southland Regional Council should consider all adverse effects of the proposed activity on water quality, whether or not this Plan permits an activity with that effect.*

*Policy 39A** *When considering the cumulative effects of land use and discharge activities within whole catchments, consider:*

1. *the integrated management of freshwater and the use and development of land including the interactions between freshwater, land and associated ecosystems (including estuaries); and*
2. *through the Freshwater Management Unit process, facilitating the collective management of nutrient losses, including through initiatives such as nutrient user groups and catchment management groups.*

Discussion

7.7.40 It is important to make a determination as to whether or not water quality standards are met, as this dictates whether or not the losses from the proposed activity are at such a scale that water quality is maintained, or whether the losses need to be mitigated to an extent where water quality is improved. The quality of the water in the receiving environment, for most parameters, exceeds the guidelines defined in the plan, and therefore water quality needs to be improved to meet the guidelines.

7.7.41 The application offers mitigations largely in the form of GMPs or rectifying unlawful activities, in an attempt to mitigate the adverse effects from the proposal. It is hard to quantify the effectiveness of these GMPs and when considering cumulative effects, it is likely that, rather than improving water quality as is required by the plans, a decrease in water quality will result due to the proposed activities occurring. The applicants' nutrient budgets demonstrate that losses over the entire landholding will decrease slightly. However, it is expected that losses will increase from the WW1 dairy platform due to the introduction of additional cows. The results of the Overseer budgets are contentious due to the soil types, the modelling of unlawful activities and state of change the farming operation has been through recently, and as such, it is questionable if the losses will actually decrease over the entire landholding.

7.7.42 With the exception of Policies 15b and 16, which have already been discussed in the key policies section, the application is generally consistent with the remainder of relevant policies, as it demonstrates how and when adverse effects will be avoided, but the effectiveness of such actions is uncertain. This is largely when considering the overall farming activities as opposed to just the discharge of effluent.

Effluent Management

*Policy 14** *Prefer discharges of contaminants to land over discharges of contaminants to water, unless adverse effects associated with a discharge to land are greater than* *a discharge to water. Particular regard shall be given to any adverse effects on cultural values associated with a discharge to water.*

Policy 17*

1. *Avoid significant adverse effects on water quality, and avoid, remedy, or mitigate other adverse effects of the operation of, and discharges from, agricultural effluent management systems.*
2. *Manage agricultural effluent systems and discharges from them by:*
    - *(a) designing, constructing and locating systems appropriately and in accordance with best practice; and*
    - *(b) maintaining and operating effluent systems in accordance with best practice guidelines; and*
    - *(c) avoiding any surface run-off or overland flow, ponding or contamination of water, including via sub-surface drainage, resulting from the application of agricultural effluent to pasture; and*
    - *(d) avoiding the discharge of untreated agricultural effluent to water.*

Note: Examples of best practice referred to in Policy 17(2)(a) for agricultural effluent include IPENZ Practice Note 21: Farm Dairy Effluent Pond Design and Construction and IPENZ Practice Note 27: Dairy Farm Infrastructure.

Note: Examples of best practice guidelines referred to in Policy 17(2)(b) for agricultural effluent include DairyNZ's guidelines A Farmer's Guide to Managing Farm Dairy Effluent – A Good Practice Guide for Land Application Systems, 2015 and A Staff Guide to Operating Your Effluent Irrigation System, 2013.

Discussion

7.7.43 Policy 17 is a key policy for this proposal and I have discussed it in the key policies section above.

Water Quantity

Objective 11* *The amount of water abstracted is shown to be reasonable for its intended use and water is allocated and used efficiently.*

Objective 12 *Groundwater quantity is sustainably managed, including safeguarding the life-supporting capacity, ecosystem processes and indigenous species of surface water bodies where their flow is, at least in part, derived from groundwater.*

Policy B7

1. *When considering any application the consent authority must have regard to the following matters:*
    - *a. the extent to which the change would adversely affect safeguarding the life-supporting capacity of fresh water and of any associated ecosystem and*
    - *b. the extent to which it is feasible and dependable that any adverse effect on the life-supporting capacity of fresh water and of any associated ecosystem resulting from the change would be avoided.*
2. *This policy applies to:*
    - *a. any new activity and*
    - *b. change in the character, intensity or scale of any established activity –*

that involves any taking, using, damming or diverting of fresh water or draining of any wetland which is likely to result in any more than minor adverse change in the natural variability of flows or level of any fresh water, compared to that which immediately preceded the commencement of the new activity or the change in the established activity (or in the case of a change in an intermittent or seasonal activity, compared to that on the last occasion on which the activity was carried out).

*Policy 20** *Manage the taking, abstraction, use, damming or diversion of surface water and groundwater so as to:*

- *1A. recognise that the use and development of Southland's land and water resources, including for primary production, can have positive effects including enabling people and communities to provide for their social, economic and cultural wellbeing;*
- *1. avoid, remedy or mitigate adverse effects from the use and development of surface water resources on:*
  - *(a) the quality and quantity of aquatic habitat, including the life supporting capacity and ecosystem health and processes of waterbodies;*
  - *(b) natural character values, natural features, and amenity, aesthetic and landscape values;*
  - *(c) areas of significant indigenous vegetation and significant habitats of indigenous fauna;*
  - *(d) recreational values;*
  - *(e) the spiritual and cultural values and beliefs of tangata whenua;*
  - *(f) water quality, including temperature and oxygen content;*
  - *(g) the reliability of supply for lawful existing surface water users, including those with existing, but not yet implemented, resource consents;*
  - *(h) groundwater quality and quantity;*
  - *(j) mātaitai, taiāpure and nohoanga;*
- *2. avoid, remedy or mitigate significant adverse effects from the use and development of groundwater resources on:*
  - *(a) long-term aquifer storage volumes;*
  - *(b) the reliability of supply for lawful existing groundwater users, including those with existing, but not yet implemented, resource consents;*
  - *(c) surface water flows and levels, particularly in spring-fed streams, natural wetlands, lakes, aquatic ecosystems and habitats (including life supporting capacity and ecosystem health and processes of waterbodies) and their natural character; and*
  - *(d) water quality;*
  - *3. ensure water is used efficiently and reasonably by requiring that the rate and volume of abstraction specified on water permits to take and use water are no more than reasonable for the intended end use following the criteria established in Appendix O and Appendix L.4.*

Policy 21 *Manage the allocation of surface water and groundwater by:*

1. *determining the primary allocation for confined aquifers not identified in Appendix L.5, following the methodology established in Appendix L.6;*
2. *determining that a waterbody is fully allocated when the total volume of water allocated through current resource consents and permitted activities is equal to either:*
    - *(a) the maximum amount that may be allocated under the rules of this Plan, or*
    - *(b) the provisions of any water conservation order;*
3. *enabling secondary allocation of surface water and groundwater subject to appropriate surface water environmental flow regimes, minimum lake and wetland water levels, minimum groundwater level cutoffs or seasonal recovery triggers, to ensure:*
    - *(a) long-term aquifer storage volumes are maintained; and*
    - *(b) the reliability of supply for existing groundwater users (including those with existing resource consents for groundwater takes that have not yet been implemented) is not adversely affected;*
4. *when considering levels of abstraction, recognise the need to exclude takes for non-consumptive uses that return the same amount (or more) water to the same aquifer or a hydraulically connected lake, river, modified watercourse or natural wetland.*

Policy 22 *Manage the effects of surface and groundwater abstractions by:*

1. *avoiding allocating water to the extent that the effects on surface water flow would not safeguard the mauri of that waterway and mahinga kai, taonga species or the habitat of trout and salmon;*
2. *ensuring interference effects are acceptable, in accordance with Appendix L.3;*
3. *utilising the methodology established in Appendix L.2 to:*
    - *(a) manage the effects of consented groundwater abstractions on surface waterbodies; and*
    - *(b) assess and manage the effects of consented groundwater abstractions in groundwater management zones other than those specified in Appendix L.5.*

Policy 23 *Manage stream depletion effects resulting from groundwater takes which are classified as having a Riparian, Direct, High or Moderate hydraulic connection, as set out in Appendix L.2 Table L.2, to ensure the cumulative effect of those takes does not:*

1. *exceed any relevant surface water allocation regime (including those established under any water conservation order) for groundwater takes classified as Riparian, Direct, High or Moderate hydraulic connection; or*
2. *result in abstraction occurring when surface water flows or levels are less than prescribed minimum flows or groundwater levels for takes classified as Riparian, Direct or High hydraulic connection.*

*Policy 42** *When considering resource consent applications for water permits to take and use water:*

1. *except for non-consumptive uses, consent will not be granted if a water body is over allocated or fully allocated; or to grant consent would result in a water body becoming over allocated or would not allow an allocation*

target for a water body to be achieved within a time period defined in this Plan; and

2. *except for non-consumptive uses, consents replacing an expiring resource consent for an abstraction from an over-allocated water body will generally only be granted at a reduced rate, the reduction being proportional to the amount of over-allocation and previous use, using the method set out in Appendix O; and*
3. *installation of water measuring devices will be required on all new permits to take and use water and on existing permits in accordance with the Resource Management (Measurement and Reporting of Water Takes) Regulations 2010; and*
4. *where appropriate, minimum level or flow cut-offs and seasonal recovery triggers on resource consents for groundwater abstraction will be imposed; and*
5. *conditions will be specified relating to a minimum flow or level, or environmental flow or level regime (which may include flow sharing), in accordance with Appendix K, for all new or replacement resource consents (except for water permits for non-consumptive uses, community water supplies and water bodies subject to minimum flow and level regimes established under any water conservation order) for:*
   - *(a) surface water abstraction, damming, diversion and use; and*
   - *(b) groundwater abstraction in accordance with Policy 23.*

Discussion

7.7.44 The application is not from an over-allocated groundwater zone and the proposed groundwater take will not result in any over-allocation when assessed against the planning framework. Consent conditions will require that the water take is metered, and abstraction records provided to Council.

7.7.45 However, the water take is not in line with reasonable and efficient use of water, is for more than 2 l/s and it is not known what the stream depletion effects will be under the proposal. Due to these factors, I am not able to say with certainty that the application is consistent with the above policies as these factors were not adequately assessed in the application.

Freshwater Management Unit

Policy 44 *Te Mana o te Wai is recognised at a regional level by tangata whenua and the local community identifying values held for, and associations with, a particular waterbody and freshwater management unit.*

Particular regard will be given to the following values, alongside any additional regional and local values determined in the Freshwater Management Unit limit setting process:

- *Te Hauora o te Wai (the health and mauri of water);*
- *Te Hauora o te Tangata (the health and mauri of the people);*
- *Te Hauora o te Taiao (the health and mauri of the environment);*
- *Mahinga kai;*
- *Mahi māra (cultivation);*
- *Wai Tapu (Sacred Waters);*
- *Wai Māori (municipal and domestic water supply);*

- *Āu Putea (economic or commercial value);*
- *He ara haere (navigation).*

*Policy 45** *In response to Ngāi Tahu and community aspirations and local water quality and quantity issues, FMU sections may include additional catchment-specific values, objectives, policies, attributes, rules and limits which will be read and considered together with the Region-wide Objectives and Region-wide Policies. Any provision on the same subject matter in the relevant FMU section of this Plan prevails over the relevant provision within the Region-wide Objectives and Region-wide Policy sections, unless it is explicitly stated to the contrary.*

As the FMU sections of this Plan are developed in a specific geographical area, FMU sections will not make any changes to the Region-wide Objectives or Region-wide Policies.

Note: It would be unfair if changes are made to Region-wide objectives and policies, which apply in other parts of Southland, without the involvement of those wider communities.

*Policy 46** *The FMU Sections of this Plan are based on the following identified Freshwater Management Units for Southland, as shown on Map Series 6: Freshwater Management Units:*

- *Fiordland and the islands;*
- *Aparima;*
- *Mataura;*
- *Ōreti; and*
- *Waiau.*

Discussion

7.7.46 The above provisions relate to the identification of Freshwater Management Units (FMU) and the subsequent development of polices and rules. As part of this process it is likely that water quality and quantity limits will be set for each unit. This is part of the process of addressing water quality and the direction provided by the NPS for Freshwater Management 2014. The site is located within the Aparima and Oreti FMUs.

Consent Duration and Monitoring

*Policy 40** *When determining the term of a resource consent consideration will be given, but not limited, to:*

1. *granting a shorter duration than that sought by the applicant when there is uncertainty regarding the nature, scale, duration and frequency of adverse effects from the activity or the capacity of the resource;*
2. *relevant tangata whenua values and Ngāi Tahu indicators of health;*
3. *the duration sought by the applicant and reasons for the duration sought;*
4. *the permanence and economic life of any capital investment;*
5. *the desirability of applying a common expiry date for water permits that allocate water from the same resource or land use and discharges that may affect the quality of the same resource;*
6. *the applicant's compliance with the conditions of any previous resource consent, and the applicant's adoption, particularly voluntarily, of good management practices; and*

7. the timing of development of FMU sections of this Plan, and whether granting a shorter or longer duration will better enable implementation of the revised frameworks established in those sections.

Policy 41	*Consider the risk of adverse environmental effects occurring and their likely magnitude when determining requirements for auditing and supply of monitoring information on resource consents.*

Discussion

7.7.47 The applicants have applied for a term of 15 years. I consider that as the effects from the proposal are likely to be significant and the activity is inconsistent with policy, the application should be declined. However, if the decision-makers decide the application is able to be granted, the above policies will apply when considering consent duration.

7.7.48 I consider that a shorter term to align with the upcoming limit-setting process in 2025 would be appropriate if consent is granted.

Regional Effluent Land Application Plan

7.7.49 The Regional Effluent Land Application Plan was notified in 1996 and became operative on 30 May 1998.

7.7.50 The objectives and policies of the Regional Effluent Land Application Plan that are relevant to this application are:

Objective 4.1.2	*To ensure that water quality and the life supporting capacity of the water ecosystem is safeguarded from the adverse effects of discharges of effluent and sludge onto or into land which may enter water.*
Objective 4.1.3	*To ensure that effluent and sludge discharges onto or into land do not adversely affect human and animal health.*
Objective 4.1.5	*To recognise and provide for the relationship of takata whenua with ancestral sites, wahi tapu and other taoka.*
Policy 4.2.2	*Utilise land treatment of effluent and sludge where this can be undertaken in a sustainable manner and without significant adverse effects.*
Policy 4.2.3	*Avoid where practicable, remedy or mitigate adverse effects on water quality, water ecosystems and water potability from effluent and sludge discharges onto or into land.*
Policy 4.2.4	*Adopt a precautionary approach to the discharge of effluent and sludge onto or into land where there are uncertainties regarding adverse effects.*
Policy 4.2.6	*Avoid where practicable, remedy or mitigate any adverse effects to human and animal health arising from discharges of effluent and sludge onto or into land.*
Policy 4.2.8	*Recognise and provide for takata whenua concerns related to the discharge of effluent and sludge onto or into land.*

Policy 4.2.10	*Monitor, as appropriate, discharges of effluent and sludge onto or into land and, where practicable, the effects.*

Discussion

7.7.51 The RELAP plan is relevant to the discharge of agricultural effluent for this application due to the combination of winter sludge and dairy shed effluent. The plan is from 1998 and is outdated when compared to national planning framework, however the plan needs to still be considered when assessing the proposal. I consider the proposal is largely consistent with the policies contained in the RELAP, however, adverse effects arising from significant N loading would not align with Policy 4.2.3.

Policy assessment conclusion

7.7.52 The proposed activities have been considered against the relevant policies of the Regional Effluent Land Application Plan, Regional Water Plan and the proposed Southland Water and Land Plan. The key policies in all plans relate to water quality and the maintenance and improvement of it. Depending on the conclusion drawn regarding the effectiveness of the GMPs offered in the proposal, the application can be considered contrary to the key policies of the plans that I have outlined at the beginning of this policy assessment. I also consider it is inconsistent with other certain policies.

7.7.53 In this policy assessment greater weight has been given to the provisions of the proposed Southland Water and Land Plan because it has been through the hearing process, has more specific policies and direction and gives effect to the most recent National Policy Statement for Freshwater Management, whereas the Regional Water Plan and the Regional Effluent Land Application Plan did not. As such, it is considered appropriate that greater weight is placed on the proposed Southland Water and Land Plan.

7.8.0 Relevant provisions of a regional policy statement (Section 104(1)(b)(v))

7.8.1 *Southland Regional Policy Statement*

7.8.2 The Southland Regional Policy Statement 2017 became operative on 9 October 2017.

7.8.3 The following objectives and policies in the Regional Policy Statement are of particular relevance to this application. In some cases below the policies have been abbreviated to exclude clauses that are not relevant to the application[11].

Objective TW.3	*Mauri and wairua are sustained or improved where degraded, and mahinga kai and customary resources are healthy, abundant and accessible to tangata whenua.*
Objective TW.4	*Wāhi tapu, wāhi taonga and sites of significance are appropriately managed and protected.*
Policy TW.3	*Take iwi management plans into account within local authority resource management decision making processes.*

---

[11] Full versions of the policies can be viewed at: https://www.es.govt.nz/Document%20Library/Plans,%20policies%20and%20strategies/Regional%20policy%20statement/Southland%20Regional%20Policy%20Statement%202017.pdf

Policy TW.4

When making resource management decisions, ensure that local authority functions and powers are exercised in a manner that:

- *(a) recognises and provides for:*
    - *(i) traditional Māori uses and practices relating to natural resources (e.g. mātaitai, kaitiakitanga, manaakitanga, matauranga, rāhui, wāhi tapu, taonga raranga);*
    - *(ii) the ahi kā (manawhenua) relationship of tangata whenua with and their role as kaitiaki of natural resources;*
    - *(iii) mahinga kai and access to areas of natural resources used for customary purposes;*
    - *(iv) mauri and wairua of natural resources;*
    - *(v) places, sites and areas with significant spiritual or cultural historic heritage value to tangata whenua;*
    - *(vi) Māori environmental health and cultural wellbeing.*
- *(b) recognises that only tangata whenua can identify their relationship and that of their culture and traditions with their ancestral lands, water, sites, wāhi tapu and other taonga.*

Objective WQUAL.1

Water quality in the region:

- *(a) safeguards the life-supporting capacity of water and related ecosystems;*
- *(b) safeguards the health of people and communities;*
- *(c) is maintained, or improved in accordance with freshwater objectives formulated under the National Policy Statement for Freshwater Management 2014;*
- *(d) is managed to meet the reasonably foreseeable social, economic and cultural needs of future generations.*

Objective WQUAL.2

Halt the decline, and improve water quality in lowland water bodies and coastal lakes, lagoons, tidal estuaries, salt marshes and coastal wetlands in accordance with freshwater objectives formulated in accordance with the National Policy Statement for Freshwater Management 2014.

Policy WQUAL.1

- *(a) Identify values of surface water, groundwater, and water in coastal lakes, lagoons, tidal estuaries, salt marshes and coastal wetlands, and formulate freshwater objectives in accordance with the National Policy Statement for Freshwater Management 2014; and*
- *(b) Manage discharges and land use activities to maintain or improve water quality to ensure freshwater objectives in freshwater management units are met.*

Policy WQUAL.2

Maintain or improve water quality, having particular regard to the following contaminants:

- *(a) nitrogen;*
- *(b) phosphorus;*
- *(c) sediment;*
- *(d) microbiological contaminants.*

Policy WQUAL.7

Recognise the social, economic and cultural benefits that may be derived from the use, development or protection of water resources.

Policy WQUAL.8	*Prefer discharges of contaminants to land over discharges of contaminants to water, where:* *(a) a discharge to land is practicable;* *(b) the adverse effects associated with a discharge to land are less than a discharge to water.*
Policy WQUAL.9	*Avoid the direct discharge of sewage, wastewater, industrial and trade waste and agricultural effluent to water unless these discharges have undergone treatment.*
Policy WQUAL.10	*Manage the siting and operation of activities that result in point source discharges of contaminants to land to ensure that adverse effects on groundwater, surface water and coastal water quality are avoided, remedied or mitigated.*
Policy WQUAL.11	*Avoid, as far as practicable, remedy or mitigate the risks that the adverse effects of land use activities and discharges of contaminants have on the sources of community water supplies.*
Policy WQUAL.12	*Integrate the management of land use, water quality, water quantity, coast and air, and the use, development and protection of resources wherever possible to achieve the freshwater objectives formulated in accordance with Policy WQUAL.1.*
Policy RURAL.1	*Recognise that use and development of Southland's rural land resource enables people and communities to provide for their social, economic and cultural wellbeing.*
Policy RURAL.5	*The effects of rural land development shall be sustainably managed and land management practices encouraged so that:* *(a) soil properties are safeguarded;* *(b) soil erosion is minimised;* *(c) soil compaction and nutrient and sediment loss is minimised;* *(d) soil disturbance is reduced;* *(e) water quality is maintained or enhanced;* *(f) indigenous biodiversity is maintained or enhanced;* *(g) the mauri of water and soils is safeguarded.*
Policy WQUAN.2	*Avoid over-allocation of surface water and groundwater, and resolve any historical instances of overallocation, while recognising the special provisions made for the Waiau catchment.*
Policy WQUAN.6	*(a) Ensure that any water taken from surface water or groundwater is used efficiently.* *(b) Where fresh water bodies are approaching full allocation, consider establishing management provisions to maximise the efficiency of using any available water.*
Policy WQUAN.8	*Integrate the management of land use, water quality, water quantity and use and development of resources wherever possible.*

Discussion

7.8.4 I consider that the proposal is inconsistent with the key policies and objectives in the RPS, which seek to halt the decline of water quality and instead maintain and enhance it. For reasons already detailed in this report, I do not consider that the application will maintain and enhance water quality, as required by the RPS.

7.9.0 Relevant provisions of national policy statements (Section 104(1)(b)(iii))

National Policy Statement for Freshwater Management (NPSFM) 2014

7.9.1 The NPSFM supports improved freshwater management in New Zealand. It does this by directing regional Councils to establish objectives and set limits for fresh water in their regional plans.

7.9.2 I consider that the pSWLP gives effect to the NPSFM, and as I have given the more up-to-date plan more weight than the operative plans I have only summarised the policies that I believe are relevant.

7.9.3 The following objectives in the National Policy Statement for Freshwater Management (NPSFM) 2014 are of particular relevance to this application:

Te Mana o te Wai

Objective AA1 *To consider and recognise Te Mana o te Wai in the management of fresh water.*

Discussion

7.9.4 The National Policy Statement explains that Te Mana o te Wai is the integrated and holistic well-being of a freshwater body, and it incorporates the values of tangata whenua and the wider community in relation to each water body. Upholding Te Mana o te Wai acknowledges and protects the mauri of the water. This requires that in using water you must also provide for Te Hauora o te Taiao (the health of the environment), Te Hauora o te Wai (the health of the waterbody) and Te Hauora o te Tangata (the health of the people).

Water Quality

Objective A1 *To safeguard:*

a) the life-supporting capacity, ecosystem processes and indigenous species including their associated ecosystems, of fresh water; and

b) the health of people and communities, as affected by contact with fresh water;

in sustainably managing the use and development of land, and of discharges of contaminants.

Objective A2 *The overall quality of fresh water within a freshwater management unit is maintained or improved while:*

a) protecting the significant values of outstanding freshwater bodies;

b) protecting the significant values of wetlands; and *c) improving the quality of fresh water in water bodies that have been degraded by human activities to the point of being over-allocated.*

Objective A3

The quality of fresh water within a freshwater management unit is improved so it is suitable for primary contact more often, unless:
a) regional targets established under Policy A6(b) have been achieved; or
b) naturally occurring processes mean further improvement is not possible.

Objective A4

To enable communities to provide for their economic well-being, including productive economic opportunities, in sustainably managing freshwater quality, within limits.

Policy A4

By every regional Council amending regional plans (without using the process in Schedule 1) to the extent needed to ensure the plans include the following policy to apply until any changes under Schedule 1 to give effect to Policy A1 and Policy A2 (freshwater quality limits and targets) have become operative:

1. *"When considering any application for a discharge the consent authority must have regard to the following matters:*
    a. *the extent to which the discharge would avoid contamination that will have an adverse effect on the life-supporting capacity of fresh water including on any ecosystem associated with fresh water; and*
    b. *the extent to which it is feasible and dependable that any more than minor adverse effect on fresh water, and on any ecosystem associated with fresh water, resulting from the discharge would be avoided.*
2. *When considering any application for a discharge the consent authority must have regard to the following matters:*
    a. *the extent to which the discharge would avoid contamination that will have an adverse effect on the health of people and communities as affected by their contact with fresh water; and*
    b. *the extent to which it is feasible and dependable that any more than minor adverse effect on the health of people and communities as affected by their contact with fresh water resulting from the discharge would be avoided.*
3. *This policy applies to the following discharges (including a diffuse discharge by any person or animal):*
    a. *a new discharge; or*
    b. *a change or increase in any discharge – of any contaminant into fresh water, or onto or into land in circumstances that may result in that contaminant (or, as a result of any natural process from the discharge of that contaminant, any other contaminant) entering fresh water."*

Policy A7

By every regional Council considering, when giving effect to this national policy statement, how to enable communities to provide for their economic well-being, including productive economic opportunities, while managing within limits.

Water Quantity

Objective B1	*To safeguard the life-supporting capacity, ecosystem processes and indigenous species including their associated ecosystems of fresh water, in sustainably managing the taking, using, damming, or diverting of fresh water.*
Objective B3	*To improve and maximise the efficient allocation and efficient use of water.*
Policy B5	*By every regional Council ensuring that no decision will likely result in future over-allocation – including managing fresh water so that the aggregate of all amounts of fresh water in a freshwater management unit that are authorised to be taken, used, dammed or diverted does not over-allocate the water in the freshwater management unit.*
Policy B6	*By every regional Council setting a defined timeframe and methods in regional plans by which over-allocation must be phased out, including by reviewing water permits and consents to help ensure the total amount of water allocated in the freshwater management unit is reduced to the level set to give effect to Policy B1.*

Policy B7

1. *When considering any application the consent authority must have regard to the following matters:*
    - a. *the extent to which the change would adversely affect safeguarding the life-supporting capacity of fresh water and of any associated ecosystem and*
    - b. *the extent to which it is feasible and dependable that any adverse effect on the life-supporting capacity of fresh water and of any associated ecosystem resulting from the change would be avoided.*
2. *This policy applies to:*
    - a. *any new activity and*
    - b. *change in the character, intensity or scale of any established activity –*

    that involves any taking, using, damming or diverting of fresh water or draining of any wetland which is likely to result in any more than minor adverse change in the natural variability of flows or level of any fresh water, compared to that which immediately preceded the commencement of the new activity or the change in the established activity (or in the case of a change in an intermittent or seasonal activity, compared to that on the last occasion on which the activity was carried out).

Policy B8

By every regional Council considering, when giving effect to this national policy statement, how to enable communities to provide for *their economic well-being, including productive economic opportunities, while managing within limits.*

Discussion

7.9.5 The application is from a lowly allocated groundwater management zone, and there is no dispute over the volume of water available to be allocated, however as detailed earlier in this report the application has not adequately assessed the effects of the proposed increase in take, so I am unable to say with certainty that the application is consistent with the NPSFM.

Integrated management

Objective C1	*To improve integrated management of fresh water and the use and development of land in whole catchments, including the interactions between fresh water, land, associated ecosystems and the coastal environment.*
Policy C1	*By every regional Council managing fresh water and land use and development in catchments in an integrated and sustainable way, so as to avoid, remedy or mitigate adverse effects, including cumulative effects.*

Discussion

7.9.6 These provisions provide helpful links between land use and water quality but also between groundwater and surface water.

Tāngata whenua roles and interests

Objective D1	*To provide for the involvement of iwi and hapū, and to ensure that tāngata whenua values and interests are identified and reflected in the management of fresh water including associated ecosystems, and decision-making regarding freshwater planning, including on how all other objectives of this national policy statement are given effect to.*
Policy D1	*Local authorities shall take reasonable steps to involve iwi and hapū in the management of fresh water and freshwater ecosystems in the region; work with iwi and hapū to identify tāngata whenua values and interests in fresh water and freshwater ecosystems in the region; and reflect tāngata whenua values and interests in the management of, and decision-making regarding, fresh water and freshwater ecosystems in the region.*

Discussion

7.9.7 Iwi have not been involved with this application, however, they were involved with the development of the regional plans. Te Ao Marama Inc has submitted on the application.

7.10.0 Relevant provisions of National Environmental Standards and other regulations (Section 104(1)(b)(i) and (ii))

National Environmental Standard for Sources of Human Drinking Water Regulations 2007

7.10.1 This NES is relevant to any application for a discharge permit. These regulations aim to reduce the risk of drinking water sources being contaminated. Regulations 7 and 8 only apply to an activity that has the potential to affect a registered drinking-water supply that provides no fewer than 501 people with drinking water for not less than 60 days each calendar year.

Discussion

7.10.2 As detailed earlier in this report, the activity is in proximity to two registered drinking-water supply that provides water to more than 501 people. The Southland District Council takes water from the Aparima River at Otautau for >501 people. The Invercargill City Council takes water from the Oreti River for >501 people.

7.10.3 The proposed activity is not expected to adversely affect the registered drinking water supply at Otautau as the take is up-gradient of this take.

7.10.4 The proposed activity is likely to have a cumulative effect on the Oreti River water take, however it is difficult to quantify to what extent this will occur.

7.11.0 Any other matters considered relevant and reasonably necessary to determine the application (Section 104(1)(c))

Te Tangi a Tauira

7.11.1 Given Policy 1A of the Regional Water Plan and Policy 2(a) of the proposed Water and Land Plan, I consider that Te Tangi a Tauira, the Iwi Management Plan for Southland, is a matter that is relevant and reasonably necessary for the determination of this application.

7.11.2 Section 1.10 of Te Tangi a Tauira states that:

> *The content and structure of this Plan reflects its primary purpose: to provide a living, working document that can assist Ngāi Tahu ki Murihiku to effectively participate in environmental policy and planning.*
>
> *The information in this Plan also provides a resource for local authorities and other government agencies that have an influence over or manage environmental and natural resources. The plan may be used to:*
>
> - *ensure that Ngāi Tahu ki Murihiku, issues and policies are clearly visible in local regional planning documents;*
> - *determine the nature and extent of consultation that may be required with regards to particular activities or places of importance; and*
> - *determine the kinds of information Ngāi Tahu ki Murihiku may require to make informed decisions.*

7.11.3 The policies that are most relevant to this application are:

General Water Policy (Section 3.5.10)

Policy 1	*The role of Ngāi Tahu ki Murihiku as kaitiaki of freshwater must be given effect to in freshwater policy, planning and management.*
Policy 3	*Protect and enhance the mauri, or life supporting capacity, of freshwater resources throughout Murihiku.*

Policy 4	*Manage our freshwater resources wisely, mō tātou, ā, mō ngā uri ā muri ake nei, for all of us and the generations that follow.*
Policy 5	*Promote the management of freshwater according to the principle of ki uta ki tai, and thus the flow of water from source to sea.*
Policy 8	*Protect and enhance the customary relationship of Ngāi Tahu ki Murihiku with freshwater resources.*

Farm Effluent Management (Section 3.5.1)

Policy 4	*Sustain and safeguard the life supporting capacity of soils for future generations.*
Policy 7	*Require soil risk assessments prior to consent for discharge to land, to assess the suitability and capability of the receiving environment. Effluent should be applied at rates that match the ability of land to absorb it.*
Policy 8	*Require best practice for land application of managing farm effluent, in order to minimise adverse effects on the environment. This includes:* *a. application rates that are specific to region and soil type;* *b. use of low rate effluent irrigation technology;* *c. use of appropriate irrigation technology to avoid irrigating over tile drains (e.g. K-line);* *d. storing effluent when the soil is too wet or heavy to irrigate;* *e. storing effluent when heaving pugging by stock has occurred;* *f. sealed storage ponds to avoid leaching of nutrients to groundwater;* *g. avoiding ponding of effluent on paddocks;* *h. monitoring of soils and groundwater (see Policy 16);* *i. developing contingency plans (e.g. for exceptionally wet years).*
Policy 11	*Avoid any surface run-off/overland flow, ponding, or contamination of water resulting from the application of dairy shed effluent to pasture.*
Policy 13	*Require the establishment of appropriate buffer zones between discharge activities and waterways (including ephemeral and waterways <3 m). The size of buffer zones should reflect local geography (e.g. size of the waterway, nature and extent of existing riparian area, boundary fences).*
Policy 14	*Require the establishment of buffer zones of at least 100 m between discharge activities and bores.*
Policy 15	*All spray drift, as a product of spray irrigation of effluent, must be managed and contained within the boundaries of the consent area.*
Policy 16	*Require monitoring provisions as a condition of consent on any discharge to land. This should include monitoring water quality (e.g. representative water samples upstream and downstream), and soil nitrogen loads.*

Policy 17	*Advocate for duration not exceeding 25 years for discharge of farm effluent to land consent applications, with opportunities for review within that time. The duration of consents must reflect potential risk to soils and water.*

Discharge to Water (Section 3.5.12)

Discharges to water may be point source discharge (e.g. actual discharges to water), or non-point source discharge (e.g. from land to water).

Policy 2	*Assess discharge to water proposals on a case by case basis, with a focus on local circumstances and finding local solutions.*
Policy 3	*Consider any proposed discharge activity in terms of the nature of the discharge, and the sensitivity of the receiving environment.*
Policy 7	*Any discharge activity must include a robust monitoring programme that includes regular monitoring of the discharge and the potential effects on the receiving environment.*
Policy 8	*Require robust monitoring of discharge permits, to detect non-compliance with consent conditions. Noncompliance must result in appropriate enforcement action to discourage further non-compliance.*
Policy 9	*Promote the use of the Cultural Health Index (CHI)*[12] *as a tool to facilitate monitoring of stream health, and to provide long term data that can be used to assess river health over time.*

Water Quality (Section 3.5.13)

Policy 2	*Strive for the highest possible standard of water quality that is characteristic of a particular place/waterway, recognising principles of achievability. This means that we strive for drinking water quality in water we once drank from, contact recreation in water we once used for bathing or swimming, water quality capable of sustaining healthy mahinga kai in waters we use for providing kai.*
Policy 3	*Require cumulative effects assessments for any activity that may have adverse effects of water quality.*
Policy 7	*When assessing the effects of an activity on water quality, where the water source is in a degraded state, the effects should be measured against the condition that the water source should be, and not the existing condition of the water source (see text box on this page).*

Comment from water quality section, page 159:

---

[12] The Cultural Health Index Assessment is a tool developed to help Rūnanga quantitatively assess the health of waterways, and participate in the management of water resources. See Tipa, G. and Teirney, L. 2003.

"For Ngāi Tahu ki Murihiku, it is not enough to say that a proposed activity will not have adverse effects on the current condition of a waterway. Many of our waterways need to be improved, and human use (e.g. abstractions, discharge) should be conditional on improving the current state of waterways where needed.

We need to be requiring improvements and enhancements to river health and water quality. An activity should do more than ensure it won't degrade a river any further."

Water Quantity (Section 3.5.14)

Policy 4	*In the Southland Plains region, the preference of Ngāi Tahu ki Murihiku is for water takes from bores, as opposed to surface water abstractions.*
Policy 11	*Avoid excessive drawdown of aquifer levels as a result of groundwater abstractions, and to ensure that abstractions do not compromise the recovery of groundwater levels between irrigation seasons.*
Policy 20	*Avoid adverse effects on the base flow of any waterway, and thus on the mauri of that waterway and on mahinga kai or taonga species.*

Stream Health Indicators

7.11.4 Policy 2(2) of the Proposed Southland Water and Land Plan requires assessment of water quality and quantity, taking into account Ngāi Tahu indicators of health. Section 3.5.11 of Te Tangi a Tauira contains the following:

Indicators used by tangata whenua to assess stream health:

- *Shape of the river*
- *Sediment in the water*
- *Water quality in the catchment*
- *Flow characteristics*
- *Flow variations*
- *Flood flows*
- *Sound of flow*
- *Movement of water*
- *Fish are safe to eat*
- *Uses of the river*
- *Safe to gather plants*
- *Indigenous vs. exotic species*
- *Natural river mouth environment*
- *Water quality*
- *Abundance and diversity of species*
- *Natural and extent of riparian vegetation*
- *Use of river margin*
- *Temperature*
- *Catchment land use*
- *Riverbank condition*
- *Water is safe to drink*
- *Clarity of the water*
- *Is the name of the river an indicator?*

Discussion

7.11.5 From a planning perspective, I consider that the application is largely consistent with most relevant policies in Te Tangi a Tauira, as the applicants are proposing monitoring conditions that are appropriate for the activity. There are two policies that I consider the application does not align with in terms of water quality, Policies 2 and 7, both of which require significant improvement of water quality. I do not consider that the proposal will achieve this, and therefore it can be considered inconsistent with these policies of the iwi management plan.

7.11.6 Te Runanga o Oraka Aparima has submitted in opposition to the application and wish to be heard at the hearing. As such, I consider it more appropriate for the runanga to speak to cultural effects arising from the proposal.

Past conduct

7.11.7 I consider that past conduct of the applicants is a matter that is relevant and reasonably necessary to the determination of this application. Case law[13] is clear that past conduct is not a legitimate ground for refusing the grant of a resource consent. However, it can be taken into account[14] in determining the adequacy of conditions, although not in a punitive manner.

7.11.8 In this case the relevance of past conduct concerns the use of Overseer, which assumes that good management practices have been applied.

Woldwide One:

Discharge Permit	There have been 12 inspections between August 2013 and June 2019. Ten of these inspections were rated compliant. An inspection in 2013 recorded issues with effluent application due to damaged nozzles on the irrigator. The most recent inspection recorded significant non-compliance due to lane run-off and over-application by the travelling irrigator, possibly entering a waterway.
Water Permit	Non-compliances recorded annually from 2015 to 2019 as monitoring records were not provided on time. There were compliance issues in the 2017/18 season, with average monthly usage reaching 109,000 litres per day in November 2017, in excess of the 60,000 litre per day limit. For the 2018/19 season water use averaged 54,000 litres per day and was compliant.

Woldwide Two:

Discharge Permit	There have been 11 inspections of the discharge between March 2015 and June 2019. All inspections were rated compliant. However there were issues with over-application of effluent due to a stalled irrigator and run-off of underpass effluent in September 2016. Those issues resulted in infringement notices being issued.
Water Permit	Non-compliances recorded annually from 2015 to 2018 as monitoring records were not provided on time. There were compliance issues in the 2017/18 season. For example, the average monthly usage reaching 120,000 litres per day in November 2017, in excess of the 80,000 litre per

---

[13] Such as Walker v Manukau CC EnvC C213/99

[14] Hinsen v Queenstown Lakes DC [2004] NZRMA 115 (EnvC)

day limit. For the 2018/19 season water use averaged 66,000 litres per day and was compliant.

Precedent

7.11.9 I note that one of the submitters has raised concern that approval of the application may set a precedent that would allow increased herd sizes on other farms, leading to an adverse cumulative effect. In essence precedent requires that an applicant should be treated on an equivalent basis as previous applicants.

7.11.10 In this case the application concerns discretionary activities, and there are policies specific to those activities, so the plan already anticipates consideration of such activities. If there are future applications for increased herd size, they should be considered against the same criteria. That will not automatically mean that the outcomes will be the same, as there will be differences between applications.

7.11.12 However, given that I consider that this proposal is inconsistent with the relevant plans and higher order planning documents, the granting of consent to essentially further intensify dairy operations in a regulatory climate that is trying to maintain and enhance water quality, could set a precedent for future applications to do the same and in doing so will not achieve an improvement in water quality.

7.11.13 In order to consider precedent effects[15], the effects asserted must come within the definition of effects that s104(1)(a) directs Council to consider. In essence, although a precedent effect is not an effect on the environment as such, should it satisfy the definition of effect as directed by s104, a Consent Authority should consider whether or not granting a consent, could conceivably result in a precedent being set, whereby encouraging other parties to apply for Resource Consent for the same activities.

7.12.0 Section 104 Matters – Value of Investment and Positive Effects

Value of investment of the existing consent holder if an application affected by Section 124 (Section 104(2A))

7.12.0 The proposal includes an application for the replacement of discharge and water permits for a dairy operation. The applicant has put significant investment into the site. There have been recent upgrades in infrastructure and purchases of new blocks of land as well as further proposed upgrades to the farming system.

Positive Effects

7.12.1 It is important to consider the positive effects of the proposal. The applicants are proposing the use of wintering barns to remove some of their stock from pasture over the winter period. This will reduce the losses generated from intensive winter grazing and provide some protection of soil structure. Should the consent be granted it will also provide for the economic wellbeing of the applicants and provide jobs for their employees, so will also consequently provide for their wellbeing.

7.13.0 Section 105 matters relevant to discharge or coastal permits

---

[15] *O R Jennings and D A Jennings v the Tasman District Council May 2003*

7.13.1 Section 105 matters need to be considered as the application is for a discharge that would contravene Section 15. Under Section 105, the consent authority must have regard to:

(a) the nature of the discharge and the sensitivity of the receiving environment to adverse effects;
(b) the applicant's reasons for the proposed choice; and
(c) any possible alternative methods of discharge, including discharge into any other receiving environment.

7.13.2 On the whole, the application takes into account the nature of the discharge and sensitivity of the receiving environment. This is shown through the use of multiple discharge methods including the use of travelling irrigators, low rate pods and slurry wagons. They have also proposed matching rates and depths of discharge to the farm dairy effluent risk categories. The applicants have demonstrated their existing effluent storage ponds will provide sufficient deferred storage.

7.13.3 The applicants have identified that a discharge to land over a discharge to water is preferred.

7.13.4 Deferring the discharge of effluent is a key good management practice and mitigation measure to address the risk of the event driven losses of nutrients to surface waterways.

7.13.5 A possible alternative for the discharge of effluent to land is the discharge of effluent to water. This is inconsistent with the policies of regional plans. The applicants have proposed the use of low rate irrigation systems, of which the alternatives are high rate options, of which slurry tanker and umbilical have been included as contingency measures to account for the failure of other systems. There have also not been any improvements in technology which would achieve a better environmental result than the current system.

7.14.0 Section 107 restrictions on grant of certain discharge permits

7.14.1 The potential for the effects listed under Section 107(1) of the Resource Management Act are discussed in the application. Section 107(1) states that a discharge permit should not be approved if, after reasonable mixing, the contaminant is likely to give rise to adverse effects.

7.14.2 If carefully managed, the proposed effluent discharge should not give rise to the effects on surface water listed in Section 107. It is likely, however, that it will contribute to cumulative loading from contaminant losses in the catchment.

7.15.0 Part 2 of the Resource Management Act 1991

7.15.1 The Council is currently operating under an operative plan, which was approved prior to relevant National Planning Standards taking effect and a proposed plan, which is still subject to appeal. Taking into account case law direction from the *King Salmon* Supreme Court decision and *Davidson* Court of Appeal decision, I consider that it is appropriate to refer to Part 2 of the RMA when assessing this application.

7.15.2 This means that the matters in Part 2 can provide guidance as to how the provisions of the RMA or provisions in planning instruments should be applied in the event of a conflict. Section 5 states the purpose of the RMA and Sections 6, 7 and 8 are principles intended to provide additional guidance as to the way in which the purpose is to be achieved.

7.15.3 The application of Section 5 involves an assessment of whether a proposal will promote the sustainable management of natural and physical resources. The enabling and managing functions found in Section 5(2) should be considered of equal importance and taken as a whole. Sections 6, 7 and 8 provide further context and guidance to the constraints found in Section 5(2)(a), (b) and (c). The commencing words to these sections differ, thereby establishing the relative weight to be given to each section.

7.15.4 In relation to the matters outlined in Section 5 it is considered that this application is inconsistent with the purpose and the principles of the Act, as set out in Section 5. This is the promotion of the sustainable management of natural and physical resources. I do not consider that the proposed consent conditions will ensure that any potential adverse effects of the activities will be avoided, remedied or mitigated.

7.15.5 Furthermore, my assessment of the application against the key policies of the proposed Southland Water and Land Plan has found that the proposal is contrary to many of these. These policies have been prepared in accordance with the RMA, gives effect to the National Policy Statement for Freshwater Management and is clear and directive.

7.15.6 All of the Part 6 matters have been covered within the various Council planning instruments, of which the application is generally consistent with and not contrary to. There is only one matter of national importance, as outlined in Section 6 of the Act that needs to be recognised and provided for in the context of this application. This is the relationship of Maori and their culture and traditions with their ancestral lands, water, sites, waahi tapu and other taonga. The area is part of Statutory Acknowledgment Area under the Ngai Tahu Claims Settlement Act 1996 and there are known areas of cultural importance within the site. Te Ao Marama Inc has submitted in opposition to the application on the grounds that water quality is already degraded and there is a need to avoid further degradation.

7.15.7 To provide completeness for this report, it is my view that the application is inconsistent with the RMA.

8 Issues/ Significance of effects/conclusion

8.1.1 In my opinion, effects arising from the proposal is likely to have unacceptable adverse effects on the environment.

8.1.2 These effects arise from the following factors:

- effects arising from an increase in cow numbers on the dairy platforms and support blocks;
- effects of additional intensive winter grazing occurring at Woldwide Run-off Limited;
- overall and localised effects on surface water quality;
- overall and localised effects on groundwater quality;
- effects on drinking water supplies;
- effects on soil;
- cumulative effects;
- the degraded state of the existing environment;
- uncertainty around the relevance and accuracy of modelled losses shown by Overseer, particularly for the Central Plains physiographic zone;

- uncertainty regarding the effectiveness and appropriateness of the proposed good management practices and mitigations;
- what forms the landholding for the proposal.

8.1.3 When considered through the lens of the NPS-FM, RPS, pSWLP and RWP, I consider that the potential adverse effects of the proposal are significant. All of the relevant planning documents direct that degradation of water quality be halted, and that water quality instead be maintained or enhanced. In my opinion, the application has not demonstrated that the adverse effects of the proposal can be appropriately avoided or mitigated – accordingly it is likely to result in further degradation of Southland's environment.

9 Recommendations

9.1.0 Consent term

9.1.1 The applicant has requested a consent term of 15 years. The application details the following reasons for the requested term:

1. Some proposed activities are for replacement of resource consents for activities that are already well established;
2. There has been a significant degree of capital investment; and
3. The applicant has been operating within the limits established by their existing consents and associated conditions.

9.1.2 The application states that considerable investment has been (or is proposed to) been undertaken to future proof their dairying operation and that the applicant's presence (of over 25 years) has not had a detrimental effect on the local environment.

9.1.3 Although some of the above points made do provide reasons for a term of 15 years, it does not take into account how the intensification of the land use activities will alter what has been occurring at the site and how the adverse effects of these activities would be considered appropriate for that length of time. As mentioned throughout this report, there has been a level of unlawful activity occurring and as such to conclude that the presence of the applicants at that location having no detrimental effect on the local environment is unfounded.

9.1.4 The applicant has also not been operating within their consented limits as claimed. The applicant has poor compliance with their previous/current water permits for the abstraction and use of groundwater. For the groundwater permits AUTH-301664 and AUTH-300627-V1 the applicant has not received a single grade of compliance throughout the exercise of the respective consents.

9.1.5 In respect of the discharge permit AUTH-300626-V2, during a number of Routine Inspections, technical non-compliances were recorded for failing to supply the relevant data. Throughout the operation of AUTH-300626-V2 there were several incidents which involved the breach of consent conditions in relation to odour from dairy shed effluent and during September 2016 the applicant was issued with two infringement notices for unlawful discharges of effluent to land where it may enter water in breach of their resource consent and Section 15 of the Resource Management Act 1991.

9.1.6 The applicant has a better compliance history under AUTH-301663 but has failed to operate in accordance with AUTH-301663 at all times, with the most recent non-compliance being recorded on 11 June 2019..

9.1.7 As such the applicant has not been operating in accordance with the limits established by their resource consents and has a poor compliance history overall.

9.1.8 When considering the term of consent, it is important to consider **Policy 14A** (*determining the term of a water permit*) and **Policy 43** of the RWP and **Policy 40** (*determining the term of resource consents*) of the pSWLP.

9.1.9 Policy 40 of the pSWLP states:

When determining the term of a resource consent consideration will be given, but not limited, to:

1. *granting a shorter duration than that sought by the applicant when there is uncertainty regarding the nature, scale, duration and frequency of adverse effects from the activity or the capacity of the resource;*
2. *relevant tangata whenua values and Ngāi Tahu indicators of health;*
3. *the duration sought by the applicant and reasons for the duration sought;*
4. *the permanence and economic life of any capital investment;*
5. *the desirability of applying a common expiry date for water permits that allocate water from the same resource or land use and discharges that may affect the quality of the same resource;*
6. *the applicant's compliance with the conditions of any previous resource consent, and the applicant's adoption, particularly voluntarily, of good management practices; and*
7. *the timing of development of FMU sections of this Plan, and whether granting a shorter or longer duration will better enable implementation of the revised frameworks established in those sections.*

9.1.10 I consider that (should consent be granted) a term of 15 years would not be consistent with the above policy. Doing so would authorise activities that are likely to result in significant adverse effects for an extended period. There is uncertainty regarding the nature and scale of the activity as well as the capacity of the water resource.

9.1.11 As discussed above, the applicant has a history of unsatisfactory compliance with previous resource consents. This supports the imposition of a shorter term consent.

9.1.12 Finally, the Council is currently working through the process of developing FMUs for Southland. The Council notified a revised Progressive Implementation Programme in October 2018, which provides for a plan change containing freshwater objectives, limits and targets for all FMUs to be notified by 2022 and operative by 2025. I consider that a term of consent that significantly exceeds the development of FMUs would be inconsistent with Policy 40(6) of the pSWLP.

9.1.13 As discussed earlier in this section the applicant has provided reasons for a 15 year term, however as noted above some of the points raised are incorrect. Overall, I recommend that if resource consent is granted, it should be subject to a term of 5 years (being the minimum contemplated by Policy 16(3)(b)of the pSWLP).

9.2.0 Whether to grant

9.2.1 The activities applied for have been considered together, and as such the highest consent test applies. In this instance the overall status of the application is a **Discretionary Activity**. Under Section 104B a Consent Authority may grant or refuse the application and should the consent be granted, impose conditions under Section 108.

9.2.2 Southland currently operates under three regional plans. I have applied more weight on the proposed Southland Water and Land Plan and the objectives, policies and direction of the plan. Greater weight has been given to the provisions of the proposed Southland Water and Land Plan because it has been through the hearing process, has more specific policies and direction and gives effect to the most recent NPS-FM, whereas the Regional Water Plan and the Regional Effluent Land Application Plan do not. As such, I consider appropriate that greater weight is placed on the proposed Southland Water and Land Plan.

9.2.3 The pSWLP is "*intended to provide direction and guidance regarding the sustainable use, development and protection of water and land resources in the Southland Region*". The pSWLP recognises that adverse effects on water quality result from both point and non-point source discharges, of which non-point source discharges to water are of most concern under this proposal.

9.2.4 Non-point source discharges from agricultural land are the most significant contributors of contaminants to water and to-date has been subject to little regulation in Southland prior to the pSWLP.

9.2.5 This is an important matter to consider and should be emphasised as it clearly illustrates the intent of the plan and the overarching goal of improving water quality for all Southlanders. This has led me to draw the conclusions detailed throughout this report and will ultimately guide my recommendation on whether or not the application should be granted.

9.2.6 The pSWLP also acknowledges that land use intensification tends to increase the amount of contaminants entering water, which in itself is contrary the objectives, policies and direction of that plan. As such at a bare minimum the proposed activities must be undertaken in accordance with GMPs to meet the minimum legal requirements and to "hold the line" on water quality. As the proposed activities include a level of intensification, the proposal must identify mitigations that improve water quality when intensification occurs.

9.2.7 Given the clear direction of the pSWLP, for this application to be granted the applicant must demonstrate that there will be no reduction in the overall quality of freshwater, and water in estuaries and coastal lagoons as a result, as per the objectives of the Plan. Further, due to the current state of the receiving environment, there must be an improvement in water quality, as per the policies of the plan. The plan does not describe or define the features of this improvement (for example, its quantum, or pace). Therefore, to say that the *"farm system changes/GMPs/mitigation* *would be essential to ensure that nutrient loss reductions were generally at or greater than 5%"*[16], over simplifies the issue.

9.2.8 There is very clear policy where applications to further intensify the dairy farming of cows will *generally not be granted where adverse effects, including cumulatively cannot be avoided or mitigated*. This means an applicant's duty first is to avoid or mitigate adverse effects[17], and this cannot be substituted by solely reducing contaminant losses by a particular amount. To aim for a target, as the applicant has relied upon, takes a "one size fits all" approach. Applications should be considered based on their merits, or lack thereof and taking a comparative approach to other applications is not sufficient.

9.2.9 Policy 39 of the pSWLP provides a very broad scope when assessing application for the use of land for farming. It directs Council to consider all the effects that may impact on water quality regardless of whether or not the Plan permits an activity with that effect. This encourages a decision maker to take a very broad approach to the applications and the consequential adverse effects on water quality that will result from the proposed activities should a consent be granted.

9.2.10 When considering the adverse effects of the proposed activities and the proposed activities overall in determining whether or not to grant the consent application, a determination needs to be made, assisted by viewing the application and the adverse effects through the lens of the Regional Plans. In making my recommendation I have had particular regard to **Policy 13** (*management of land use activities and discharges*), **Policy 15B** (*improve water quality where standards are not met*), **Policy 16** (*farming activities that affect water quality*) of the pSWLP.

9.2.11 Policy 13 requires the management of land use activities and discharges from both point and non-point sources in order to achieve policies 15A-15C. As the water quality in the receiving environment does not meet standards, an improvement in water quality needs to demonstrate through the avoidance or remedying or mitigation of adverse effects. For reasons stated earlier in the report, I do not consider that the proposed activities can achieve this and as such the proposed activities are contrary to the policies.

9.2.12 Policy 16 then requires that applications to further intensify the dairy farming of cows or intensive winter grazing generally not be granted where adverse effects, including cumulatively on water quality cannot be avoided or mitigated (policy 16(1)(b)(i)) or where water quality does not meet the required standards (policy 16(1)(b)(iii). In respect of the proposed activities both further intensification of dairy farming and further intensification of intensive winter grazing is proposed, and I consider that Policy 16 is not achieved and the proposal is contrary to the policy. As the application currently stands, and with my current understanding of the documents that are meant to make up the application, not all areas of the proposal are covered by a Farm Environmental Management Plan, and as such the proposal is also contrary to Policy 16(2).

9.2.13 This report outlines in detail the effects of the proposed activity, both adverse as well as positive. When considering this application and its effects through the lens of the policies of the regional plans, specifically the pSWLP, I consider that the proposal and its effects are not acceptable.

9.2.14 This is despite of any modelled reduction in losses, and especially so when considering the effects of the farming operation on water quality. The proposal will also result in adverse effects on soil health and quality which have been largely ignored in the application. The application has

---

[16] Memorandum of Michael Freeman and Nessa Legg 5 September 2019

[17] As does every person undertaking activities under the RMA

provided a number of mitigations, such as the increased use of the winter barns to mitigate adverse effects. However, the application has also heavily relied on the removal of illegal activities to demonstrate a contaminant loss reduction, on which the applicants consultant’s conclusions on the significance of effects and any improvement in water quality have been based. This needs to form part of the consideration as to whether or not an improvement in water quality would have occurred should the applicant have been operating lawfully.

9.2.15 Having regard to all of the effects of the proposal, I conclude that the adverse effects from the proposed activities will be significant. I do not consider that the modelled reduction in nutrient loss would be the same if the baseline reflected the applicants actual lawful operations. As such there is increased uncertainty surrounding the improvement in water quality that the application claims will occur, especially if this was to be compared to a lawful operation.

9.2.16 With regards to the objectives and policies of the regional plans, I also consider that the proposal is contrary to policy. I do not consider that should the application be granted, the intent and direction of the plan would be achieved nor would it “hold the line” or improve water quality where it is degraded.

9.2.17 The proposal is also contrary to policies in the pSWLP that require an improvement of water quality and that direct decision makers to generally not grant consent applications such as this one. I acknowledge that the term “generally” infers that a level of discretion exists when deciding whether or not the application should be granted. In this instance, the proposal fails to provide certainty that modelled losses are actually indicative of what will occur, and as such it cannot be concluded that an improvement in water quality would be achieved if consent was granted.

9.2.18 There is uncertainty around whether or not the applicant actually will undertake a number of mitigations, especially those included in the Phosphorous Mitigation Plans. The wording in these plans is uncertain and provides for a number of ways in which a mitigation can be undertaken, as such no assessment as to the effectiveness of these mitigations can be undertaken. I consider that the discretion to grant consent provided by the word “generally” in Policy 16 of the pSWLP is not intended to apply if the application is contrary to policy. To use that discretion in this instance would not align with the direction of the pSWLP – specifically due to the failure to maintain and improve water quality as directed by the plans, policies and objectives.

9.2.19 To grant the application would likely result in a deterioration of water quality, which has the potential to result in other significant adverse effects including on the ecology of the receiving environments, human and animal health and placing increased pressure on the coastal marine area, specifically the estuaries in the receiving environment. This will also result in significant adverse effects on the cultural significance and mauri of the receiving environment.

9.2.20 Both the RWP and pSWLP seek to avoid degradation of water quality. The proposed plan in particular directs that where water quality is already degraded the proposed activities must result in an improvement in water quality. The proposed plan directs that if an application does not avoid or mitigate effects on water quality, it should generally be declined. As I have determined that in my opinion adverse effects on the environment will be unacceptable and I do not consider that the proposal sufficiently avoids or mitigates these adverse effects. I also consider that the proposal is contrary to the policies and objectives of the regional plans, and does not result in a scenario where discretion afforded by the word “generally” in Policy 16 of the pSWLP would be applicable. For completeness, I also consider that the proposal does not achieve the purpose of Part 2 of the Resource Management Act 1991.

9.2.21 For the reasons detailed in this section, and the rest of this report, I recommend that the applications for Resource Consent should be **declined**.

Aurora Grant
Team Leader Consents
Lead reporting officer

Alex Erceg
Consents Officer
Supporting reporting officer

Appendix 1

List of industry agreed GMP and Woldwide proposal (APP-20191140 and APP-20191052)

This list details industry agreed GMP's (taken from https://www.canterburywater.farm/gmp/) and if they are implemented or proposed for the Woldwide operations. It is not a comprehensive discussion of what is proposed for the applications and was formulated using the original applications and sharepoint 4 updates to keep track of changes made to the applications. The S42A reports discuss the proposed mitigations and GMPS in detail. This document does not incorporate the sharepoint 5 changes which will be addressed in a separate addendum.

Industry agreed GMP	Implemented/ proposed for Woldwide operations?

Consider the following:

Biophysical characteristics such as soil types, topography, and climate.	WW1 – No WW2 – No WRO – No Horner Block – No
Physical characteristics such as waterways, artificial drainage networks, irrigation.	WW1 – Yes WW2 – Yes WRO – No Horner Block – No
Risk factors such as soil loss, nutrient loss and damage to soil structure.	WW1 – Yes WW2 – Yes WRO – No Horner Block – No
Management or practices that are required by third parties to be recorded e.g. offal pits, feed storage, effluent storage and application area and irrigation	WW1 – Yes WW2 – Yes

area.	WRO – No Horner Block – No
Outdoor pigs: Farm in low rainfall area and on flat land to minimise runoff.	N/A

GMP: Maintain accurate and auditable records of annual farm inputs, outputs and management practices.

Maintain accurate and auditable records that:

set out objectives to be met;	WW1 – No WW2 – No WRO – No Horner Block – No
identify all relevant farming activities and practices, including those that demonstrate that relevant GMPs are being applied;	WW1 – Unknown WW2 – Unknown WRO – No Horner Block – No
demonstrate the assessment of all risks to water quality;	WW1 – No WW2 – No WRO – No Horner Block – No
identify how and when actions to mitigate risks will be undertaken;	WW1 – Yes WW2 – Yes WRO – No Horner Block – No

allow the generation of an annual actual OVERSEER® nutrient budget.	WW1 – No – prior to change in farm system WW2 – No – prior to change in farm system WRO – No – no modelling Horner Block – No

Utilise industry templates for recording key information – such as water use, fertiliser inputs, and spray diaries, planting dates, paddock rotation, feed inputs and composition, stock numbers and production outputs or yield.
Review the planned actions annually (e.g. carry out a self-audit).

Farm Environment Plans (FEPs) may be used to assist with this GMP; FEPs include the industries' specific planning tools such as NZ Pork Farm Environment Plan, Sustainable Milk Plans, NZ GAP or Global GAP, Land and Environment Plans, ProductionWise.	WW1 – No – effluent, slurry and fertiliser discharges only to be recorded WW2 – No WRO – No Horner Block – No
Some regional councils may have approved consistent templates to assist in preparing FEPs.	N/A
Mixed systems may need to combine or adapt existing FEPs.	N/A

Feed

GMP: Store, transport and distribute feed to minimise wastage, leachate and soil damage.

Design feed storage facilities to minimise wastage and soil damage, i.e. sealed or compacted surface.	WW1 – Unknown WW2 – Unknown WRO – No Horner Block – No
Minimise leachate generation (e.g. make silage at optimum moisture content) and prevent leachate from entering surface waterbodies, groundwater or stockwater.	WW1 – Unknown WW2 – Unknown WRO – No Horner Block – No
Site silage stacks so that overland flow of water from heavy rain cannot enter the stack.	WW1 – Unknown WW2 – Unknown WRO – No Horner Block – No
Site feed areas away from waterways.	WW1 – Yes WW2 – Yes WRO – No Horner Block – No
Distribute feed so as to minimise soil damage (from farm equipment and animals) and potential surface run-off to waterways, i.e. avoid Critical Source Areas.	WW1 – N/A WW2 – N/A WRO – No Horner Block – No
Deer: Make sure silage is made at the optimum moisture content to reduce possible leaching, recommended at 30% dry matter or more.	N/A
Outdoor pigs: Feed diets and feed levels appropriate for the physiologic state	N/A

of the animal i.e. separate gestating and lactating sow diet.	

Farm effluent and wastewater management

Our intent: Minimise risk of contamination of waterbodies from stored and applied effluent.

GMP: Ensure the effluent system meets industry specific Code of Practice or equivalent standard.

Dairy: All new effluent systems are designed to Farm Dairy Effluent (FDE) Design Code of Practice. The main objectives of the system are: to capture all FDE; to spread the FDE at a time that allows uptake by plants; to uniformly spread the FDE to the desired depth, and at the desired intensity; to control FDE application to within the boundaries of the application area; to ensure that FDE systems can be operated safely; and to comply with all regulatory requirements, including consent conditions.	Ponds: WW1 – N/A WW2 – New pond only (subject of separate application) WRO – N/A Discharges: WW1 – N/A WW2 – New pond only (subject of separate application) WRO – N/A Horner Block – No

GMP: Have sufficient, suitable storage available to enable farm effluent and wastewater to be stored when soil conditions are unsuitable for application.

Dairy: Suitable storage is calculated using the Dairy Effluent Storage Calculator. This enables FDE to be stored when soil and management conditions are unsuitable for FDE land application. All areas that FDE is collected from are sealed (this includes feed pads). All new effluent systems are designed to FDE Design Code of Practice standard. Storage facilities are sealed and maintained to ensure containment of effluent. Storage is actively management to ensure storage is available when required.	WW1 – Yes WW2 – Yes – New pond subject of separate application WRO – N/A Horner Block – No
Deer: Enclosure systems should be located and managed to minimise environmental impact of effluent. In particular:	N/A
Store effluent for later dispersal to land where appropriate;	WW1 – Yes

	WW2 – Yes WRO – N/A Horner Block – No
Effluent and run-off water should not enter natural waterways untreated;	WW1 – Yes WW2 – Yes WRO – N/A Horner Block – No
Solid waste should be kept away from waterways;	WW1 – Unclear (“application of solids WW2 – Yes – New pond subject of separate application WRO – N/A Horner Block – No
Faecal/urine surface material should be cleared annually;	WW1 – Unknown WW2 – Unknown WRO – No Horner Block – No
Paddock enclosure systems should not result in significant or irreparable soil loss or erosion.	WW1 – Unknown WW2 – Unknown WRO – No Horner Block – No

GMP: Apply effluent to pasture and crops at depths, rates and times to match plant requirements and minimise risk to waterbodies.

Dairy: FDE is applied to pasture and crops at depth, rates and times to best prevent loss and to increase utilisation; area complies with consent (**use OverseerFM® to calculate**). Take account of nutrients supplied by effluent or manure when calculating fertiliser requirements, e.g. use the DairyNZ FDE calculator app to determine the amount of nutrients applied. **See FDE**	WW1 – Yes WW2 – Yes WRO – N/A Horner Block – No

Design Code of Practice.	
Outdoor pigs: No effluent to be spread on the outdoor unit. Intensive grazing Our intent: Minimise risk of contaminant loss to waterbodies, and maintain soil structure and quality.	N/A

GMP: Select appropriate paddocks for intensive grazing, recognising and mitigating possible nutrient and sediment loss from critical source areas.

Where possible, select paddocks for winter grazing that are not vulnerable to pugging and compaction, do not have significant artificial drainage such as mole and tile drains, waterways, temporary streams or natural drainage channels (running in times of high rain). Choose wintering paddocks away from waterways if possible.	WW1: No IWG to be undertaken (no change from status quo) WW2: No IWG to be undertaken; said in app to be ceasing of IWG but implemented consent precludes IWG, so it has already been implemented and IWG is not a part of the activity can that can be ceased. WRO: No

GMP: Manage grazing to minimise losses from critical source areas.

Sow crops for grazing across slopes if possible rather than up and down hills, to reduce runoff.	WW1 – N/A WW2 – N/A WRO – No Horner Block – No
Graze lower lying areas and areas closest to waterways last.	WW1 – N/A WW2 – N/A WRO – No
Deer: Where possible, shift deer to dry, sheltered areas before wet weather arrives.	N/A
Deer: Monitor animals regularly on self-feed silage pits to make sure all animals retain the required body condition score.	N/A

Nutrient management

Our intent: Balancing the application of nutrients to match plant requirements and minimise risk of losses.

GMP: Manage the amount and timing of fertiliser inputs, taking account of all sources of nutrients, to match plant requirements and minimise risk of losses.

Manage nutrients supplied from all sources including the soil, brought in feed, previous grazing and crops and any organic sources applied.	WW1 – Yes WW2 – Yes WRO – No Horner Block – No
Regularly soil test to identify nutrient needs, particularly paddocks that are going into crop.	WW1 – Yes (annually) WW2 – Yes (annually) WRO – No Horner Block – No
Expert guidelines, for example using crop calculators, expert agronomic advice or codes of practice should be used where appropriate.	WW1 – unknown WW2 – unknown WRO – No Horner Block – No
Nitrogen and phosphorus fertiliser is applied strategically to meet agronomic requirements, and to avoid adverse environmental impacts (e.g. strategic use around Critical Source Areas). Detailed guidelines are provided in **The Fertiliser Association of New Zealand's Code of Practice for Nutrient Management** (with emphasis on fertiliser use).	WW1 – Yes WW2 – Yes WRO – No Horner Block – No
Nutrient budgets as a tool to manage nutrient loss can be helpful.	WW1 – Yes WW2 – Yes WRO – No Horner Block – No
Practices such as use of side dressings and split applications may be helpful to reduce the risk of leaching and ensure greater utilisation of nutrients by plants.	WW1 – Yes WW2 – Yes WRO – No Horner Block – No

Dairy: All farmers have and use a predictive nutrient budget (OverseerFM®) as the basis for managing nutrients on their farm (milking platform, and any support land). Predictive nutrient budgets and nutrient management plans are developed by Certified Nutrient Management Advisors, and updated when the farm system changes. The OverseerFM® data input standards are used to create OverseerFM® nutrient budgets.	WW1 – Yes WW2 – Yes WRO – No Horner Block – No
The Dairy Industry's Audited Nitrogen Management System contains recording and reporting requirements for N fertiliser on dairy farms (including milking platform, and any contiguous support land).	WW1 – Yes WW2 – Yes WRO – No Horner Block – No
Outdoor pigs: No NPK fertilisers are to be applied to the outdoor pig unit.	N/A

GMP: Store and load fertiliser to minimise risk of spillage, leaching and loss into waterbodies.

Follow **fertiliser industry code of practice for fertiliser handling, storage and use**.	WW1 – Unknown WW2 – Unknown WRO – No Horner Block – No
Locate storage sites away from waterways.	WW1 – No WW2 – No WRO – No Horner Block – No

GMP: Ensure equipment for spreading fertilisers is well maintained and calibrated. Implementation guidance:

Any contractors used for fertiliser spreading should be accredited. The current industry standard is Spreadmark.	WW1 – No WW2 – No WRO – No

	Horner Block – No
Ensure your spreading equipment is calibrated according to its design specifications specific to the product being spread.	WW1 – No WW2 – No WRO – No Horner Block – No
Information on fertiliser applications is kept (or sought from contractors), including product, rate, date, location.	WW1 – Yes WW2 – Yes WRO – No Horner Block – No

Irrigation and water use

Our intent: To apply irrigation water efficiently to meet plant demands and minimise risk of leaching and runoff.

GMP: Manage the amount and timing of irrigation inputs to meet plant demands and minimise risk of leaching and runoff.

There is a demonstrable reason why irrigation is to be applied, for example:

to replace soil moisture deficit	N/A
for the purpose of herbicide activation	N/A
to prepare soil for cultivation	N/A
frost protection	N/A
for fertigation	N/A

GMP: Design, calibrate and operate irrigation systems to minimise the amount of water needed to meet production objectives.

Any new development, upgrade or redevelopment is consistent with irrigation industry codes of practice.	N/A
The irrigation system is evaluated annually to demonstrate optimal performance using irrigation industry guidance.	N/A
Dairy: Actual irrigation water take is measured with a water meter. Soil moisture levels are tracked throughout the season to justify irrigation events, e.g. using soil moisture balance calculations or soil moisture probes or tapes.	N/A
Dairy: Actual annual irrigation use is evaluated for consistency with estimated agronomic needs for the season based on climatic data and pasture/crop requirements.	N/A
Dairy: Dairy sheds will use no more water for dairy shed washdown and milk cooling than is necessary to produce hygienic and safe milk (Sustainable Dairying: Water Accord). Actual water use in the dairy shed is measured with a water meter.	N/A
Horticulture and Arable: Water is applied to maintain soil between stress point and field capacity - knowledge of evapotranspiration, field capacity and use of soil probes can assist in achieving this.	N/A
Horticulture and Arable: Volumes applied are informed by all relevant factors e.g. crop type, plant growth stage, soil type and field capacity.	N/A

Cultivation and soil structure

Our intent: To minimise direct and indirect losses of sediment and nutrients to water without being prescriptive about cultivation or soil management techniques used, as there are many agronomic considerations to take into account on a paddock-by-paddock and season-by-season basis.

GMP: Manage farming operations to minimise direct and indirect losses of sediment and nutrients to water, and maintain or enhance soil structure, where agronomically appropriate.'

Consider:

Distance from surface waterways, effectiveness of buffers	WW1 – N/A WW2 – N/A WRO – No Horner Block – No
Slope of land (degree and length) in relation to waterway	WW1 – N/A WW2 – N/A WRO – No Horner Block – No
Soil type and texture, quality (e.g. pugging, or compaction susceptibility)	WW1 – N/A WW2 – N/A WRO – No Horner Block – No
Climatic and weather conditions to determine timing of cultivation	WW1 – N/A WW2 – N/A WRO – No Horner Block – No
Cultivation methods (pre-, during, and post-cultivation; contour, no- or low-tillage)	WW1 – N/A WW2 – N/A WRO – No Horner Block – No

Measures to prevent sediment and nutrients entering waterways (e.g. sediment traps or interception drains, headlands or diversion bunds, grazing techniques)	WW1 – N/A WW2 – N/A WRO – No Horner Block – No
Measures to prevent soil loss through erosion, overland flow and wind blow (e.g. space planted trees, windbreaks, cover crops)	WW1 – GMP only to reduce contaminant loss WW2 – GMP only to reduce contaminant loss WRO – No Horner Block – No
Measures to prevent or remedy soil damage	WW1 – GMP only to reduce contaminant loss WW2 – GMP only to reduce contaminant loss WRO – No Horner Block – No
Previous use of land, and future use of land	?
Using sub-soiling or ripping to remedy compaction of soils	WW1 – No WW2 – No WRO – No Horner Block – No

Leave grassed areas around rocks, gullies and riparian margins. If spraying out pasture, first identify areas that won't be worked or re-sown e.g. gullies, runners, riparian margins and rocky areas.
In heavy soils, cultivate soil when conditions are dry enough to reduce compaction and pugging and improve drainage and soil structure.

Ground cover

Our intent: Reduce risk of erosion, overland flow and leaching associated with exposed soil.

GMP: Manage periods of exposed soil between crops/pasture to reduce risk of erosion, overland flow and leaching.

Consider soil conditions and crop rotation.	WW1 – N/A WW2 – N/A WRO – No Horner Block – No
Areas that are harvested, grazed or stock damaged (resulting in bare soil) are re-sown as soon as practical to minimise periods of exposed soil.	WW1 – N/A WW2 – N/A WRO – No Horner Block – No
Rest and re-sow erosion damaged areas.	WW1 – N/A WW2 – N/A WRO – No Horner Block – No
Use cover crops (green feed, oats, mustard, other biological activates) to reduce losses and nutrient use; this also increases organic matter.	WW1 – N/A WW2 – N/A WRO – No Horner Block – No
When developing paddocks, retain native vegetation such as tussock and shrub habitat in gullies, steep and higher country as this will regulate run off of water, help retain water quality, reduce soil movement and provide filter areas prior to water entering streams (a significant co-benefit is that it also provides cover for newborn stock).	WW1 – N/A WW2 – N/A WRO – No Horner Block – No
• Outdoor pigs: Maintain groundcover in accordance with the following. • For dedicated outdoor units or those in a pastoral rotation the minimum ground cover is:	N/A

 - For dry sows: at least 40% cover on 75% of the land (less than 40% cover permissible on 25% of the land); - Each paddock to have on average more than 10% cover; - For lactating sows: at least 70% cover. - For outdoor units as part of an arable operation the minimum ground cover is: - For dry sows: 25% cover (100-0% over 2 years); - For lactating sows: at least 70%; - Reduce fallow during and immediately after the pig phase of the rotation e.g. by planting a catch crop.	

GMP: Retire all Land Use Capability Class 8 and either retire, or actively manage, all Class 7e to ensure intensive soil conservation measures and practices are in place.

Sediment, phosphorus and faecal bacteria

Our intent: Minimise transport of sediment, phosphorous and faecal bacteria to water bodies.

GMP: Identify risk of overland flow of sediment and faecal bacteria on the property and implement measures to minimise transport of these to waterbodies.

Identify, record and manage risk to and from critical source areas such as wallows, bank erosion, pugging, trampling or slips on steep hillsides to minimise or eliminate sediment entering waterways.	WW1/2 – No – Non-committing language used in some places: "This area should be left in rank grass …" WRO – No Horner Block – No

Where appropriate use methods to minimise or eliminate sediment entering waterways such as: vegetated buffer strips/riparian planting adjusted in width for slope, hydrology, bank stability, land use and proximity to critical source areas; sediment traps; paddock contouring; earth bunds; raised headlands.	WW1/2 – No – Non-committing language used in some places: “riparian margin […] should be extended …” WRO – No Horner Block – No
Deer - Fence pacing considerations: Maintain appropriate feeding levels to reduce stress and fence pacing. Identify the best stock class to fit the soil types to minimise the risk of soil erosion, as identified in the Deer Farmers Landcare Manual. Maintain pasture length in winter or wet periods, to prevent soil being washed off in heavy rain. In particularly vulnerable areas retain tussock cover or native vegetation to regulate water runoff and to reduce risk of soil loss particularly in gullies or along riparian margins. If fence pacing is bad, fill in area and re-sow or plant with trees and if damage is extreme, re-fence to remove the problem area. If fence pacing continues, review fence placement as this can be a contributing factor.	N/A

GMP: Locate and manage farm tracks, gateways, water troughs, self-feeding areas, stock camps, wallows and other sources of run-off to minimise risks to water quality.

Locate and design laneways so that run-off is filtered by a vegetated strip. Design and manage laneways to minimise water ponding, excessive effluent build-up and erosion.	WW1 – Yes (e.g. Lane adjacent to waterway, west wintering barn) / No WW2 – Unknown WRO – No Horner Block – No
In areas exposed to wind erosion, establish shelter belts with trees that will filter the wind and provide added shade and shelter.	WW1 – No WW2 – No WRO – No Horner Block – No
On tracks, allow for cut-offs and slumps that will take the run off away from streams.	WW1 – Yes, some nib boarding WW2 – Yes, some nib boarding WRO – No Horner Block – No
Deer - wallow considerations: Identify natural springs and wallows prior to cultivating paddocks and pipe or drain into retired areas; Provide a suitable area away from waterways for safe wallowing.	N/A

GMP: To the extent that is compatible with land form, stock class and intensity, exclude stock from waterways.

Plan and prioritise waterway areas (including wetlands) to fence, based on the	WW1 – Yes

vulnerability of the land, significance of the waterway and potential to impact on water quality off-farm.	WW2 – Yes WRO – No Horner Block – No
Exclusion of extensively farmed stock from waterways in hill and high country areas may not be practical but rather a mix of mitigations and practices can be used to minimise sediment and faecal bacteria losses from farms.	N/A
Actively manage stock, stock density and stock classes adjacent to waterways to reduce risks to water where fencing is not practical.	WW1 – No WW2 – No WRO – No Horner Block – No
Exclude stock from significant waterways, drains and significant wetlands.	WW1 – Yes WW2 – Yes WRO – No Horner Block – No
Locate and manage crossing of waterways so it will not result in degradation of those waterways.	WW1 – Yes WW2 – Yes WRO – No Horner Block – No
Provide alternative stock-water sources away from waterways where possible.	WW1 – No WW2 – No WRO – No Horner Block – No
Provide shade and shelter away from waterways where appropriate.	WW1 – No WW2 – No

	WRO – No Horner Block – No
Place salt blocks and supplementary feed away from riparian margins.	WW1 – No WW2 – No WRO – No Horner Block – No
Leave an appropriate buffer depending on slope, to filter runoff, even if only temporarily during vulnerable periods.	?
During high risk periods for erosion e.g. winter grazing, fawn weaning, actively manage stock to prevent slumping, pugging or erosion.	WW1 – N/A WW2 – N/A WRO – No Horner Block – No

GMP: Monitor soil phosphorus levels and maintain them at or below the agronomic optimum for the farm system.

To determine the level of phosphorus fertiliser needed, conduct regular, on-going soil testing (Olsen P or an equivalent, recognised soil test) at the block scale to monitor trends, patterns and the impacts of nutrient management decisions.	WW1 – No (“will be maintained at biological optimum and no higher”) WW2 – No (“will be maintained at biological optimum and no higher”) WRO – No Horner Block – No
Leave an unfertilised strip as a buffer zone beside creeks, drains and storm water flood zones. Allow more distance as slopes become steeper.	WW1 – Yes WW2 – Yes WRO – No Horner Block – No

Earth & Environmental Science Ltd.
+64-21-2800750
abigail@eescience.co.nz
www.eescience.co.nz

Supplementary response report for Woldwide One Ltd. and Woldwide Two Ltd., and Woldwide Four Ltd. and Woldwide Five Ltd. consent applications.

1.0 Background

1.1 In early 2019 Environment Southland engaged Earth & Environmental Science Ltd. (E&E Science) to review two separate resource consent applications lodged by Woldwide. The application for Woldwide One Ltd. and Woldwide Two Ltd. (WW1/WW2) was prepared by Legg (2019) whereas the application for Woldwide Four Ltd. and Woldwide Five Ltd. (WW4 & WW5) was prepared by Landpro (2019). The two reviews (Lovett 2019a and 2019b) included assessment of information provided in the resource consent applications to address potential effects on freshwater resources in the receiving environment, as a result of the proposed activities. Where required, additional information to support an assessment of effects from the proposed activities was presented in the reviews. Final reviews for WW1/WW2 (Lovett, 2019a) and WW4 & WW5 (Lovett, 2019b) were delivered to Environment Southland in July 2019.

1.2 The applicants subsequently lodged additional information with Environment Southland on 23 August (Freeman, 2019) in a document titled "*Water quality assessments: Woldwide One Limited and Woldwide Two Limited & Woldwide Four Limited and Woldwide Five Limited*". The purpose of this report is to address any new information provided by in Freeman (2019) in the context of the two reviews previously prepared by Lovett (2019a, 2019b).

1.3 For ease of reading and referencing this document has been formatted in sections equivalent to those presented in Freeman (2019).

2.0 Soil and physiographic environment

2.1 No new information was presented.

3.0 Receiving water bodies

3.1 The location of WW1, WW2, WW4, WW5, and WRO farms within the surface water catchments was provided. Maps could have been improved by delineating and naming the groundwater catchment boundaries (or Freshwater management Units). The closest downstream water quality monitoring sites in each catchment was identified correctly (3.1 - 3.4; Figure 1 – 3).

3.2 Land use in the catchments was identified by type and would have been strengthened by percentage (or proportion) cover. New information on soil types in the area was presented using S-map. This map identified heavier soils (Braxton and Glenelg) on WW1/WW2 (including Horner Block) resulting in runoff during rainfall events and artificial drainage; and a reasonable area of more free draining soils providing contaminant transport to groundwater on WW5 (3.5 – 3.6; Figure 4).

3.3 Additional groundwater information presented in 3.7 – 3.10 (Figures 5 – 6) was in general agreeance with that identified in Lovett 2019a and 2019b, including identification of: groundwater FMU's; groundwater recharge and discharge processes; and groundwater flow direction. Figure 6 further supported the inferred groundwater flow directions recharging the Aparima River and Waimatuku Stream.

4.0 Statutory water quality objectives and standards

4.1 A summary of relevant plans and objectives (RWPS and pSWLP) were identified in the context of water quality (4.1 – 4.6; Table 1), and provided useful background information for water quality information presented in Section 5.

5.0 Existing water quality in the vicinity and downstream of the property

Surface water quality

5.1 Information presented in 5.1 – 5.3 including Tables 2 – 5 was a considerable improvement on that presented in Legg (2019) and Landpro (2019). In particular, water quality information presented in Freeman (2019): was easier to read and interpret; appeared to lack previous errors in reporting of water quality results; more clearly identified time periods for data (e.g., 2008 – 2017); made use of additional data publicly available through Environment Southland; more clearly referenced appropriate standards and guidelines.

5.2 It is argued (and demonstrated) by Freeman (2019) that there is difficulty in interpretation of water quality results due to some disconnection between sampling methodology and 'states' or 'standards' identified in guidelines and framework documents (e.g., NOF and NPSFM, pSWLP, ANZECC) (5.2, 5.3, 5.5, 5.6). This issue is resolved to an extent by identification that "*In recent decades surface water quality management has moved towards more complex and meaningful water quality standards and guidelines such as those in the NPSFM that focus more on a statistical description against specific targets that relate more directly with specific uses and values of that water*". Further, a range of issues were identified in the process of putting water quality results meaningfully into policy.

5.3 Overall conclusions regarding water quality information and interpretations made in Lovett (2019a and 2019b) identified that water quality in all catchments occupied by Woldwide farms (WW1/WW2, WW4, WW5, WRO) showed degradation, and that the likely cause of this degradation was land-use impacts from intensive agriculture. This conclusion is largely supported by Freeman (2019) in statement 5.4 "*These data indicate that water quality in all four major surface water bodies that receive drainage from these properties is degraded to a greater or lesser extent, and does not, or is currently unlikely to, meet all the relevant numerical standards or guidelines".* Further in support of these observations, Freeman (2019) indicates that "*It is not of any significant benefit to undertake a detailed comparison of all water quality variables for each river/stream. Instead it useful to appreciate that while there are some significant differences there are three significant common broad water quality-related issues: 1. High concentrations of faecal indicator microorganisms; 2. Raised nutrient concentrations leading to plant growth in the stream and further downstream; and 3. Generally poor water clarity at times.*"

5.4 Additional surface water quality data (5.8, Table 6) provides a summary of the relative water quality between rivers. These results are used to highlight the comparatively greater degradation of the Waimatuku Stream over a broad range of nutrient, bacterial, and clarity parameters (5.9). Freeman (2019) offered no further discussion as to why these relative differences in water quality are likely to occur. It is suggested that the following hydrological characteristics be considered as key drivers in the increased water quality degradation of the Waimatuku Stream, which are inherently linked to impacts of land-use in the Waimatuku Catchment (e.g., in vicinity of Woldwide farms):

- Waimatuku is a lowland catchment largely fed by land surface recharge (transferring contaminants from land use into the shallow groundwater system during recharge);
- The majority of recharge occurs in months where soil moisture is naturally higher (e.g., autumn, winter, spring) or artificially higher due to the impacts of irrigation of effluent;

- Shallow groundwater (and associated contaminants) originating from recharge in the upper Waimatuku Catchment emerges as streamflow in the middle and lower catchment; and
- The Waimatuku Catchment lacks a larger 'dilution' source (e.g., from higher elevation and/or alpine waters) that forms a larger component of flow in the Orauea, Aparima, and Oreti Rivers.

5.5 Consideration of more recent data provides further support of water quality results showing impacts of land-use in the catchments, as presented in 5.10 "*… more recent data has been compiled and presented along with the older data dataset, primarily to obtain a general understanding of recent water quality. …., the recent peaks in nitrate nitrogen has abruptly ended the apparent earlier five year trends of decreasing concentrations in all rivers except the Oreti River.*" The author uses this information to further highlight difficulties in establishing meaningful statistical assessments, which is warranted. However, it also indicates that water quality assessments undertaken in Legg (2019) and Landpro (2019), which relied on 2008 – 2017 data and did not consider more recent data, were deficient in identifying the most recent current state of water quality as continuing to degrade.

5.6 The author identifies that "… *it is not necessary to provide detailed comparisons of all key variables for all rivers over time*" (5.11). This is likely as an efficiency measure to save time, but also indicates that further investigation of data in a scientific manner has the potential to result in the same conclusions being reached (e.g., all water quality datasets clearly show impacts of land use).

Nitrate nitrogen concentrations

5.7 Further comparison of values and patterns in surface water quality (Total Oxidised Nitrogen) for the four main waterways is presented (5.12; Figure 7 – 8) and supports information presented in Lovett (2019a and 2019b). Results show highly variable TON concentration in all rivers and comparatively higher degradation is observed in the Waimatuku Stream. A further explanation to support these relative observations would have been useful, such as that provided in comment 5.4 above.

5.8 It is suggested that a scatter graph (or similar) is a more appropriate way of presenting data from discrete measurements (e.g., Figure 7), such as following the format presented in Lovett (2019a and 2019b). A line graph presented in this way alludes to the intermediate values (e.g., those occurring between the two discrete measurement points) are likely to fall along the interpolated line. However, it is common knowledge (and as described in 5.13) that many parameters (particularly TON concentrations) are highly variable over time, which makes the graph (as presented) not fit-for-purpose.

Periphyton biomass

5.9 The report makes an (accidental) reference error in 5.14 – and refers to Figure 7 instead of Figure 8.

5.10 It is suggested that a scatter graph (or similar) is a more appropriate way of presenting data from discrete measurements (e.g., Figure 8), such as following the format presented in Lovett (2019a and 2019b). A line graph presented in this way alludes to the intermediate values (e.g., those occurring between the two discrete measurement points) are likely to fall along the interpolated line. However, it is common knowledge (and as described in 5.15) that many parameters (including periphyton chlorophyll-a) are highly variable over time, which makes the graph (as presented) not fit-for-purpose.

5.11 Further difficulties in interpretation of water quality results in the context of policies are warranted (5.15 – 5.18).

Additional sources of contaminants

5.12 It is agreed that additional contaminant sources including "… *arable land use, treated wastewater and stormwater from small settlements, septic tank discharges and stormwater discharges from roading and other settlements/activities*" are likely to contribute some contaminants to local surface water and groundwater. It is suggested that the relative contribution from intensive agriculture is still considerably higher than these other sources combined due to the geographic setting, land cover (%), and relatively low levels of infrastructure (e.g., roading, urban sewerage discharge) in the vicinity of the farms.

Conclusions on current surface water quality

5.13 Overall conclusions regarding surface water quality (e.g., 5.20, 5.22, 5.23) presented in Freeman (2019) largely conform with that presented and discussed in Lovett (2019a and 2019b) (e.g., surface water is clearly degraded in all surface water catchments). The quality of information presented in Freeman (2019) builds substantially on that presented in Legg (2019) and Landpro (2019), contains fewer (if any) errors, and is a more accurate portrayal of the current state of surface water quality.

5.14 Identification of the difficulty in assessment of water quality against relevant standards is valid, including inconsistencies in sampling and assessment approaches. However, when the data is interpreted using a scientific approach, there is no doubting that there are clear negative impacts on water quality as a result of land use. The dominant coverage of Woldwide farms (WW1/WW2, WW4, WW5) in the upper Waimatuku catchment (in particular) indicates that a considerable amount of this degradation may be caused directly by practices occurring on these farms.

5.15 Although Freeman (2019) presented additional surface water quality in downstream environments of the Heddon Bush, there was very limited additional information for WRO (e.g., Merrivale area; Orauea River). Further, the additional water quality information was largely limited to nitrate nitrogen, with little consideration of other water quality parameters (e.g., phosphorous, *E. coli*, total coliforms).

Groundwater quality

5.16 A map of regional nitrate nitrogen concentrations (2007 – 2012) referred to in 5.24 – 5.28 was previously provided on Beacon by Environment Southland. It is understood that this map removed from the Environment Southland portal in early 2019 and was not available on the portal at the time of writing Freeman (2019). It is important to note the following limitations associated with the 'regional nitrate map': nitrate data was 'outdated' (e.g., was for the period 2007 – 2012); the map had a coarse spatial resolution and lacked vertical (e.g., depth) resolution or constraints; and the map relied heavily on interpolation of data which considerably influenced the dataset in some areas (especially those with a low number of data points). Some of these limitations are acknowledged by Freeman (2019) (e.g., 5.25 and 5.26). Even if the described limitations of the regional nitrate map are taken into consideration– it is clear that there has likely been a general increase in nitrate concentration over the entire area since the 2007 - 2012 period. This is clearly demonstrated by spot measurement results (in many cases) being considerably higher than the reported values on the 2007 – 2012 map (Figure 9).

5.17 Information provided in 'Attachment A' is used to support the argument that localised nutrient contamination of groundwater may occur in the Heddon Bush area (5.27, 5.28) and that actual nitrate-nitrogen concentrations are potentially lower than observed (5.30, 5.31). A review of the suitability of information provided in Attachment A is provided in Section 11 of this report, and specifically sub-section 11.8.

5.18 The potential for a 'deeper' confined aquifer in the Heddon bush area is proposed by Freeman (2019) based on measurement of "*significantly deeper water levels than found in shallow bores*" (5.29). However, insufficient hydrogeological information to support this is presented. Information such as groundwater level measured in a number of bores, corrected for topography, and taken under 'static' groundwater conditions could have been provided to support this idea.

5.19 Additional groundwater information provided in 5.31 – 5.41, Figure 10 – 15, and Table 7. All of the water quality results indicate that nitrate nitrogen is consistently (e.g., over many years) elevated (e.g., in all but one instance >3 mg/L and up to >25 mg/L). Although it is argued that the concentrations are 'highly variable', overall it is clear that all results show the impacts land use as rainfall recharges through the land surface to shallow groundwater. Variation is further supported by patterns identified in nutrient concentration (e.g., lower in summer and higher in winter) which align well with the hydrogeological understanding of the catchment being dominated by land surface recharge (Lovett 2019a and 2019b).

5.20 It is suggested that calculation of a (annual) trend in a highly variable (seasonal) dataset is unlikely to result in a useful interpretation (e.g., trendlines in Figure 10 and 11). Identification of sampling dates would have provided for a better understanding of seasonal trends – which is unable to be determined from Figures 10 - 14.

5.21 Reference to 'potential wellhead contamination' is made. Please refer to 5.16 of this report or Section 11 of this report for further discussion on the outcomes of the 'wellhead protection'.

5.22 Interpretation of the Environment Southland 'code' for bore use is included in this report (5.32, 5.35). It is suggested that regardless of the bore code (e.g., dairy, water supply) that appropriately collected water quality samples from all bores will provide a representation of groundwater quality at that site.

5.23 Results for the Heddon Bush bore (5.41, Table 7) are aligned with those presented in Lovett 2019a and show no bacterial contamination and relatively low levels of nitrate nitrogen (1.8 – 2.33 mg/L). It is useful to consider that although the actual depth of the bore is relatively shallow (in the context of a drinking water supply), that the bore is comparatively deep (when considering the depth to water table is often < 2 m BGL in the Heddon Bush area). The following comment provided in Lovett 2019a is useful context here:

> "*Heddon Bush School previously used a bore (unknown bore number) to abstract groundwater for the water supply (1995 – 2017). It is understood that water levels in the bore declined and the bore ran dry in 2017 (Hamilton, 2019). A replacement bore (E45/0718) was drilled in 2017 to 14.9 m below ground level (BGL) and was constructed with a 0.7 m screened interval from 14.2 – 14. 9 m BGL (Environment Southland, 2019). Available water quality results for the Heddon Bush School water supply were compiled, including one water quality sample (Environment Southland, 2019) and three water quality samples provided in the application. The results for bacterial analysis of 46 water samples were provided by the school (Hamilton, 2019), and 3 results were provided in the application. These samples had been collected from either the bore or 'kitchen tap' and were analysed by the Invercargill City Council water testing laboratory. Concentrations of bacterial parameters including E. coli, faecal coliforms, and enterococci were consistently reported as 'absent' or below detection level (<1.0 cfu/100 mL). The single groundwater quality sample showed likely impact from land use processes including elevated nutrients (NO_3-N) of 2.33 mg/L and a total coliform count of 3 cfu/100 mL (Table 3.3). Additional groundwater quality results for Heddon Bush School would be required to provide a more reliable determination of groundwater quality at the site.*"

Conclusions for groundwater quality

5.24 Overall conclusions regarding groundwater quality (e.g., 5.20, 5.22, 5.23) presented in Freeman (2019) largely align with that presented and discussed in Lovett (2019a and 2019b) (e.g., groundwater is clearly degraded in regards to nitrate nitrogen). However, there is a heavy reliance on nitrate nitrogen data and it is suggested that additional data (e.g., phosphorous, bacterial contamination) would have added value in the interpretation by Freeman (2019).

5.25 The primary conclusions associated with nitrate nitrogen data are that:

a. Groundwater quality reflects the predominant rural land use in the catchment contributing to nitrate nitrogen leaching through to groundwater;
b. Groundwater with elevated nitrate nitrogen concentrations subsequently discharges to surface waters;
c. The relatively high nitrate nitrogen concentrations are also a potential concern due to groundwater use as a source of drinking water, particularly since many are greater than the NZDWS, MAV of 11.3 mg/L;
d. Deeper groundwater (e.g., that abstracted by Heddon Bush School) in this area may be older groundwater less affected by the effects of the recent decades of land use;
e. Groundwater nitrate nitrogen concentrations appear to be generally higher than 2007 - 2012;
f. Some high nitrate nitrogen potentially reflects localised effects of dairy shed effluent disposal. On one hand this may over-emphasise the high nitrate concentration in some areas and on the other this may represent a large issue being overall deterioration of localised groundwater quality from many FDE applications.

5.26 Several of the conclusions made by Freeman (2019) are not as well supported by information presented in Lovett 2019a and 2019b and Section 11 of this report. These conclusions are largely associated with the effects of potential contamination of monitoring bores.

5.27 The quality of information presented in Freeman (2019) builds substantially on that presented in Legg (2019) and Landpro (2019), contains fewer (if any) errors, and is a more accurate portrayal of the current state of groundwater quality, albeit lacking in consideration of parameters other than nitrate.

5.28 Identification of the difficulty in assessment of water quality against relevant standards is valid, including inconsistencies in sampling and assessment approaches. However, when the data is interpreted using a scientific approach, there is no doubting that there are clear negative impacts on water quality as a result of land use. The dominant coverage of Woldwide farms (WW1/WW2, WW4, WW5) in the upper Waimatuku catchment (in particular) indicates that a considerable amount of this degradation may be caused directly by practices occurring on these farms.

5.29 Although Freeman (2019) presented additional groundwater quality information for the Heddon Bush area, there was very limited additional information for WRO (e.g., Merrivale area; unclassified groundwater zone). Further, the additional water quality information was largely limited to nitrate nitrogen, with a large emphasis on the outdated nitrate map that is no longer publicly available from Environment Southland (for reasons explained above). Additional consideration of other water quality parameters (e.g., phosphorous, *E. coli*, total coliforms) would have been useful to inform wider contamination issues within the groundwater system.

5.30 No assessment of additional groundwater take (increased abstraction proposed) was provided.

Assessment of effects on drinking water supplies sourced from groundwater

5.31 Information describing the high use of groundwater for drinking water resources in the Heddon Bush area is presented (5.46), with the greatest risk identified to be well-drained soils under intensive land use activities (5.47). The high level of risks to groundwater supplies are clearly identified (e.g., nitrate and bacterial contamination) (5.48) and in particular the risk to shallow groundwater in Southland based on the hydrogeological setting (5.49).

5.32 Freeman (2019) identifies how proposed (new) management practices are likely to overall reduce nutrient, bacterial, and sediment contamination that currently originates from Woldwide farms and that there is a very low significance of potential increases in contamination (5.50, 5.51). Although there is potential for a very slight reduction in the contaminant risk of the proposed activities on Woldwide farms, it is the presence (magnitude) of that risk that should be taken into consideration (rather than the slight reduction in that risk) since a change in overall vulnerability status does not of itself result in a change in effect.

Estuary water quality

5.33 Estuary systems of each main river are correctly identified (5.52) and reference to recent broad scale mapping was made (5.53) including key findings (5.54). Provision of this information supplements the (relatively) basic information provided in Legg (2019) and slightly more comprehensive information provided in Landpro (2019).

5.34Information presented in sections 5.55 – 5.58 is equivalent to that presented in Lovett 2019a and Lovett 2019b which was required to supplement the basic information in the original applications (Legg, 2019; Landpro, 2019). This information provides an estimate of total nutrient loadings to each estuary (other than Waimatuku) (Table 8), potential reduction from mitigation measures (Table 9), and description of mitigation measures (Table 10).

5.35 Freeman (2019) indicates that Woldwide operate under the highest level of mitigations (Level 3), aside from establishment of wetlands which is not viable in the geographic setting. Wintering barns were not considered by Aqualinc (2014) so have not been accounted for.

6.0 Implications of water quality for targeting of mitigation

6.1 It is agreed that priorities for mitigation should include a range of parameters (N, P, sediment, and bacteria) based on outcomes of water quality results and the dominant control of soil types on shallow recharge and/or drainage (6.1). However, the following statement indicating that observed water quality degradation "… *will be from land use activities upstream and downstream in the catchment, with only a relatively tiny contribution from the individual properties*". This statement is not supported by any evidence and is a qualitative statement only. Further, although this implies the contribution is small or insignificant, there is still a cumulative impact on the environment that needs to be addressed.

7 Contaminant loss mitigation proposals, modelling, and water quality

Existing and proposed good management practices and mitigation

7.1 Information regarding existing and proposed good management practices and mitigation measures are predominately presented in the FEMP'S.

Overseer and uncertainty

7.2 An indication of limitations associated with Overseer nutrient modelling particularly inherent uncertainty are more accurately identified here compared to Legg (2019) and Landpro (2019) ((7.2, 7.3). Reference is made to a more comprehensive report by Freeman et al., (2017) that explored appropriateness and guidance in the use of Overseer for regulation.

Overseer modelling and water quality effects

7.3 A summary of Overseer modelling results prepared by Duncan (2019) and Crawford (2019) is presented (Table 11 – 14). These results generally show comparison of the current farm system to that of the proposed farm system, and include a percentage reduction in nutrient loss. Values presented in Table 11 – 14 differ slightly to those presented in the original application (see Figure 6.1 and 6.2 in Lovett 2019a; and Table 6.1 in Lovett 2019b).

7.4 Only total estimated nutrient losses are provided and the (previously reported) nutrient loss per hectare of land has been omitted from these tables.

7.5 A thorough discussion regarding the inherent uncertainties in Overseer (to either over- or under- estimate nutrient loads is provided) in 7.5 – 7.11. This is significantly more detail that provided in the original applications and adequately addresses the inherent uncertainties identified in Overseer and the subsequent difficulty in determining how water quality may be influenced (e.g., improved or degraded).

Surface water and groundwater catchments

7.6 Hydrology of WW1/WW2 and Horner Block are further discussed, including surface water catchments (7.12 – 7.14, Figure 16) and groundwater catchments (7.14, Figure 17), with subsequent discussion of WW4 and WW5 farms (7.15 – 7.17). Overall, this discussion appears to consider the likely proportion of water routed to surface water and groundwater from each of the farms. Given the complexity of local hydrology including shallow drainage and surface water routing and a shallow groundwater table, it is extremely difficult to predict the routes of water flow with any certainty to the point that they might be considered closer to assumptions rather than observed pathways. On several occasions statements are made that indicate the contribution to downstream systems will be 'very small' both in terms of nutrient contribution and nutrient reduction (7.14; 7.17). These statements are not supported by any quantitative data.

Water quality effects on estuaries

7.7 Information presented regarding the downstream estuary environments is a considerable improvement on Legg (2019) and Landpro (2019). Figures provided in the estimated nutrient loadings are similar to that presented in Lovett (2019a and 2019b; Section 6.2 Receiving Environment).

7.8 Freeman (2019) indicates that these values "*can't be used in any meaningful way to estimate contributions to nutrient concentrations in the relevant estuaries/river mouth*". Although it is acknowledged that there are limitations around calculation of these loads, it is argued that these values indicate farming activities from WW1/WW2 and WW4 and WW5 (including WRO) contribute a considerably to the degradation of overall water quality of the receiving estuaries.

8 Fecal indicator organisms and sediment losses before and after development

8.1 A relevant summary of constraints associated with estimation of sediment losses is presented (8.1). In lieu of more appropriate methods, use of P-loss estimated in Overseer can be used as a proxy for sediment loss.

9 Water quality issues raised by submitters

Heddon Bush Primary School

9.1 A summary of the submission lodged by Ministry of Education is presented including the primary concern that the proposed activities may contribute to increased nitrate over time (9.1). This is a valid concern given the intensity of land use in the upper catchment and the (comparatively) shallow depth of the drinking water supply bore (*c.* 14.9 m BGL). It is not useful to deflect attention here to 'potential' contaminant pathways caused by well head security (9.3 – 9.6) and the reader is referred to Section 11 of this report.

9.2 Groundwater quality results presented in Freeman (2019) align with those presented in Lovett 2019a, both of which indicate a limited impact of land use on water quality (e.g., 1.8 – 2.3 mg/L nitrate; predominantly absence of fecal indicators).

9.3 Freeman (2019) indicates that "*With the reduction in contaminant loss that will occur at the properties the proposal <u>will not</u> result in any additional risk to the existing quality of the current water supply.*" This statement relies heavily on the Overseer estimates of nutrient loss, for which the significant limitations have been described. Therefore, it is suggested that a more appropriate statement would be "… is unlikely to…".

9.4 The recommendation that Heddon Bush School should continue to monitor groundwater quality and likely treat (disinfect) groundwater in the future is sensible and justified (9.9).

10 Conclusions on the effects of the proposal on water quality

10.1 Based on information provided in the entirety of application documents, it is agreed that there is <u>potential</u> for the proposed activities and mitigation measures to slightly reduce the losses of sediment, nutrients, and bacterial contaminants from WW1/WW2, WW4, WW5, and WRO farms. However, this reduction in nutrient loss is not guaranteed, largely due to a combination of natural complexity in the hydrological system and inherent uncertainties in modelling. Key limitations include: reliance on estimates from Overseer; that the estimate is based on the assumption the best management Practices and the highest level of Mitigation measures will be undertaken at all times (which may not be possible operationally); and since the proposed increase in number of cows will result in (an overall) increased effluent application to land. There is a considerably higher probability that a reduction in nutrient losses would occur if all mitigation measures were employed and cow numbers remained the same as they are currently.

10.2 It is agreed that a catchment-wide effort to reduce contaminant losses would likely be required to considerably reduce losses to surface water and groundwater (and therefore result in a meaningful improvement in water quality). However, it is also recognised that the area covered by WW1/WW2, WW4, WW5, and WRO farms and the actual losses from these properties to play an important role in overall loadings to the local and regional groundwater and surface water catchments.

11 Attachment A: Bore assessment in Heddon Bush

11.1 John Scandrett of Dairy Green Ltd. (undated) prepared an eight-page document titled "*Groundwater Well and/or Bore Assessment – Heddon Bush; Central Southland*". This document was submitted to Environment Southland in August 2019 and was included as 'Attachment A' of the Freeman (2019) report. The document included a visual inspection of groundwater bores and provision of in assessment of those bores for suitability for groundwater monitoring.

11.2 A primary limitation of the report is that the location of bores is unable to be determined and no quantitative hydrogeological information is provided, while *pro forma* bore numbers ("E45/XXXX") are assigned to each bore. For a more comprehensive and sound assessment of the suitability of each monitoring bore to be considered, it is essential that the following information is provided:

a. Location including bore identification numbers and GPS co-ordinates;
b. Bore construction information including bore depth, bore log, aquifer, screened interval, water level (with hydrogeological context);
c. Hydro-chemical information including water quality results (not limited to nitrate nitrogen);
d. Groundwater management zone;
e. For any Environment Southland monitoring bores an indication of type of monitoring (e.g., water quality and/or groundwater level measurement), and dates monitoring was undertaken.

11.3 The report identifies a selection criterion as targeting "…*shallow wells that have demonstrated high groundwater nitrate concentrations*". It is important to consider the following limitations associated with this selection criteria:

a. The definition of what is considered 'high' has not been provided for context. For example: 'high' could be defined as anything above natural background concentrations (e.g., > 1.0 mg/L), or in contrast anything above the current maximum acceptable value for drinking water standards of 11.3 mg/L. The significance 'high' would also (likely) be related to the actual use for the groundwater (e.g., a 'high' concentration for drinking water supply would be very different to a 'high' concentration for dairy shed washdown).
b. The selection criteria does not identify any timeframe or duration for the 'high' nitrate concentrations (e.g., it is not known if the results are one-off samples or whether concentration is consistently high over several months and/or years).
c. Often bores are tested for water quality following drilling or at the time of bore construction (completion), at which time water quality is likely representative of the underlying aquifer.

11.4 The assessment criteria defined in the report is somewhat arbitrary since there is no justification for the selection of the assessment criteria and there are no references to standard or proven criteria. Furthermore, the following regarding each assessment criteria should be considered:

a. Assessment criteria 2 (well head protection) is defined arbitrarily as being 'no = poor', 'some= moderate', and 'high = adequate'. The assessment would have been strengthened of the criteria considered good practice well head construction conditions (e.g., Rule 53, in Southland LWP, 2018) including: height of casing above ground level, casing material (e.g., PVC, steel), casing condition, presence of concrete pad, presence of stock exclusion, padlock, exclusion of rainfall.
b. There is no reasoning to identify why assessment criteria 3 (proximity to potential contaminant source) and assessment criteria 6 (distance to surface waterway) use different distances for the 'close, moderate, distant' criteria. This resulted in all bores being classified as:
    - AC3: close (< 200 m); moderate (200 m – 500 m); and distant (> 500 m);
    - AC6: close (<100 m); moderate (100 m – 500 m); and distant (>500 m)
c. Furthermore, assessment criteria number 3 (proximity to contaminant source) is largely redundant since all wells visited were identified as close (< 200 m) - as would be expected on operating farms. The actual distance (m) to all upgradient contaminant sources would have been a better measure of 'proximity to contaminant source', or a definition of close should be reduce to a more realistic distance (e.g., 10 m).
d. The 'low, medium, high' criteria used for assessment criteria 7 is a subjective definition which is not supported by any reference material. At minimum, a quantitative grading criterion or a matrix would have provided a better representation of bore suitability.

11.5 The assessment is likely to present a small selection (six) of all bores in the Heddon Bush area which is a somewhat bias approach. The report would be strengthened if the total number of bores in the area were identified and the total number of bores for which nitrate concentrations were available were presented. The Environment Southland database shows > 50 bores in the Heddon Bush area which are in three different groundwater management zones (Upper Aparima, Waimatuku, and Central Plains).

11.6 A step-by-step protocol for the collection of groundwater samples in New Zealand informed collection of State of the Environment monitoring undertaken by Environment Southland from 2006 – 2019 (MfE, 2006). From March 2019 these guidelines have been replaced by the National Environmental Monitoring Standards (NEMS, 2019). Although the protocols are best practice tools rather than a mandatory requirement, Environment Southland follow the protocols for all groundwater sampling in the region. One of the key requirements of the sampling protocol is to purge (e.g., pump groundwater from) the sampling bore until (a minimum of) three times the (casing) storage volume has been removed. The aim of this procedure is to ensure that the groundwater sample collected is representative of groundwater in the local aquifer, rather than any 'sitting' or 'stagnant' water from within or surrounding the bore screen and/or casing. This method is used to reduce the influence of any potential contamination on water quality results. Therefore, even though there may be potential contamination of the bores as described in the Scandrett report, it is likely that the water quality results should still be representative of the actual groundwater quality of the aquifer from which the sample was taken. Furthermore, the three well volumes are also likely to purge any potential contaminants that may have entered the aquifer during pumping (abstraction). Although the bores are most prone to show potential contamination (since they are not regularly pumped), it appears as though well head security is considerably better for the bores than the well.

11.7 Maintenance of a bore and wellhead is the responsibility of the bore owner (e.g., the consent holder for drilling and/or groundwater abstraction). "*Rule 53 – Bores and wells*" of the Southland SLWP (2018) identifies current policy for the drilling, construction, and use of bores for groundwater supply (Appendix 1). Any bores that potentially provide a pathway for contaminants to enter the groundwater system should be modified appropriately and as soon as possible to prevent any further contamination.

11.8 In summary, the assessment of bores in the Scandrett report lacks basic information including location and hydrogeological context and is based on a largely cryptic and indefinite assessment criteria. Without additional hydrogeological information the importance of water quality results in terms of interpreting impacts of land use on nitrate concentration the Heddon Bush area is no further informed. However, of significance, is that the Scandrett report primarily implicates all bore owners who have either incorrectly sited, and/or constructed, and/or maintained bores (in relation to Rule 53, Appendix 1). In all instance's improvements to well head security for the three bores and three wells should be undertaken for them to conform to Rule 53. It should be noted that wherever appropriate purging and sampling of the bore or well is practiced, the risk of unrepresentative interference to the water quality result is mostly avoided since adequate purging ensures that an external groundwater sample is obtained. To some extent the Scandrett report confirms the challenges in obtaining consistent water quality results due to the inherent hydrogeological and land use influences on the composition of groundwater samples taken. If contamination of the aquifer has occurred through the preferential pathway provided by the bore and if this condition is ubiquitous for the area's bores, it could be argued that this is a fair representation of the impacts of local land use (e.g., intensive agriculture) on the underlying aquifer.

APLovett

Abigail Lovett

2 September 2019

References

Freeman, M., 2019. Water quality assessments. Woldwide One Limited and Woldwide Two Limited & Woldwide Four Limited and Woldwide Five Limited. Report prepared for Woldwide One Limited, Woldwide Two Limited, Woldwide Four Limited and Woldwide Five Limited.

Landpro, 2019. Woldwide Four Limited and Woldwide Five Limited Resource Consent Application to Southland Regional Council. Application prepared on behalf of applicant by: Landpro Ltd. 13 Pinot Noir Drive, PO Box 302, Cromwell. 160 p + Appendices.

Legg, N., 2019. Woldwide Farming Group: Woldwide One Limited and Woldwide Two Limited Resource Consent Application, submitted to Southland Regional Council. Application prepared on behalf of applicant by: Dairy Green Ltd., 10 Kinloch Street, PO Box 5003, Waikiwi, Invercargill, 9843. 164p + Appendices.

Lovett, A., 2019a. Review of Resource Consent Application by Woldwide One Ltd. and Woldwide Two Ltd. Earth & Environmental Science Report 2019/02, prepared for Environment Southland Regional Council. 55p.

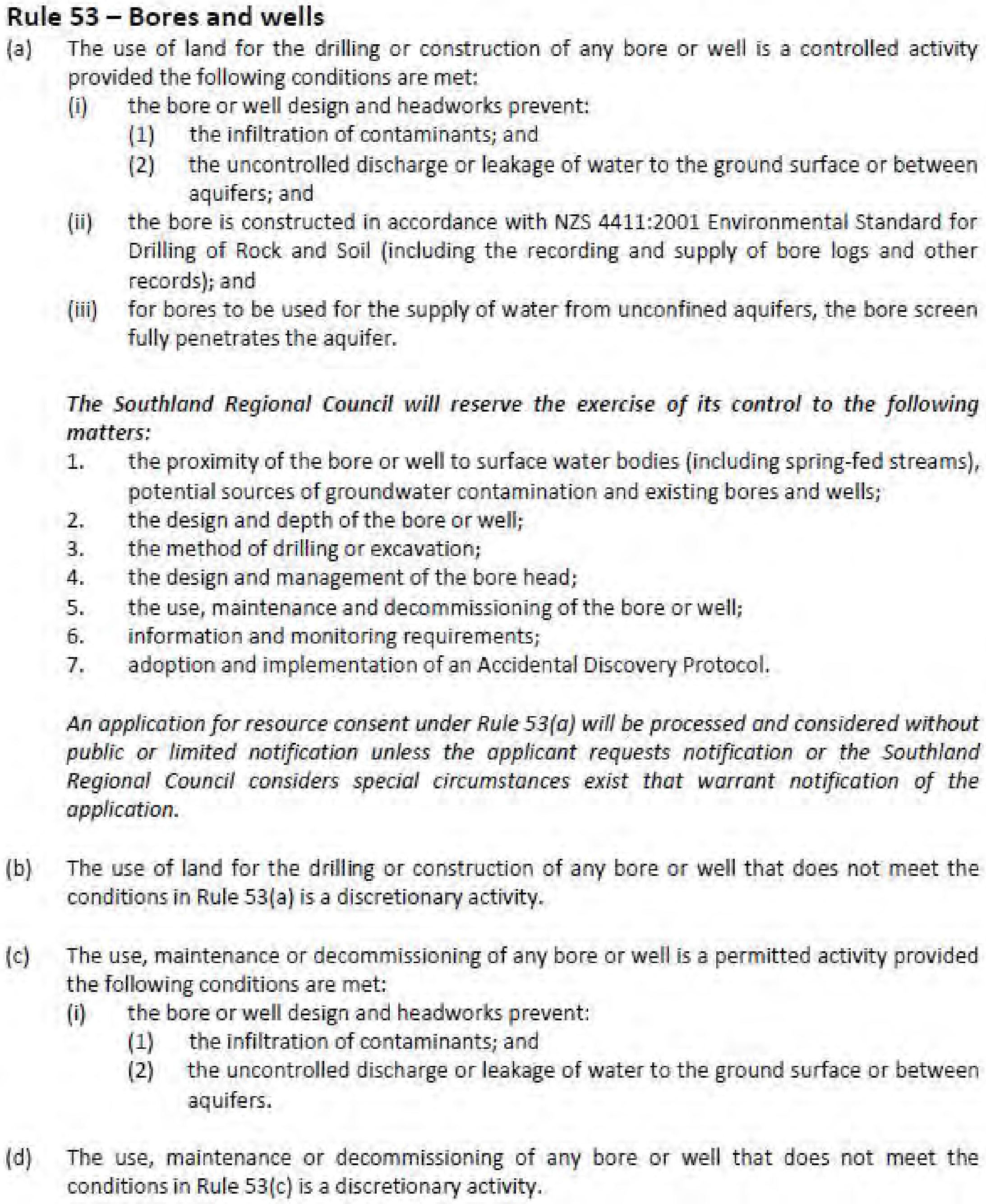
Lovett, A., 2019b. Review of Resource Consent Application by Woldwide Four Ltd. and Woldwide Five Ltd. Earth & Environmental Science Report 2019/03, prepared for Environment Southland Regional Council. 51p.

Ministry for the Environment, 2006. A National Protocol for State of the Environment Groundwater Sampling in New Zealand. Ministry for the Environment, Manatū Mō Te Taiao PO Box 10-362, Wellington, New Zealand ISBN: 0-478-30112-X, ME number: 781.

NEMS, 2019. National Environmental Monitoring Standards. Water Quality, Part 1 of 4: Sampling, Measuring, Processing and Archiving of Discrete Groundwater Quality Data. Version: 1.0.0, 31 March 2019. http://www.nems.org.nz/documents/water-quality-part-1-groundwater/

pSWLP 2018. Proposed Southland Water and Land Plan Decisions Version 4 April 2018. Environment Southland Regional Council. https://www.es.govt.nz/Document%20Library/Plans,%20policies%20and%20strategies/Regional%20plans/Southland%20Water%20and%20Land%20Plan/Proposed%20Southland%20Water%20and%20Land%20Plan%20-%20Part%20A%20-%20Decisions%20Version%20(4%20April%202018)%20PDF.pdf

Appendix 1: Rule 53, Page 79 and 80, Southland Land and Water Plan (2018)



Rule 53 – Bores and wells

(a) The use of land for the drilling or construction of any bore or well is a controlled activity provided the following conditions are met:

- (i) the bore or well design and headworks prevent:
  - (1) the infiltration of contaminants; and
  - (2) the uncontrolled discharge or leakage of water to the ground surface or between aquifers; and
- (ii) the bore is constructed in accordance with NZS 4411:2001 Environmental Standard for Drilling of Rock and Soil (including the recording and supply of bore logs and other records); and
- (iii) for bores to be used for the supply of water from unconfined aquifers, the bore screen fully penetrates the aquifer.

The Southland Regional Council will reserve the exercise of its control to the following matters:

1. the proximity of the bore or well to surface water bodies (including spring-fed streams), potential sources of groundwater contamination and existing bores and wells;
2. the design and depth of the bore or well;
3. the method of drilling or excavation;
4. the design and management of the bore head;
5. the use, maintenance and decommissioning of the bore or well;
6. information and monitoring requirements;
7. adoption and implementation of an Accidental Discovery Protocol.

An application for resource consent under Rule 53(a) will be processed and considered without public or limited notification unless the applicant requests notification or the Southland Regional Council considers special circumstances exist that warrant notification of the application.

(b) The use of land for the drilling or construction of any bore or well that does not meet the conditions in Rule 53(a) is a discretionary activity.

(c) The use, maintenance or decommissioning of any bore or well is a permitted activity provided the following conditions are met:

- (i) the bore or well design and headworks prevent:
  - (1) the infiltration of contaminants; and
  - (2) the uncontrolled discharge or leakage of water to the ground surface or between aquifers.

(d) The use, maintenance or decommissioning of any bore or well that does not meet the conditions in Rule 53(c) is a discretionary activity.

Earth & Environmental Science Ltd.

+64-21-2800750
www.eescience.co.nz

Review of Resource Consent Application by Woldwide One Ltd. and Woldwide Two Ltd.

Abigail Lovett

Earth & Environmental Science Report 2019/02
July, 2019

Prepared for Environment Southland Regional Council

Quality control record

Title: Review of Resource Consent Application by Woldwide One Ltd. and Woldwide Two Ltd.

Client: Environment Southland Regional Council

Version: Final Version 1

Issue date: 26.07.2019

Job number: 19008

File location: Projects\EnvironmentSouthland\ResourceConsents\Woldwide\WW1_WW2\Reporting

Review

Technical: Jens Rekker

Organisation: JH Rekker Consulting Ltd.

Date: 05.07.2019

Client: Alex Erceg

Organisation: Environment Southland Regional Council

Date: 23.07.2019

Document details

Author/s: Abigail Lovett

Reference: Lovett, A., 2019. Review of Resource Consent Application by Woldwide One Ltd. and Woldwide Two Ltd. Earth & Environmental Science Report 2019/02, prepared for Environment Southland Regional Council. 55p.

Approved for release by:

Signature ALovett

ABIGAIL LOVETT, 26/07/2019

Contents

Executive summary

Environment Southland requested that Earth & Environmental Science Ltd. review a resource consent application submitted by Woldwide One Ltd. and Woldwide Two Ltd. The review included assessment of information provided in the application to address potential effects on freshwater resources in the receiving environment as a result of the proposed activities. Where required, additional information to support an assessment of effects from the proposed activities was presented.

The application sought consents to allow for continued operation of Woldwide One and Woldwide Two dairy farms, located *c.* 10 km to the north of Otautau at Heddon Bush. Support for these farms is provided by Horner Block and Woldwide Runoff (Merrivale, Western Southland), which are also used as support blocks for other farms. Woldwide Runoff consists of Merrivale and Merriburn Blocks, which are located on rolling lowland hill country approximately 20 km west of Otautau. Existing consents for Woldwide One and Woldwide Two included Effluent Discharge Permits for discharge of farm dairy effluent and Water Permits for abstraction of groundwater. An existing permit for Land-use for expanded Dairy Farming was held by WW2. The application proposed amalgamation of current effluent discharge and water permits for a single farm unit Woldwide One and Woldwide Two; and that the Land-use for expanded Dairy Farming permit be replaced by a consent for Dairy Farming, to include an additional 160 cows. The land use permit was to include a designated area of Woldwide Runoff used for stock from Woldwide One, and Woldwide Two. The applicant sought consent periods of 15 years.

Woldwide One and Woldwide Two are located in the Waimatuku, Central Plains, and Upper Aparima Groundwater Management Zones; and in the Waimatuku Stream, Oreti River, and Upper Aparima Freshwater Management Units. The farms are located on Central Plains and Oxidising Physiographic Zones, and are characterised by a high level of soil variability including contrasting physical and chemical properties. Underlying soils include Braxton, Drummond, Glenelg, Waiau, and Tuatapere. Primary surface waterways include Merry Creek and Fenham Creeks which flow through the farms before converging with the Orauea River, all of which are in the Waiau Catchment. The groundwater management zone is characterised as 'unclassified' Soil classes include Orawia, Waimatuku, Malakoff, Riverine, and Aparima + Papatotara.

Background information and results of dataset analysis were presented to characterise the receiving environment. Surface water quality results showed that land use in the catchment/s had a considerable impact on the water quality of Waimatuku Stream, Oreti River, and Aparima River, including nutrient, bacterial, and sediment contamination. Groundwater results indicated that the groundwater system had been impacted from land use processes, including elevated nitrate in hotspots and bacterial contamination. The most likely source of bacterial contamination and increased nitrate and phosphorous is land use in the catchment, including dairy farming and sheep and beef grazing. Groundwater levels showed strong seasonal signals due to the influence of rainfall, land surface recharge, and abstraction. There was no evidence of a long-term decline in groundwater level over time. Since the aquifers are predominantly recharged via rainfall, they are particularly vulnerable to changes in climate (such as predicted lower rainfall in summer) and increased abstraction. Soil moisture datasets indicate that drainage is likely to occur during the period May – September, with differences in weather promoting earlier or later onset of land surface recharge. Soil moisture is a controlling factor in the timing and rate of effluent irrigation, since application of effluent can lead to leaching of nutrient and bacteria to groundwater and discharge of contaminants (including sediment) to surface water. Land use on Woldwide One, Woldwide Two, and Horner Block has the potential to affect the Heddon Bush School supply due the close proximity (*c.* 2 km) to the properties. The bore is at a (relatively) deep depth (14. 9 m), and currently shows no bacterial contamination and slightly elevated nitrate concentration.

The description of the receiving environment provided in the application is basic and relies on limited data sources Although considerable surface water and groundwater datasets exist, very little, if any analysis of data has been undertaken. Even so, the limited data presented clearly indicates that surface water, groundwater, and estuarine environments have been impacted by land use in the catchments. In contrast, the application repeatedly states that there will be 'less than minor' or even an 'improvement' in water quality as a result of the proposed activities. These statements have been made with a lack of supporting information and rely heavily on Overseer analysis, for which the limitations or uncertainty are not adequately described.

Operation of proposed activities on Woldwide One, Woldwide Two, and Horner Block will result in a minimum of 23,300 kg/N/yr and 390 kg/P/yr being lost to the environment. Nutrient loadings are likely to affect surface water, groundwater, and estuarine environments. Bacterial and sediment contamination of surface water is likely to occur due to shallow drainage and overland flow. An important omission is that the application fails to provide estimated nutrient losses from

WRO, despite intensive winter grazing being predicted to increase from 52 Ha – 100 Ha. Therefore, the full effects of farming operations of Woldwide One and Woldwide Two are incomplete. The application states that the farms are operating under Mitigation Level 3 (the highest level). Any instance where these mitigation measures are not followed will result in an increase of nutrient, sediment, and/or bacterial loss to the receiving environment. As a result, the negative effects of farm operations and activities on groundwater and surface water resources will be increased. The conclusion of the AEE is that water quality will be maintained. However, in the opinion of the reviewer this assessment is not supported by water quality results presented in the application or within this report.

Significant omissions in the application are that:

- An assessment of the effect of increased abstraction from bore E45/007 has not been undertaken;
- A cumulative effects assessment on the receiving environment for proposed activities on the Horner Block has not been undertaken;
- A description of how soil moisture management is actually implemented or how relevant soil moisture data is used to determine current soil conditions to ensure effects of FDE application are minimised has not been provided.; and
- A cumulative effects assessment on the receiving environment for exported activities on Woldwide Runoff, including nutrient budgets, has not been considered.

1.0 Introduction

Environment Southland requested Earth & Environmental Science Ltd (E&E Science) undertake a review of Resource Consent Application for Woldwide One Ltd. and Woldwide Two Ltd. (WW1/WW2) prepared on behalf of the applicant by Legg (2019) of Dairy Green Ltd, Invercargill. The scope of the review included: assessment of completeness of information provided in the consent application in terms of addressing potential effects on groundwater and surface water quality and quantity in the receiving environment; and provision of information required for determining the effects of the proposed activities on surface and groundwater resources.

On several occasions, consent application documents refer to various legal opinions which have been sought regarding terms such as 'landholding' and 'single business entity'. For the purposes of this technical review, all farm operations associated with the proposed consents for WW1 and WW2 are considered for completeness, regardless of the ownership structure of the property. The potential effects of all farm operations associated with import and/or export of services (e.g., effluent disposal, grazing, cut and carry), from the properties in the application are considered, including the Horner Block. This review also includes an assessment of Woldwide Runoff (WRO) which is composed of Merrivale and Merriburn (leased) Blocks.

1.1 Consent application summary

All information provided in this section was obtained from the consent application document (Legg, 2019). Information has been collated to provide a summary of farm location, current consented activities, and proposed consented activities. The applicant operates two adjoining Dairy Platforms (farms) WW1 and WW2 located on Hundred Line Road East, Heddon Bush (Table 1.1). Farm operations for WW1 and WW2 include support from the nearby Horner Block (Table 1.1). WRO is a dry stock farm used as a support block for all Woldwide Farms, including (but not limited to) WW1 and WW2. WRO includes Merrivale and Merriburn Blocks and is located in Merrivale, Western Southland (Table 1.1). WW1 and WW2 use WRO for grazing support including intensive winter grazing (IWG) and supplement production. Additional activities on WRO include a forestry and gravel extraction operations and an area of native bush.

Table 1.1: Summary of current farming operations for WW1 and WW2 Dairy Farms and relevant Support Blocks.

Name	Location	Description	Area	Current land-use
Woldwide 1 (WW1)	Hundred Line Road East, Heddon Bush	Woldwide 1 Dairy Farm	502 Ha (479 Ha effective) FDE *c.* 400 Ha, FDE 42 Ha + ? (HB)*	540 cows Effluent Discharge
Woldwide 2 (WW2)	Hundred Line Road East, Heddon Bush	Woldwide 2 Dairy Farm		800 cows Effluent Discharge
Horner Block	Hundred Line Road East, Heddon Bush	Support farm (WW1 & WW2 + others)	160 Ha (155 Ha effective) 97 Ha FDE	Effluent Discharge Cut & carry
Woldwide Runoff Merrivale	20 Gill Road, Merrivale	Support Farm (WW1 & WW2 + others)	507 Ha (321 Ha effective)	Grazing
Woldwide Runoff Merriburn	1711 Otautau-Tuatapere Road	(Leased) Support Farm (WW1 & WW2 + others)	385 Ha (338 Ha effective)	Grazing

* The area for which WW1 effluent and/or slurry is discharged on the Horner Block is not provided.

1.1.2 Current consents

The applicant currently holds the following consents for WW1 Dairy Farm:

- AUTH-301663: Effluent Discharge Permit (2017 - 2027)
    - 540-cow herd, milked twice/day, hard-home slurry (400 cows)
    - Method: Land disposal, maximum discharge of 10 mm and 5 mm depth
    - Farm Dairy Effluent (FDE) discharge: most of WW1, other part of Horner Block (area not provided) (Pg. 18)
    - Buffers implemented
- AUTH-301664: Water Permit (2017 - 2027)
    - Bore E45/0071, groundwater abstraction, maximum 60 m^3/day

The applicant currently holds the following consents for WW2 Dairy Farm:

- AUTH-20171278-01: Effluent Discharge Permit (2017 - 2027)
    - 880-cow herd, milked twice/day, hard-home slurry (640 cows), underpass, silage pad
    - Method: Low-depth travelling irrigator (maximum 10 mm depth / application); and Umbilical system and slurry tanker with trailing shoe (maximum 5 mm depth / application)
    - FDE discharge: liquid effluent discharged on 194 Ha of WW2; slurry effluent discharged on 42 Ha of Horner Block.
    - Buffers implemented, "*except for a buffer of 100 m from Lot 3 DP237*"
- AUTH-20171278-02: Water Permit (2017 – 2027)
    - Bores E45/0083 and E45/0727, maximum daily abstraction of 96 m^3/day combined
- AUTH-20171278-03: Land-use for expanded Dairy Farming (2017 – 2027)

Summary of support farms for WW1 & WW2:

- 'Horner Block' is a 160 Ha support block for multiple dairy platforms including WW1 and WW2. Support operations include cut and carry pasture (imported to WW1 & WW2); and discharge of pond slurry (exported from WW1 & WW2). Consent for discharge of effluent and slurry is granted via consents attached to the primary farm blocks, respectively (e.g., WW1 and WW2).
- Woldwide Runoff (WRO) is located in the Merrivale/Western Southland area and is used as a support block for multiple dairy platforms including (but not limited to) WW1 and WW2. The Merriburn Block and Merrivale Block are used by WW1 and WW2 for grazing support including Intensive Winter Grazing (IWG).

The applicant currently undertakes the following (permitted) activities on WRO:

- Dry stock farming - 732 Ha (2018/2019 stocking numbers)
    - Grazing of R1 (1,265) and R2 (1,265) heifers
    - Grazing of mating bulls (70)
    - Grazing of carry over cows (37)
    - Intensive winter grazing of above stock – (52 ha in 2018)
    - Dry stock grazing
    - Production of baleage
- Forestry: commercial pine plantation (100 Ha) and native bush (60 ha)

1.1.3 Proposed consents

The applicant proposes that the existing consents for WW1 and WW2 be modified to allow for granting of consents for a single farm unit WW1/WW2 (Pg. 25). The applicant is seeking consents to be granted for a period of 15 years. At this stage, consideration of specific consent conditions has not been taken into consideration. Consent conditions should be set at such time (if or when) consents are to be granted. The applicant proposes the following changes to existing consents:

- Land use:
  - Replace AUTH-20171278-03 (Land-use for expanded Dairy Farming (2017 – 2027)) with a consent for Dairy Farming at WW1/WW2 and WRO (to only include areas used for WW1/WW2 stock).
    - Increase cow numbers from 540 cows to 700 cows at WW1. This is an increase of 160 cows and equivalent to a 30% increase at WW1. Total proposed stocking numbers are 700 cows on WW1 and 800 cows on WW2 (e.g., 1,500 cows on WW1/WW2). This is equivalent to a 10% increase in stock numbers if the farms are considered overall (WW1/WW2).
    - Increase number of cows to be held in WW1 wintering barns from 400 to 625
    - Total cow numbers in wintering barns is proposed as 625 in WW1 and 625 in WW2 (1,250)
- Effluent Discharge:
  - Replace existing discharge permits (AUTH-301663 and AUTH-20171278-01) with a single discharge permit for WW1/WW2 for slurry (5 – 15% dry matter content).
  - Discharge of agricultural effluent (dairy shed, wintering barn, silage pad, underpass) to land for 1,500 cows (an increase of 160 cows)
  - Discharge of 15 kg/N/Ha/yr to WW1 and WW2 discharge areas; and 250 kg/N/Ha/yr on Horner Block
  - Effluent discharge Methods:
    - Travelling irrigator to apply dairy shed effluent to land, ≤ 10 mm/application
    - Slurry tanker with trailing shoe to apply pond slurry to land, ≤ 2.5 mm/application
    - Umbilical system (contingency) for pond slurry to land, ≤ 3.0 mm/application
    - Pods (future-proof) for dairy shed effluent to land, ≤ 10 mm/hr (max 10 mm)
    - Cannon / rain-gun (future-proof) for dairy shed effluent to land ≤ 10 mm/hr (max 10 mm)
  - A new (separate) consent for the discharge of slurry to 97 ha of the Horner Block from WW1/WW2
    - Method: umbilical system and slurry tanker with trailing shoe
- Water Use:
  - Replace existing water permits (AUTH-301664 and AUTH-20171278-02) with a single water permit for groundwater abstraction for WW1/WW2 for a total abstraction of 187 m^3/day
    - Bore E45/0071, maximum take of 91 m^3/day (an increase of 31 m^3/day)
    - Bores E45/0083 and E45/0727, maximum daily abstraction of 96 m^3/day (unchanged)

The applicant plans to make the following changes to activities currently undertaken on WRO, relevant to WW1/WW2:

- Dry stock farming - 732 Ha
  - Grazing of 417 R1 heifers (all year) – no change
  - Grazing of 417 R2 heifers (all year) OR (May, season II) – June/July may be wintered in barns
  - Intensive winter grazing (stock from all farms) – 100 ha (increase from 52 Ha in 2018)
  - Grazing of mating bulls - to be on WRO year-round
  - Carry over cows - to be on WRO year-round
  - Dry stock grazing
  - Production of baleage

1.1.4 Summary

The applicant has proposed a number of changes to existing resource consents granted to WW1 and WW2. In terms of an assessment of effects, the proposed consent activities have the potential to impact both water quality and quantity in the hydrological environment, including groundwater and surface water resources. The (proposed) consents to allow for operation of WW1/WW2 Dairy Farm that are relevant to water resources include: increase in number of dairy cows (+160); increased effluent discharge (e.g., volume, rate, timing, and methods); and increase in groundwater abstraction. The effects of the proposed activities will be assessed in terms of the entirety of the land use activity and intensification of current land use on the receiving environment.

2.0 Geographic setting

2.1 Location

WW1, WW2, and Horner Block Farms are located on relatively flat topography in the Heddon Bush area, to the east of the Aparima River. WW1 and WW2 are located in the upper (northern) area of the Waimatuku Groundwater Management Zone (GMZ) and cross into the western Central Plains GMZ (Figure 2.1, Table 2.1). WW1 and WW2 are located in the Waimatuku Stream and Oreti River Freshwater Management Unit (FMU). The Horner Block is located within the Waimatuku sub-unit of the Aparima FMU and in the Waimatuku GMZ (Figure 2.2, Table 2.1). Surface water bodies that drain the local catchment include Terrace Creek, Middle Creek, and Waimatuku Stream. WW1, WW2, and the Horner Block are located in both Central Plains and Oxidising physiographic zones (Table 2.1, Figure 2.3). Soils in the area have a relatively high number of classes, consisting of contrasting physical and chemical properties. Predominant soils include Braxton, Drummond, Glenelg, Waiau, and Tuatapere (Table 2.1).

WRO Merrivale and Merriburn are located in the Merrivale area on rolling lowland hill country approximately 20 km west of Otautau (Table 2.1). The groundwater management zone in the area is 'unclassified'. WRO is located within the Merry Creek and Fenham Creek catchments, both of which flow into the Orauea River are located in the Waiau FMU. The Orauea River then confluences with the Waiau River approximately 4 km north of Tuatapere township. WRO is located within several physiographic zones, including Hill Country, Oxidising, Gleyed, Marine Terraces, and Peat. There are a relatively high number of soil classes on WRO with contrasting physical and chemical properties, including Orawia, Waimatuku, Malakoff, Riverine, and Aparima + Papatotara (Table 2.1). There is no identified groundwater abstraction associated with WRO activities and it is unknown where stock water is sourced from.

Table 2.1: Summary of freshwater management unit (pSWLP, 2018), groundwater management zone (pSWLP, 2018), physiographic zones, and main soil types for WW1, WW2, and support blocks.

Name	Freshwater management unit (FMU)	Groundwater Management Zone	Physiographic Zone	Soil type
Woldwide 1 (WW1)	Aparima (Waimatuku sub-unit), Oreti	Waimatuku, Central Plains	Central Plains, Oxidising	Drummond (*c.* 348 Ha)* Braxton (*c.* 105 Ha)* Glenelg (*c.* 49 Ha)*
Woldwide 2 (WW2)	Aparima, (Waimatuku sub-unit), Oreti	Waimatuku, Central Plains	Central Plains, Oxidising	
Horner Block	Aparima, (Waimatuku sub-unit)	Waimatuku, Upper Aparima	Central Plains, Oxidising	Braxton, Drummond + Glenelg, Waiau + Tuatapere
WRO Merrivale	Waiau	Unclassified	Hill Country, Oxidising, Gleyed, Marine Terraces, Peat	Malakoff, Waimatuku, Makarewa
WRO Merriburn (leased)	Waiau	Unclassified	Hill Country, Oxidising, Gleyed, Marine Terraces, Peat	Aparima, Orawia, Makarewa

* Source: Duncan (2019)

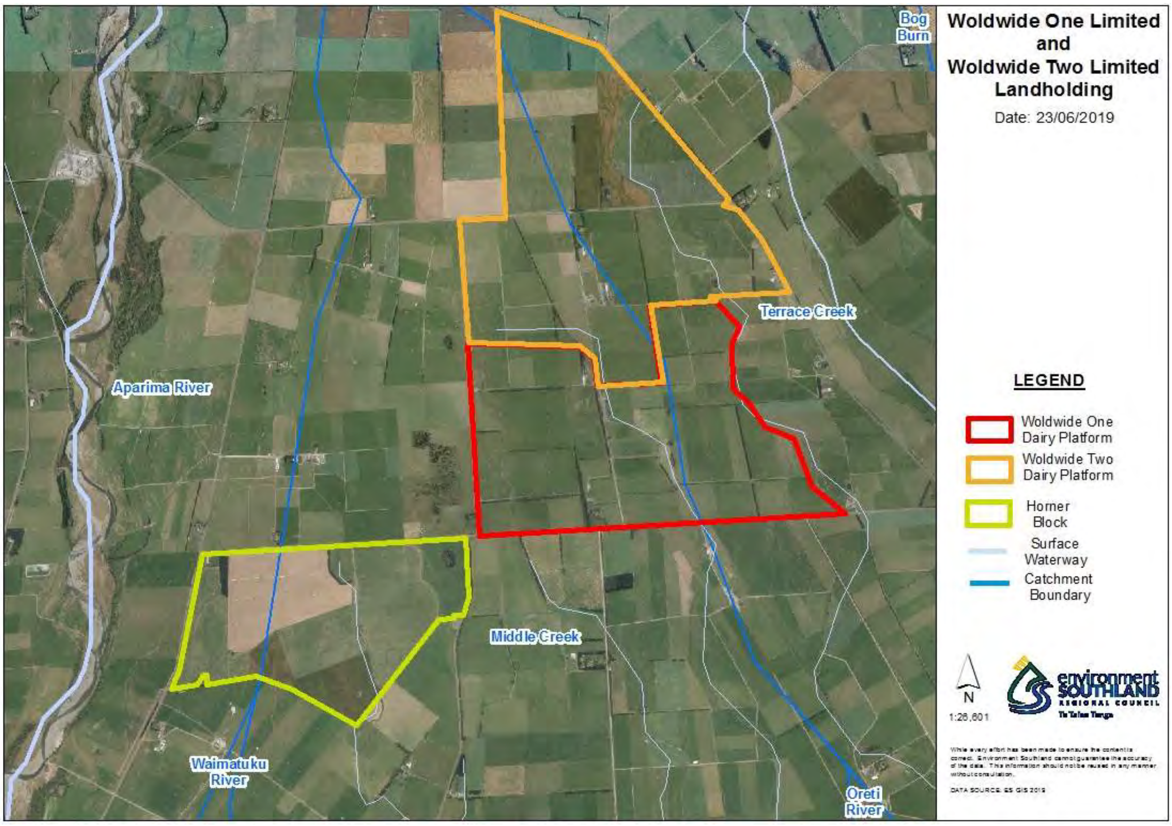


Figure 2.1: Location of WW1, WW2, and Horner Block property boundaries and surface water catchments (Environment Southland, 2019).

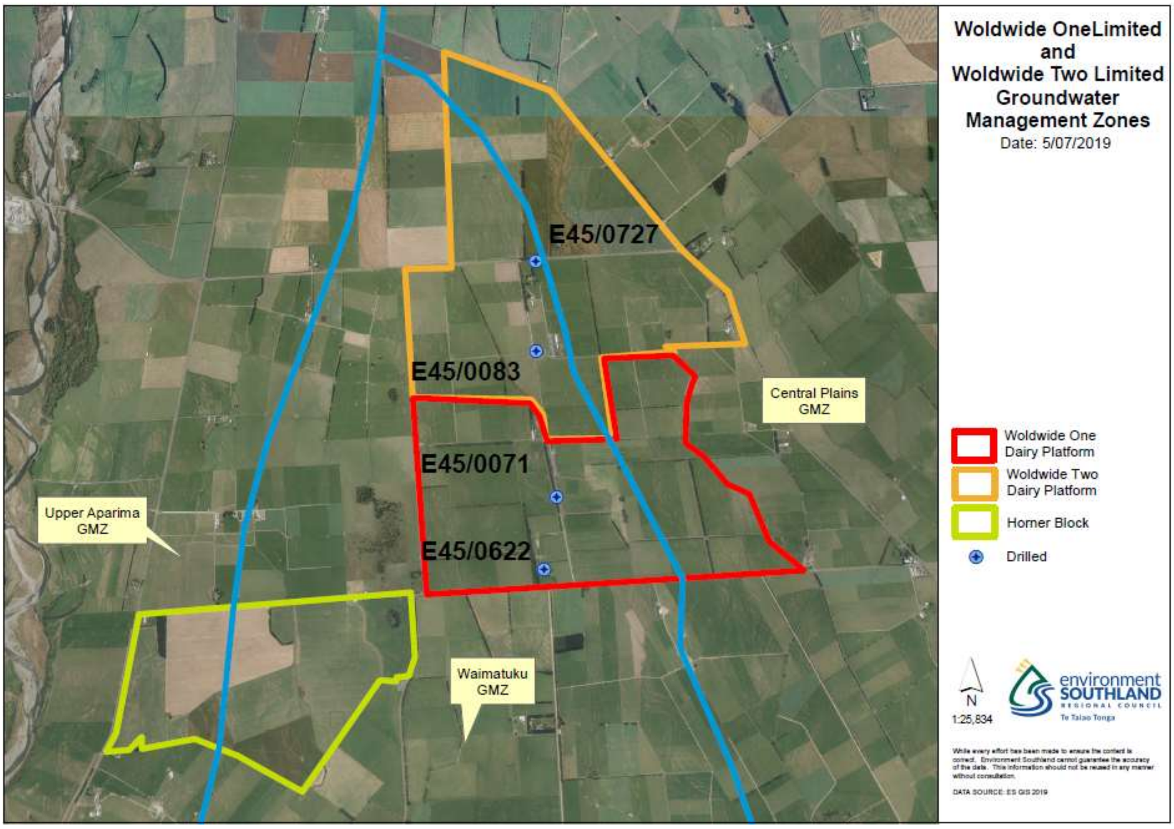


Figure 2.2: Location of WW1, WW2, and Horner Block property boundaries, groundwater management zones and relevant bores (Environment Southland, 2019).

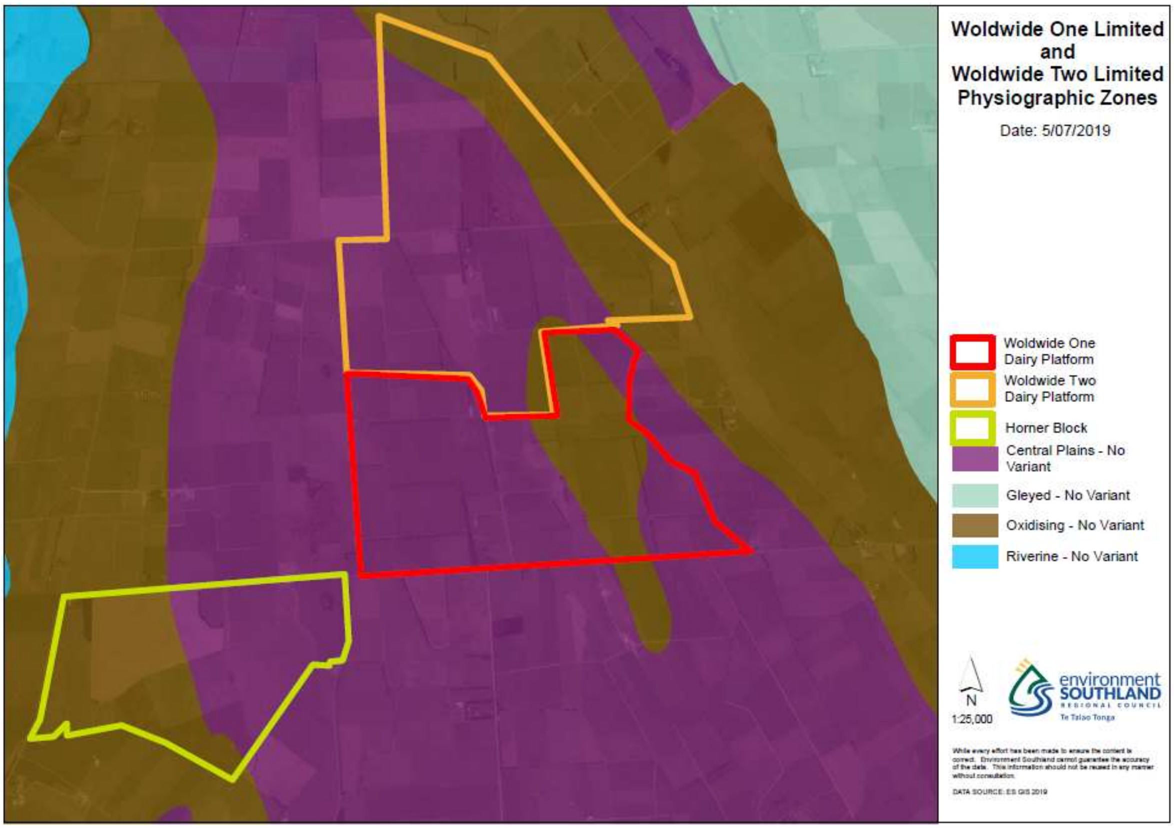


Figure 2.3: Location of property boundaries for Woldwide One (WW1), Woldwide Two (WW2), and the Horner Block, including physiographic zones (Environment Southland, 2019).

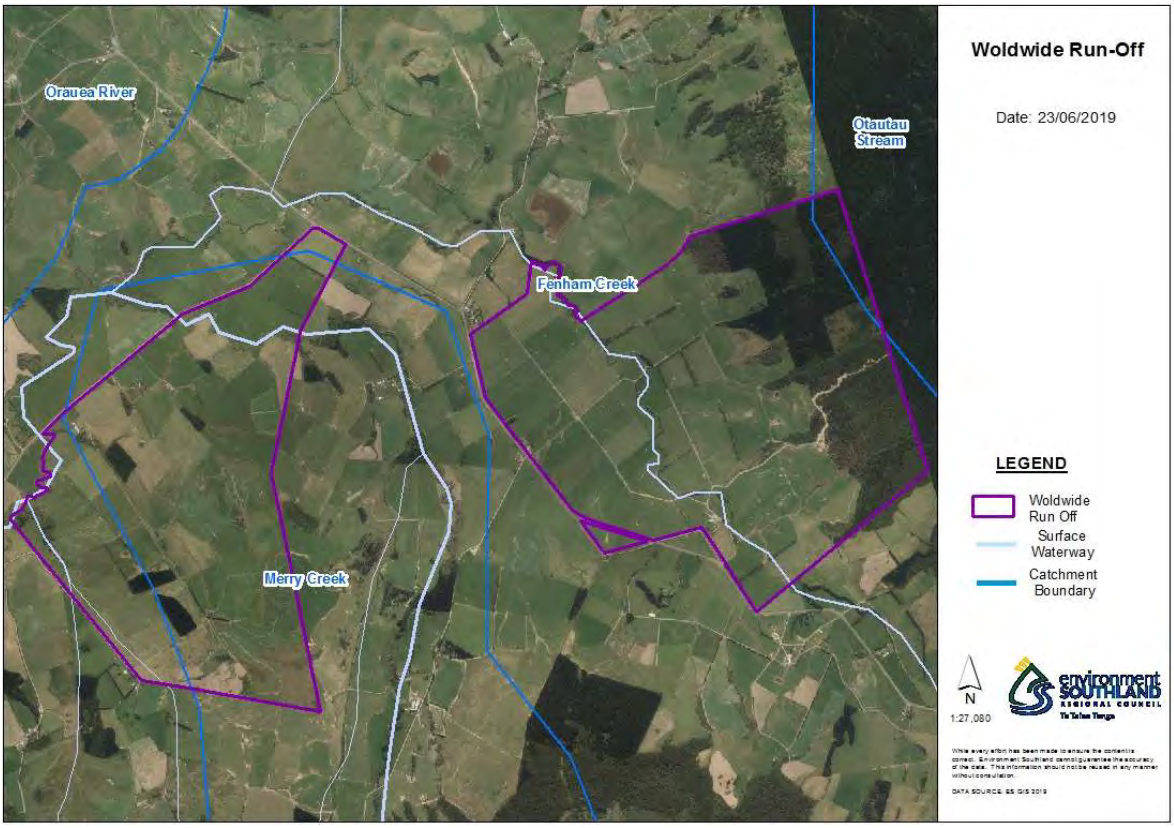


Figure 2.4: Location of property boundaries for Woldwide Runoff (Merrivale and Merriburn) including Freshwater Management Units (Environment Southland, 2019).

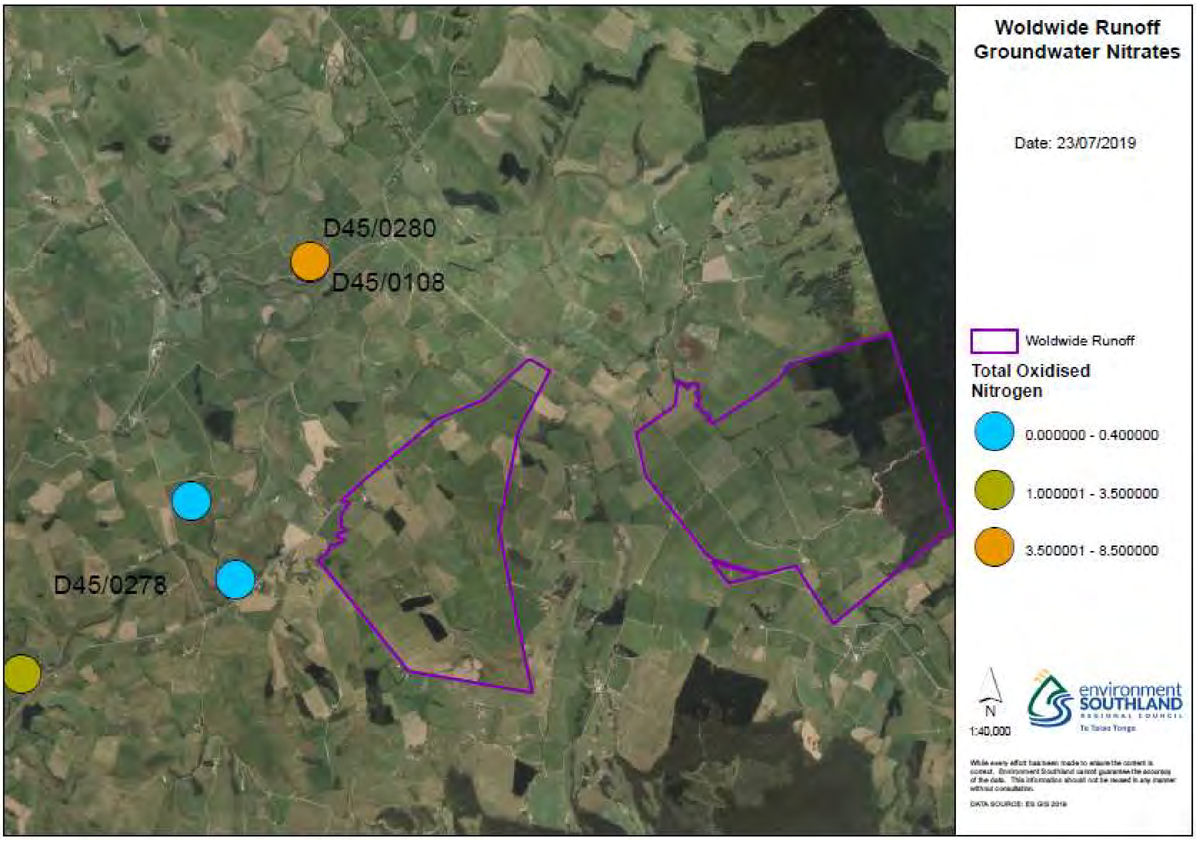


Figure 2.5: Location of property boundaries for Woldwide Runoff, nearby bores, and total oxidised nitrogen concentation (Environment Southland, 2019).

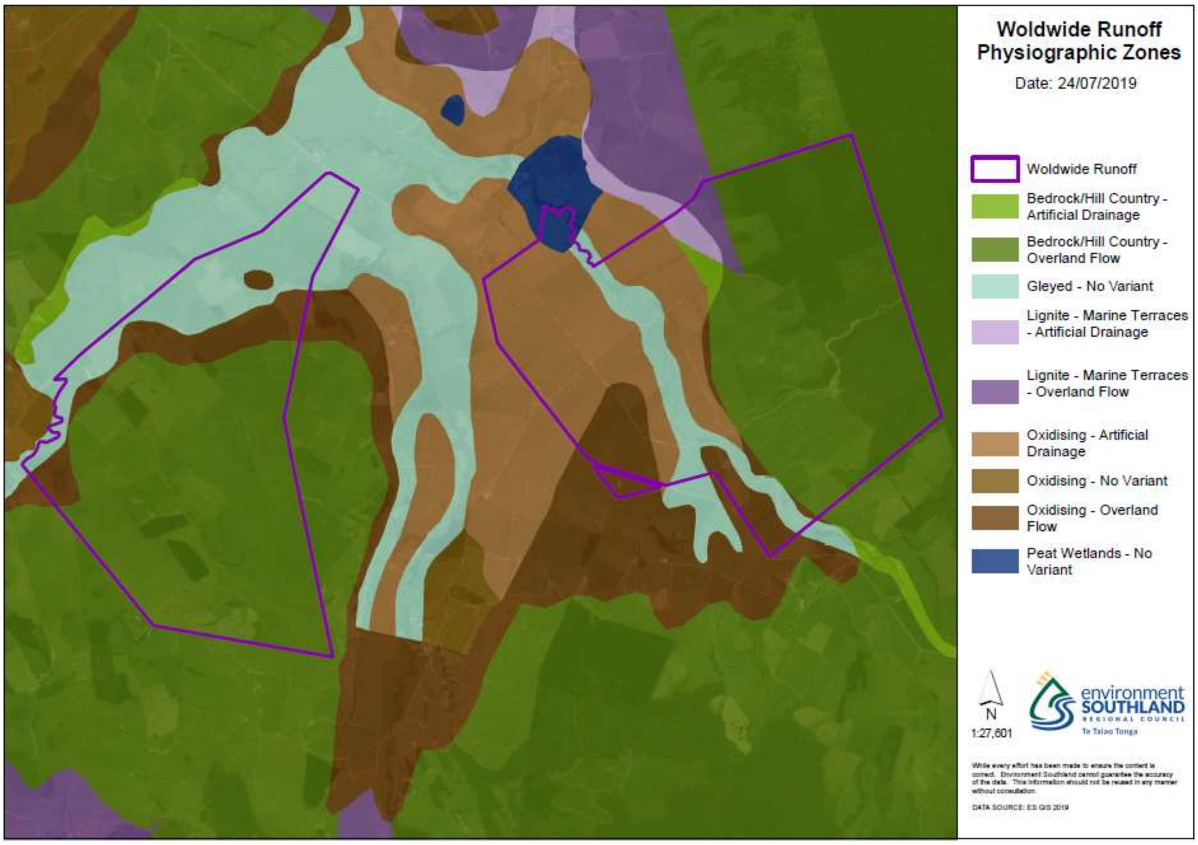


Figure 2.6: Location of Woldwide Runoff property boundaries including physiographic zones (Environment Southland, 2019).

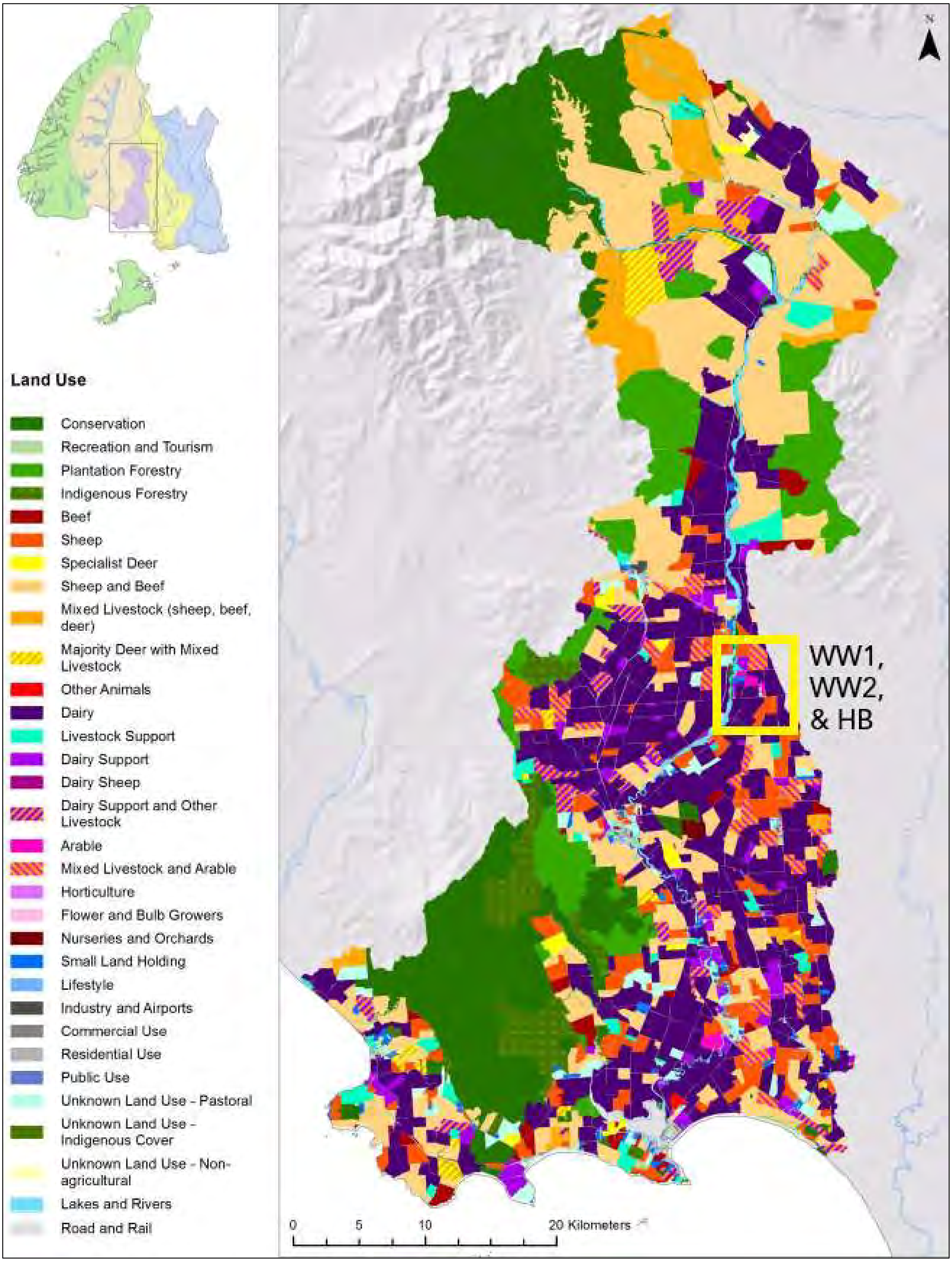


Figure 2.7 Location of WW1, WW2, and Horner Block in the context of the Aparima FMU and other land uses within the catchment. Modified from Nicol and Robertson (2018

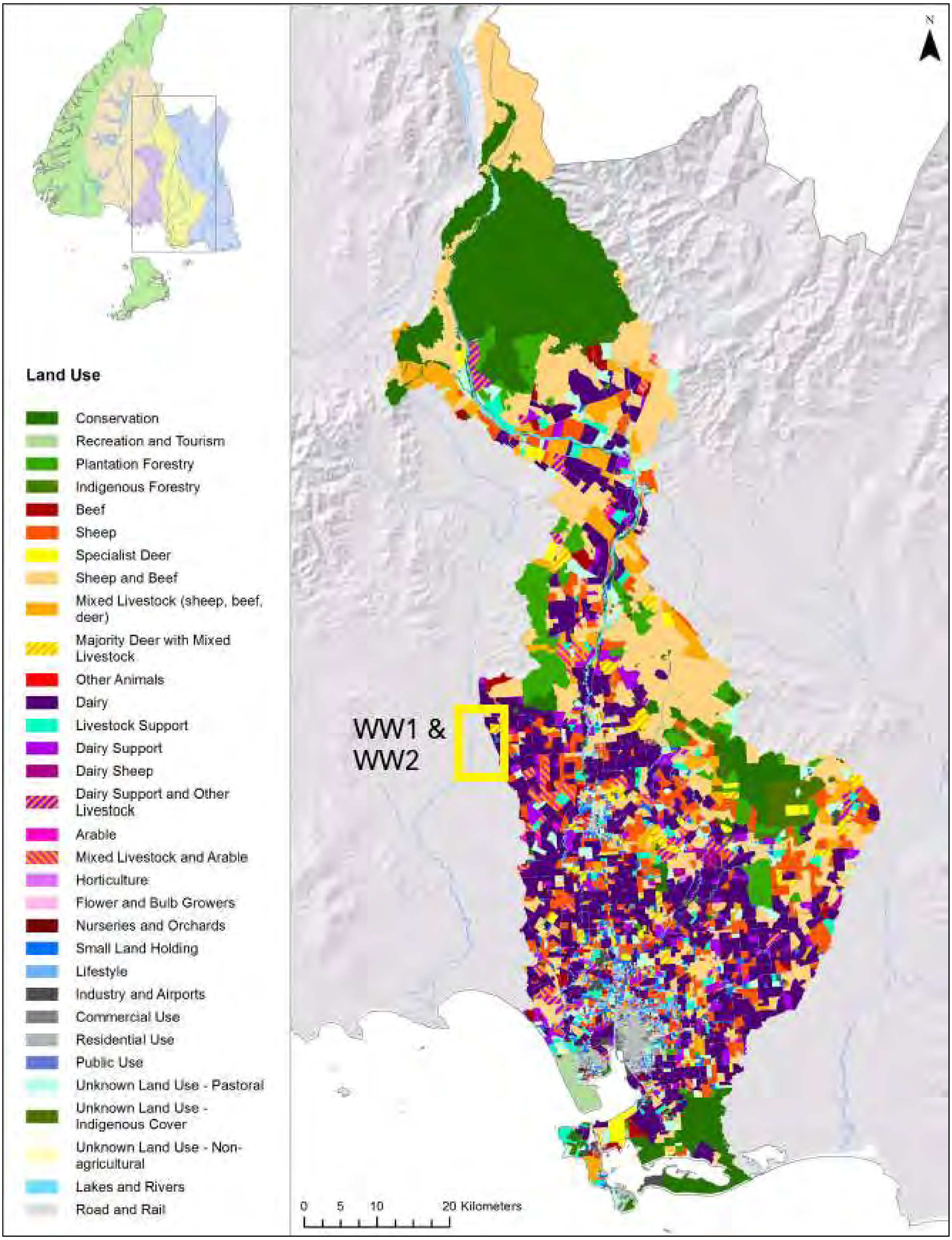


Figure 2.8 Location of WW1, WW2, and Horner Block in the context of the Oreti FMU and other land uses within the catchment. Modified from Nicol and Robertson (2018).

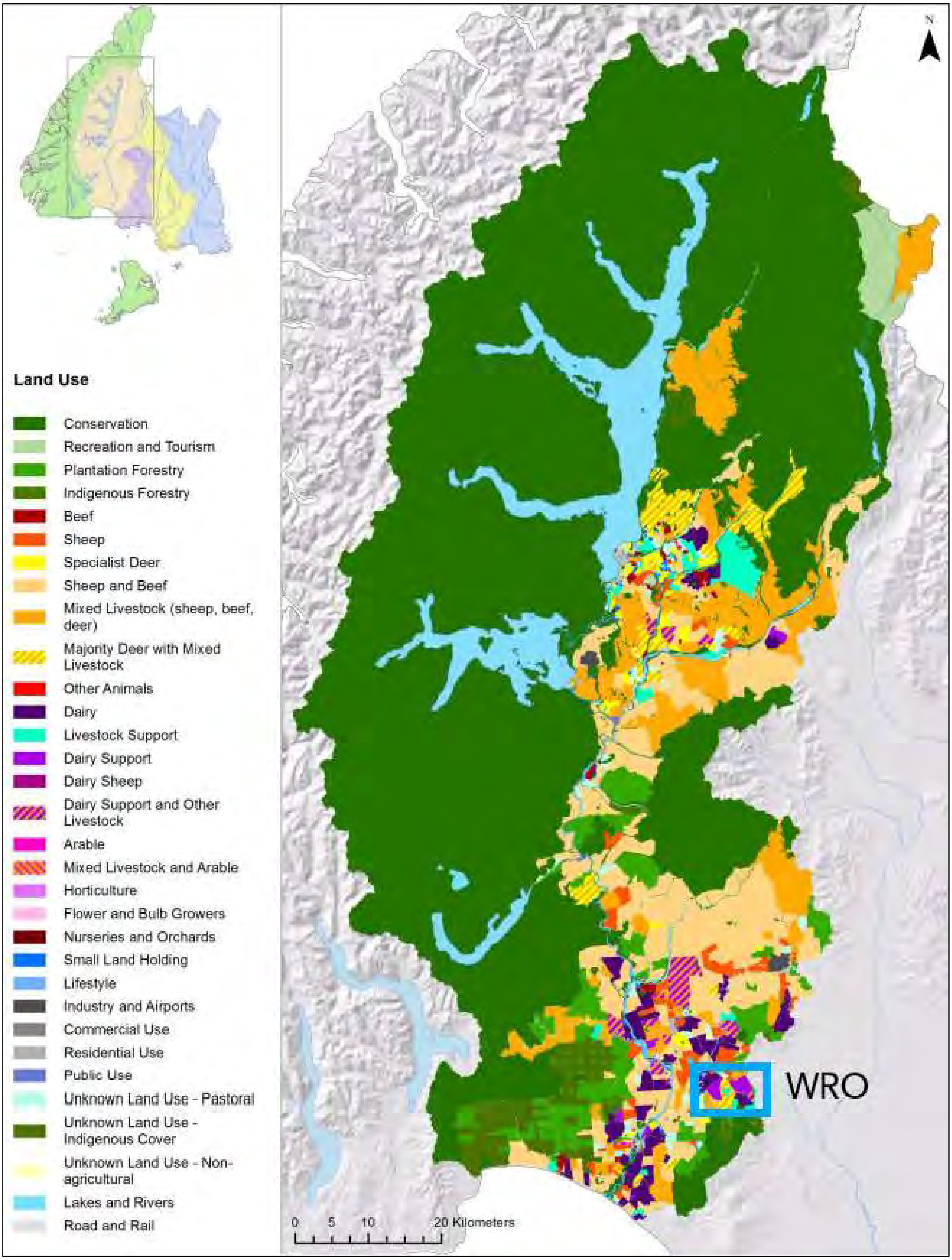


Figure 2.9 Location of WRO in the context of the Waiau FMU and other land uses within the catchment. Modified from Nicol and Robertson (2018).

2.2 Water resources management

Continued use of freshwater resources in the Southland Region is dependent on availability of the resource at sufficient quality and quantity. Current pressures on the water resources include an increasing demand for surface and groundwater, a trend which is expected to continue as population growth and land use intensification continue to rise. Meanwhile, groundwater plays an important role in environmental, social, and cultural resources both in terms of maintaining stream and spring flow, sustaining flow for aquatic habitat, and supporting recreational and cultural activities. Further stress on freshwater resources are likely to be driven by long-term changes to regional climate such as observed decreases in precipitation in summer (Beyer, 2017; NIWA, 2017; MfE, 2016). The combination of recent and projected changes in climate (e.g., reduced recharge rates) with conjunction with increases in surface and groundwater abstraction and intensification of land use, mean that appropriate management of freshwater resources in the region is essential.

The FMU concept is used to plan and manage freshwater resources, and can be defined as `*the water body, multiple water bodies or any part of a water body determined by the regional council as the appropriate spatial scale for setting freshwater objectives and limits and for freshwater accounting and management purposes*" (Ministry for the Environment, 2016). Five FMUs have been set for the Southland Region, in accordance with the National Policy Statement for Freshwater Management 2014 (NPSFM, 2017). The Southland region FMU's include Aparima, Fiordland and Islands, Mataura, Oreti, and Waiau.

The framework for groundwater management in Southland heavily relies on the confinement status of the aquifer systems, so aquifers have been identified as confined or unconfined (Environment Southland, 2019). Confined aquifers are separated from the land surface, usually through a layer of impermeable material (e.g., rock or sediment) that separates the groundwater from the surface above. The confining layer acts as a barrier to groundwater and prevents vertical movement in or out of the aquifer. Unconfined aquifers are fed by rainwater (e.g., land surface recharge) or inflow surface waters (e.g., wetlands, lakes, streams). Many unconfined aquifers in Southland are located very close to the land surface (e.g., < 5 m below ground level (BGL)). Due to the high level of connection with the land surface, shallow unconfined aquifers can be heavily influenced by land use including bacterial and nutrient enrichment. To assist with groundwater management in Southland, unconfined aquifers have been subdivided into 26 groundwater management zones. These zones have been delineated based on areas of similar hydrogeological characteristics. Confined aquifers are managed separately as they respond differently to abstraction and recharge so are therefore more difficult to quantify.

2.3 Hydrological parameters and water quality indicators

The following hydrological parameters are regularly used to describe and benchmark the quality and quantity of surface waters and groundwater in New Zealand.

Nitrogen (N) is found in several different forms in terrestrial and aquatic ecosystems, including ammonia (NH_3-N), organic and particulate nitrogen, nitrate (NO_3-N), and nitrite (NO_2-N). Phosphorous is also found in a variety of different forms, and most commonly water quality results state Total Phosphorous (TP), which is a measure of all forms of phosphorus that are found in a sample, including dissolved and particulate, organic, and inorganic. N and P are essential plant nutrients and commonly applied in various forms as fertilizer to promote plant growth. However, in excess, these nutrients can cause significant water quality issues such as eutrophication, increase in aquatic plant growth, algal blooms, and decrease in macroinvertebrate community. Natural levels of NH_3-N and NO_3-N in surface waters are typically low (e.g., < 1.0 mg/L), as are natural levels of P in waterways (e.g., < 0.002 mg/L). Therefore, N and P concentrations are commonly used an indicator of the effects from land use processes (e.g., agricultural runoff, leaching, industry, waste water urban). Primary sources of nutrients include runoff from agricultural land and animal manure storage areas, wastewater treatment plants, and industrial discharge. New Zealand Drinking Water Standards (NZDWS) maximum acceptable value (MAV) for NO_3-N is 11.3 mg/L. The National Objectives Framework (NOF) prescribes a national bottom line of 6.9 mg/L of NO_3-N in surface water (nitrate toxicity to fish) (MfE, 2016). Units for water quality parameters presented in mg/L and g/m^3 can be used interchangeably (e.g., 1.0 mg/L and 1.0 g/m^3 are equivalent).

E. coli is the main indicator of the risk of getting sick from contact with surface waters, as high levels of *E. coli* can make people and animals sick. Primary contact involves activities such as swimming and water skiing whereas secondary contact includes activities such as boating and fishing. The compulsory national bottom line for secondary contact is 1,000 cfu/100 mL of *E. coli*, however limits for primary contact have not yet been established. In addition, faecal coliforms and total coliforms are additional parameters commonly used for reporting of water quality.

Soil moisture is measured as percentage of "Water Filled Pores" which indicates pore space (e.g., gaps in the soils structure) that are filled with water. A completely saturated soil has 100% water filled pores. When a soil is above field holding capacity, rapid drainage to the shallow groundwater system and/or surface water runoff and drainage are likely occur. Environment Southland currently monitor soil moisture at 22 sites throughout the region. These monitoring sites can be used by landowners to determine the appropriate rate and timing for irrigation and application of FDE.

Groundwater level measurements provide an indication of changes in groundwater level over time. Observed changes are likely to be driven by a combination of natural and anthropogenic factors. Natural drivers include seasonal, annual, or long-term changes in rainfall, which effects the volume of surface water and/or land surface recharge to the groundwater system. Anthropogenic factors include abstraction from surface waters (which are the source of recharge) and/or groundwater abstraction from the aquifer. Changes in groundwater levels can be observed at a local, catchment, or regional scale. Although groundwater level measurements should ideally be undertaken under static water level conditions (e.g., where there is little or no impact on the water level from pumping in that monitoring well or from nearby), this is not always possible. Therefore, interference effects are a key limitation on the accuracy of groundwater level data.

3.0 Hydrological setting of the receiving environment

In this section, a summary of the hydrological setting of receiving environments that are potentially affected by the proposed consent activities is provided, including the Waimatuku, Oreti, Aparima, and Waiau Catchments. Hydrological knowledge and processes are presented to describe the current state of the freshwater resources, and where sufficient data is available, to describe any trends in hydrological parameters (e.g., water quality; groundwater level). Information provided in this section is required in order to determine the effects of the proposed activity on the receiving environment in terms of the proposed land use activities on the natural environment and proposed intensification of current land use.

3.1 Waimatuku Catchment

The Waimatuku GMZ is located in a topographic depression and is bounded to the north by alluvial fans of the Taringatura Hills, to the west by a limestone ridge, and to the east by an elevated gravel terrace (Environment Southland, 2019). The Waimatuku Stream Catchment overlies the groundwater zone and covers an area of approximately 180 km^2 (Figure 3.1). The surface water catchment is characterised by low elevation and low relief. Baseflow in the Waimatuku Stream is augmented by the rain-fed Bayswater (peat) Bog and a number of spring-fed tributaries (e.g., Middle Creek) that drain the surface and shallow groundwater system. Waimatuku Stream discharges into the Waimatuku Estuary on the southern Southland Coast.

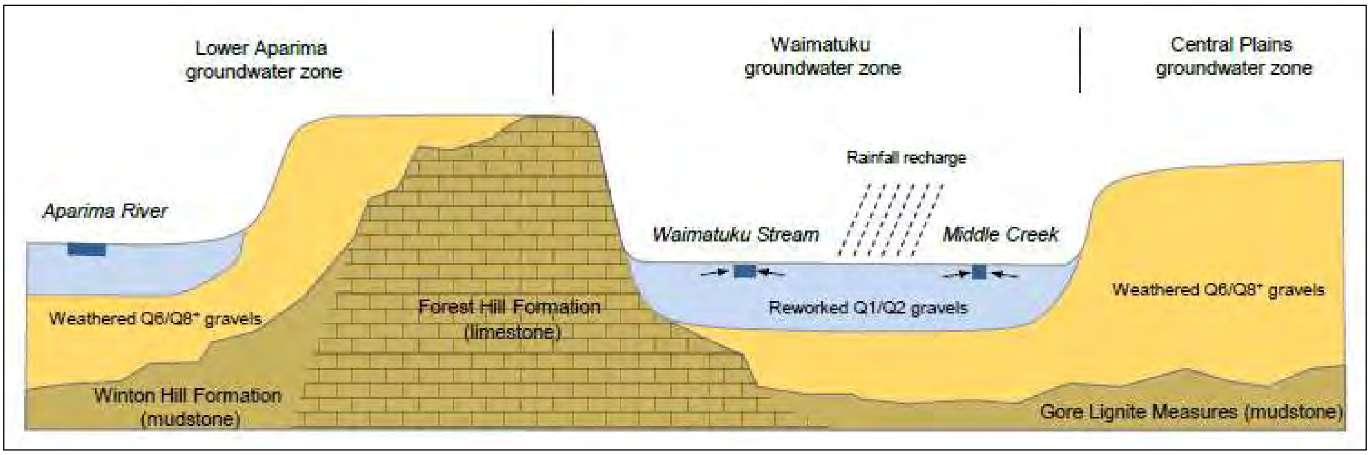


Figure 3.1: Schematic cross-section depicting the hydrogeological controls on the Waimatuku GWZ and adjacent Lower Aparima and Central Plains groundwater zones (Environment Southland, 2019).

3.1.1 Groundwater

The Waimatuku aquifer occupies an area where a former flow-path of the Aparima River entrenched into older, weathered gravel deposits (Q8) and to partially re-work and deposit a layer of younger gravel (Q2) (Figure 3.1). The total thickness of the aquifer is estimated to be 30 – 50 m, with 5 – 10 m of alluvial sediments overlying re-worked Q8 alluvial deposits. The Q2 – Q8 alluvial deposits overlie limestone (Forest Hill Formation) in the vicinity of Isla Bank and mudstone (Gore Lignite Measures) across the remainder of the Waimatuku GMZ. A limited groundwater resource is hosted in the underlying tertiary sediments via secondary permeability (e.g., fractures, solution voids and joints) and isolated alluvial (e.g., sand and gravel) layers within the mudstone.

The Waimatuku aquifer is unconfined. Shallow Q2 gravel deposits generally exhibit moderate to low permeability, meanwhile deeper Q8 gravels are usually lower yielding (e.g., due to silt and/or clay in matrix). Hydraulic properties in the area include a specific capacity of around 50 m^3/day/m, with higher yields towards the south - possibly due to reworking of gravels. The aquifer primarily receives recharge via rainfall and land surface recharge process of approximately 467 mm/yr. Groundwater is understood to generally flow towards the south and shallow groundwater subsequently discharges as a high proportion of baseflow to the Waimatuku Stream. Deeper groundwater is likely to move at a slower rate, and water that is not discharged to surface water (e.g., Waimatuku Stream) is likely to follow the topographic plane to the south.

Overland flow and surface water in the zone are routed via sub-surface and surface drains and tributaries to Terrace Creek, Middle Creek, and Waimatuku Stream. A large area of wetland is located along the base of the limestone ridge to the north-west of Isla Bank. Based on the hydrogeological setting, it is highly likely that land-surface processes exert a considerable influence on the local groundwater quality within the Waimatuku GWMZ and in downstream groundwater and surface water environments.

Groundwater quality in the Waimatuku GMZ is characterized by relatively low concentrations of dissolved ions. Several deeper bores particularly near existing or previous wetlands have elevated iron (Fe) and manganese (Mn) concentrations. Elevated Mn and Fe reflect reducing conditions in these environments, which are caused by low levels of dissolved oxygen in the groundwater. Twelve bores in the Waimatuku aquifer contained water quality samples for nitrate-nitrite nitrogen (NO_2-NO_3) concentration over time (Figure 3.2). Overall, NO_2-NO_3 concentration ranged from < 1 mg/L to 20 mg/L (Figure 3.3). Four monitoring sites showed a decreasing trend in NO_2-NO_3 concentration over time, three of which had low initial concentrations (E46/0860, E46/0156, E46/0094), and one site E46/0491 which had very high initial concentrations (e.g., > 10 mg/L). In comparison, the majority of sites (seven) showed an increasing trend in NO_2-NO_3 concentration over time (e.g., E45/0445, E45/0162, E46/0093). Water quality results for Total Phosphorous over time were limited to one monitoring site (E46/0094). Concentration of TP at E46/0094 has stayed relatively consistent over time and ranged between 0.03 – 0.06 mg/L (Figure 3.3). Water quality results for bore E45/0622 located on WW1 indicate NO_2-N concentrations ranging from < 0.002 – 0.30 mg/L and NO_3-N concentration ranging from 0.003 - 15.40 mg/L, with an average concentration of 3.6 mg/L (Figure 3.4). *E. coli* concentration in bore E45/0622 has ranged from < 1 – 350 MPN (Figure 3.4). Overall, the water quality results from bore E45/0622 indicate that land use processes are affecting shallow groundwater quality at this location.

Groundwater level of the Waimatuku Aquifer has been monitored using a continuous water level sensor at bore E46/0110, located at Isla Bank. Results of the daily average groundwater level for the period October 2000 – 2019 are presented in Figure 3.5. Seasonal changes include lower groundwater levels in summer (e.g., Dec-Feb) and higher groundwater levels during winter (e.g., Jul-Sept). The annual variability (range) for the period 2000 – 2007 is *c*. 0.6 m, with an observed increase to *c.* 1 m for the period 2007 –2016 (Figure 3.5). More recently, groundwater level appears to have reduced in variability to approximately 0.75 m annual range.

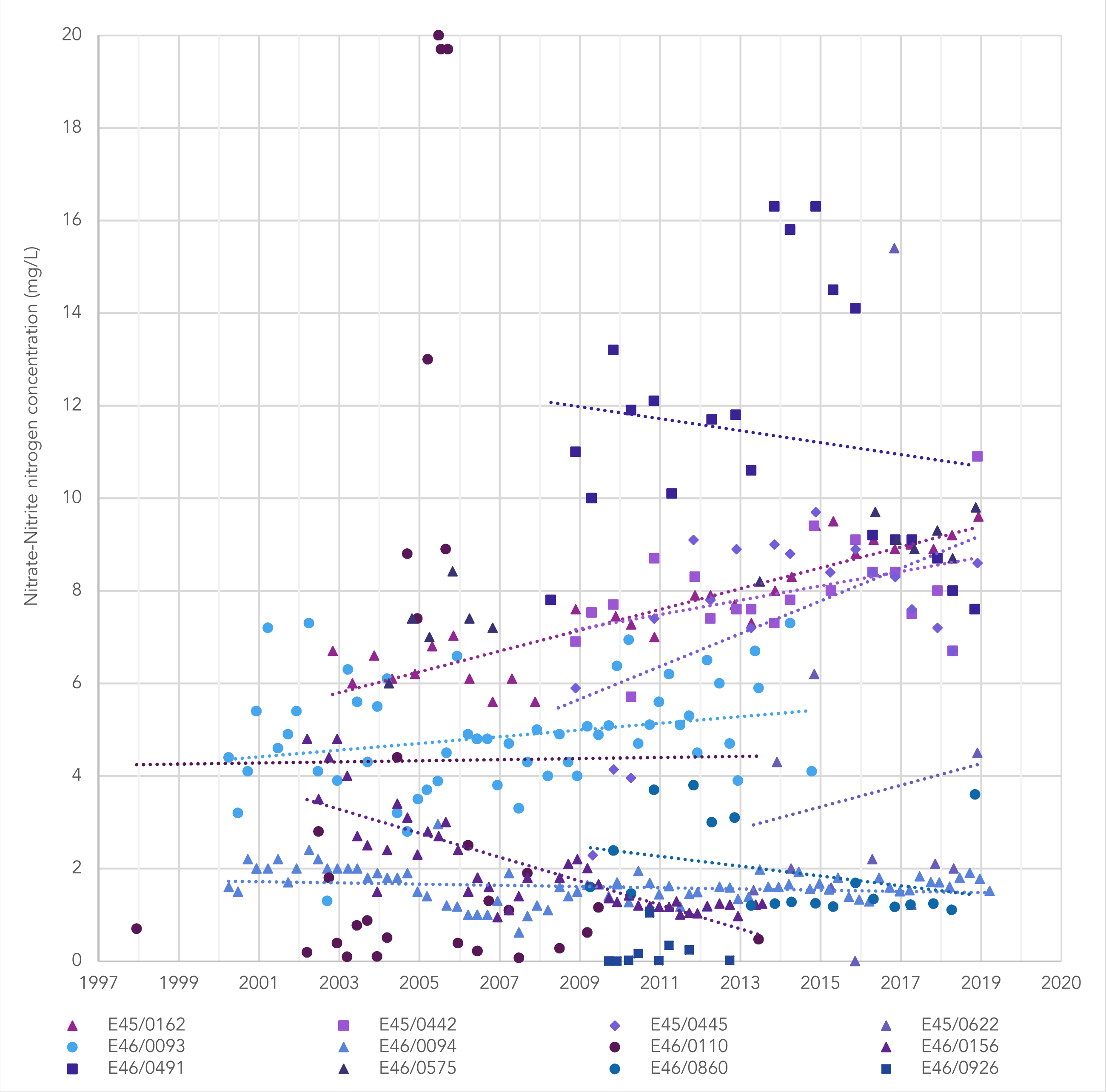


Figure 3.2: Nitrate-Nitrite nitrogen (NO_2-NO_3) concentration for twelve groundwater monitoring bores in the Waimatuku Catchment.

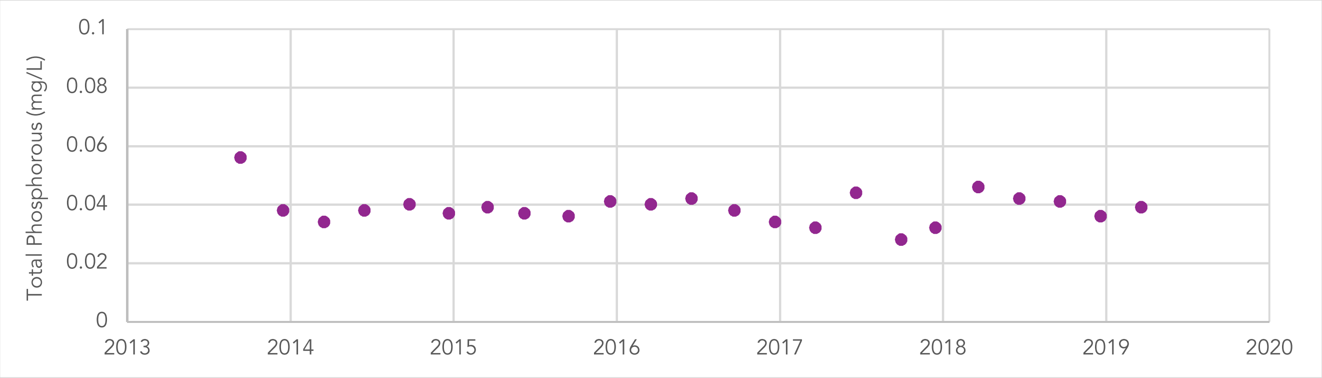


Figure 3.3: Concentration of Total Phosphorous in groundwater sampled from bore E46/0094, located in the lower Waimatuku GMZ.

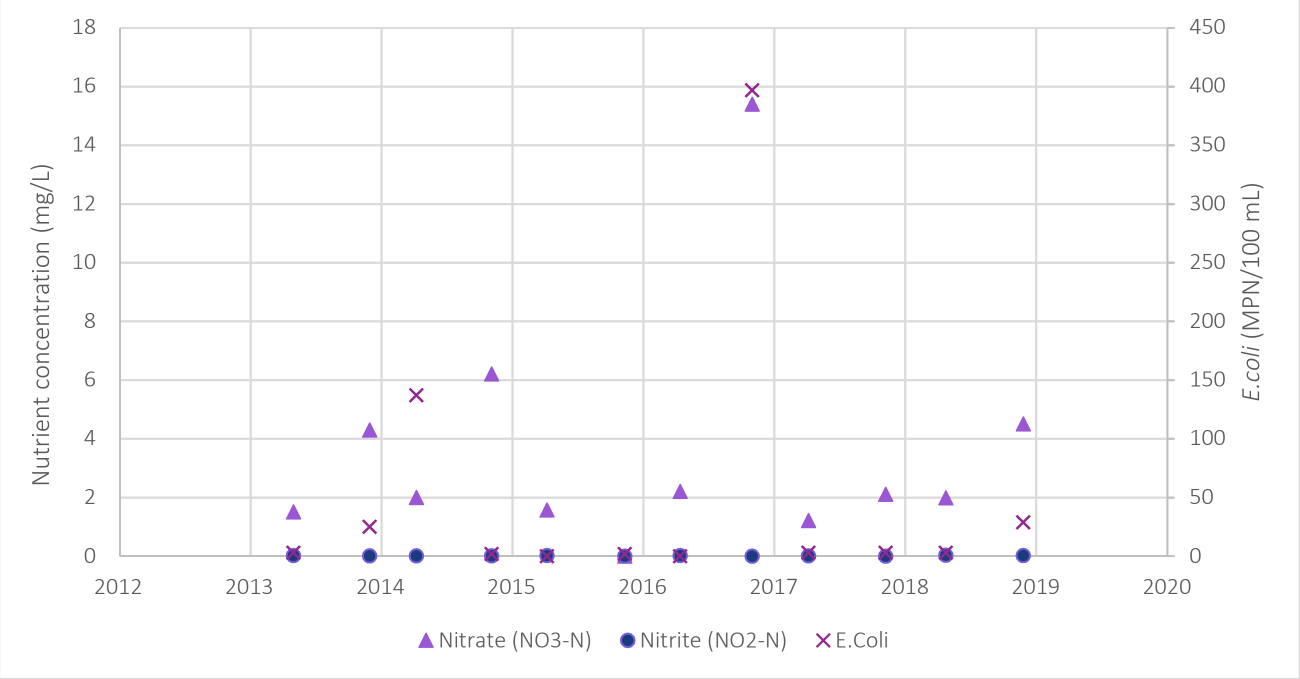


Figure 3.4: Water quality results nutrients and bacterial parameters for bore E45/0622 located on the WW1, within in the Waimatuku GMZ.

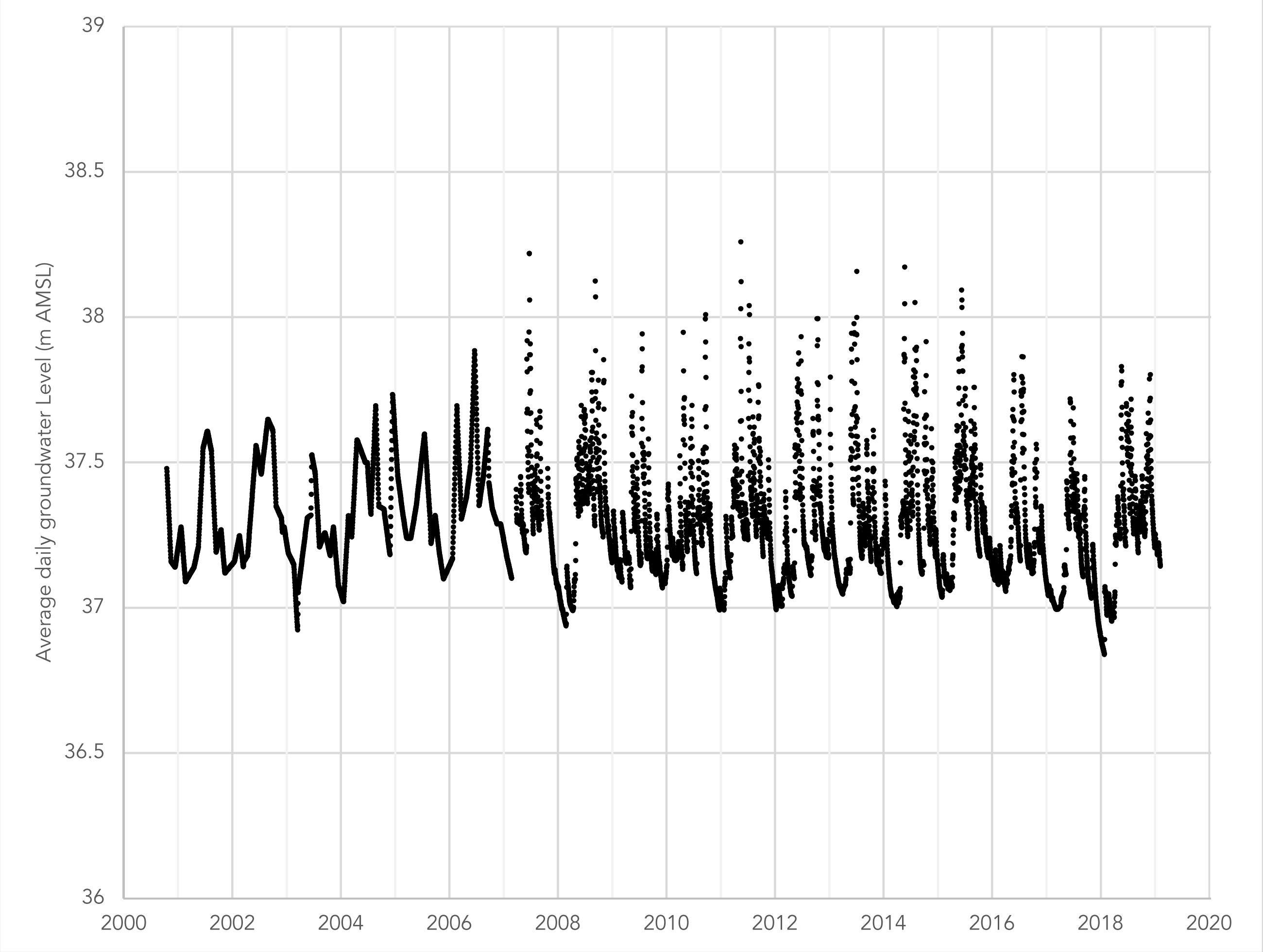


Figure 3.5: Average daily groundwater level of bore E45/0100 located in the Waimatuku aquifer at the Isla Bank monitoring site (Environment Southland, 2019)

3.1.2 Surface water

Environment Southland have monitored water quality at two State of the Environment (SOE) Monitoring Sites on the Waimatuku Stream, including downstream (d/s) of Bayswater Bog (2001 – 2014) and at Lorneville-Riverton Highway (2001 – 2019). Concentration of NO_2-NO_3 in Waimatuku Stream has ranged between 0.02 – 3.6 mg/L at the d/s Bayswater Bog site, and 0.31 – 7.8 mg/L at the Lorneville-Riverton monitoring sites (Figure 3.6, Table 3.1). These results indicate an increase in concentration in a downstream direction. In addition, both monitoring sites indicated an increasing trend of NO_2-NO_3 over time (Figure 3.5). Concentration of Total Phosphorous in Waimatuku Stream has ranged from 0.05 – 1.4 mg/L at the d/s Bayswater Bog site and 0.02 – 1.10 mg/L at Lorneville-Riverton monitoring sites (Table 3.1). Average *E. Coli* and Faecal Coliform concentrations for the Waimatuku Stream have been close to the minimum bottom line at d/s Bayswater Bog monitoring site of 681 cfu/100 mL and 756 cfu/100 mL, respectively (Table 3.1, Figure 3.7). Average bacterial concentrations at Lorneville-Riverton Highway were 1,207 cfu/100 mL for *E. coli* and 1,388 cfu/100 mL of Faecal coliforms (Table 3.1, Figure 3.8 and Figure 3.9).

Table 3.1: Summary of key surface water quality parameters for the Waimatuku Stream monitoring sites. Note: median and averages are only representative of samples that were greater than the detection level for each laboratory analysis parameter.

Site	d/s Bayswater Bog				Lorneville-Riverton			
Parameter	*E. coli*	Faecal coliforms	NO_2-NO_3	Total Phosphorous	*E. coli*	Faecal coliforms	NO_2-NO_3	Total Phosphorous
Unit	(cfu/100 mL)	(cfu/100 mL)	mg/L	mg/L	(cfu/100 mL)	(cfu/100 mL)	mg/L	mg/L
Minimum	10	10	0.02	0.05	30	72	0.31	0.02
Maximum	9,300	12,000	3.60	1.40	21,000	21,000	7.80	1.10
Average*	*681*	*756*	*1.44*	*0.13*	*1,207*	*1,388*	*3.55*	*0.07*
Median*	*310*	*340*	*1.40*	*0.10*	*500*	*580*	*3.30*	*0.06*

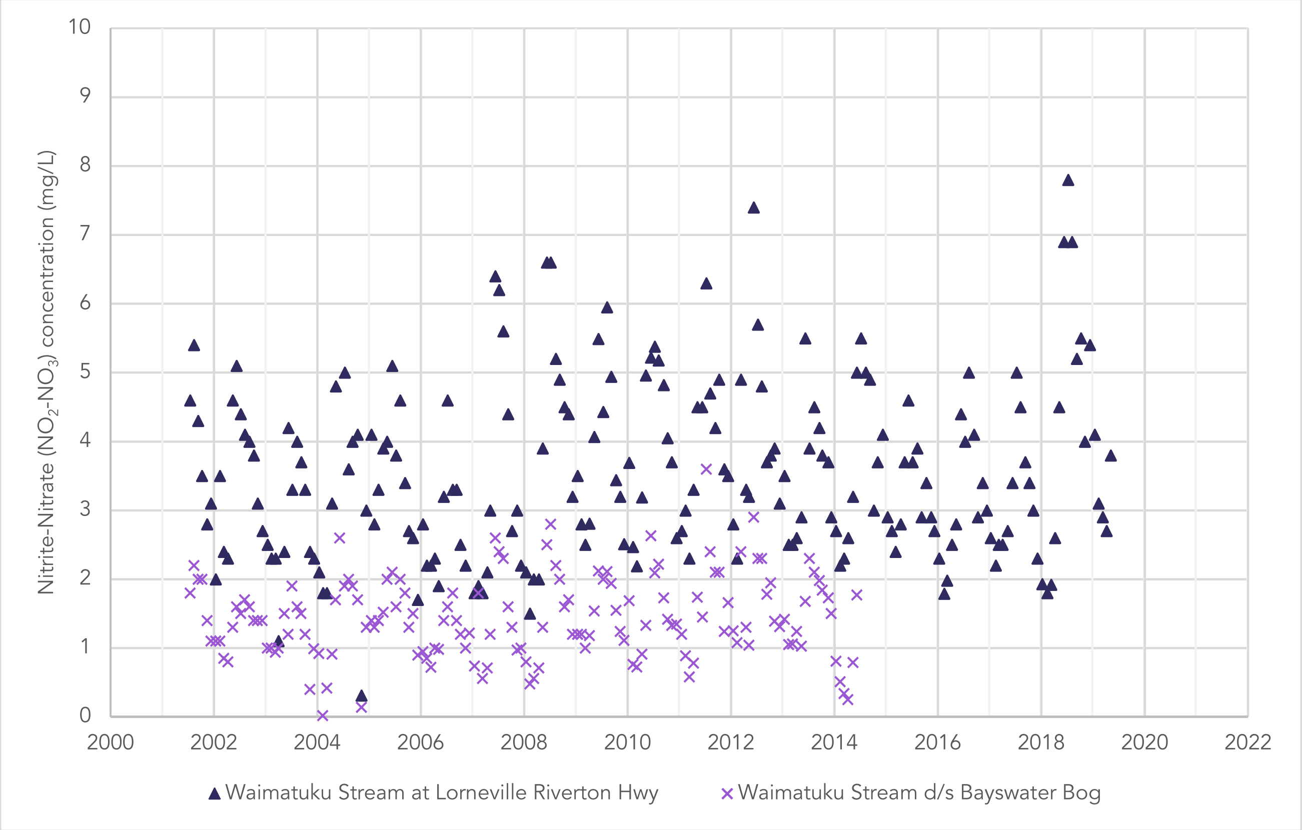


Figure 3.6: Concentration of Nitrite-Nitrate Nitrogen (NO_2-NO_3) for the Waimatuku Stream monitoring sites at d/s Bayswater Bog and Lorneville-Riverton Hwy. (Environment Southland, 2019).

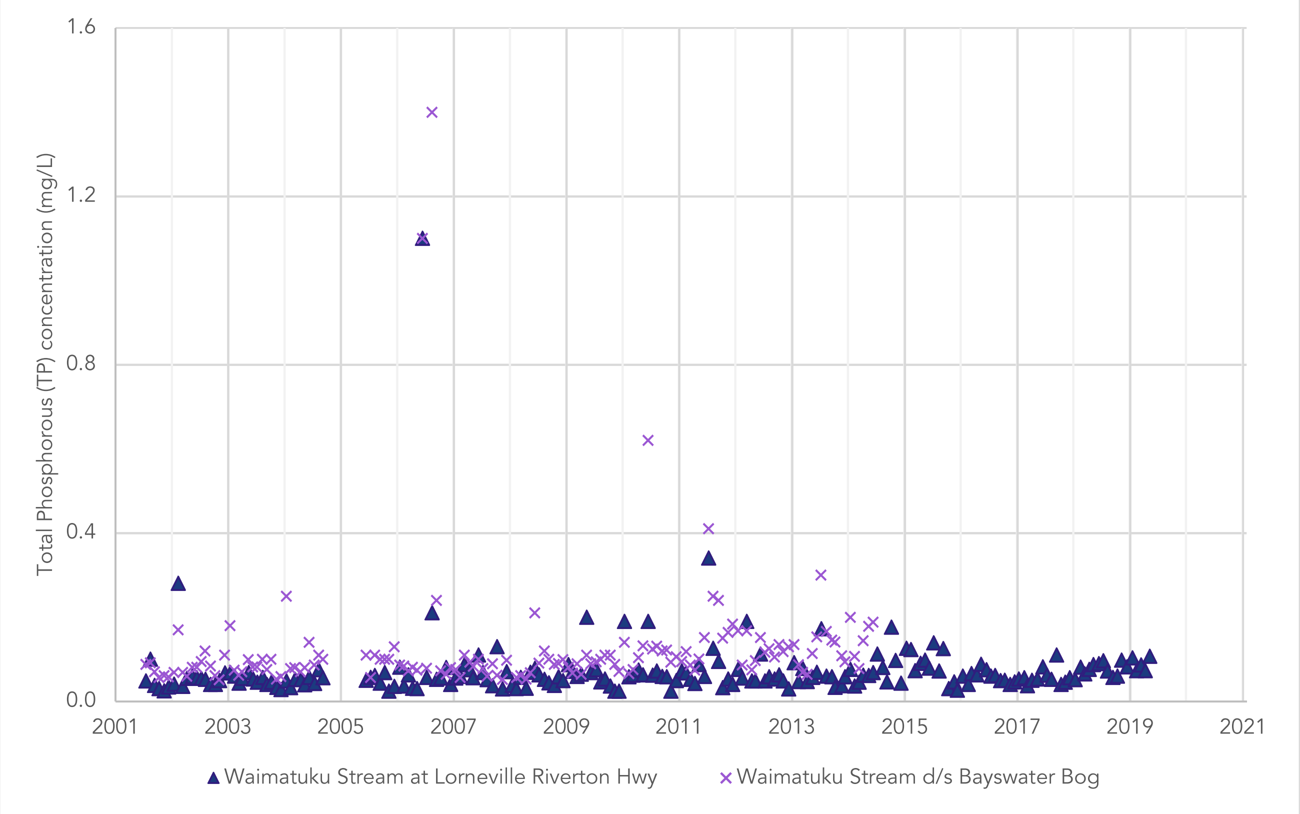


Figure 3.7: Concentration of Total Phosphorous (TP) for the Waimatuku Stream monitoring sites at d/s Bayswater Bog and Lorneville-Riverton Hwy. (Environment Southland, 2019).

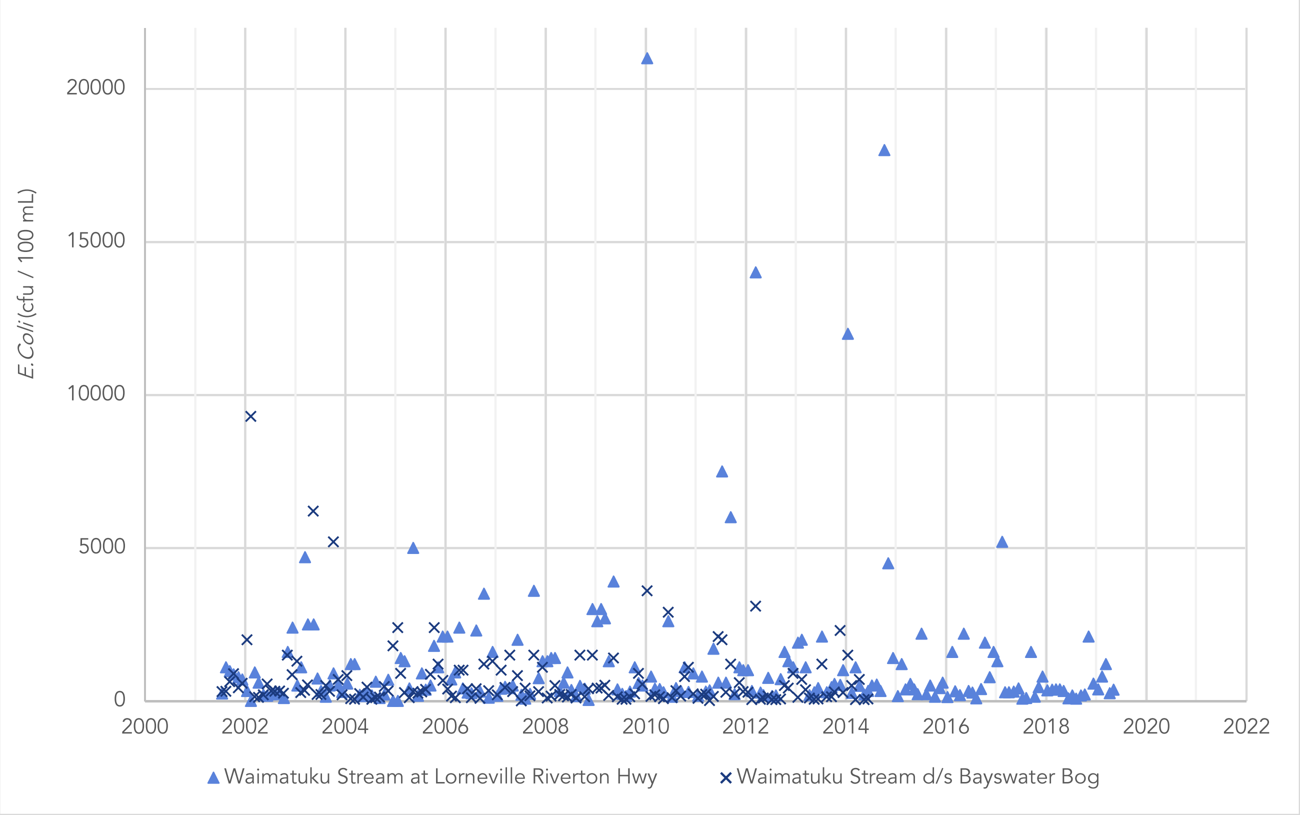


Figure 3.8: Concentration of E. Coli for the Waimatuku Stream monitoring sites at d/s Bayswater Bog (2201 – 2014) and Lorneville-Riverton Hwy. (2001 – 2019) (Environment Southland, 2019).

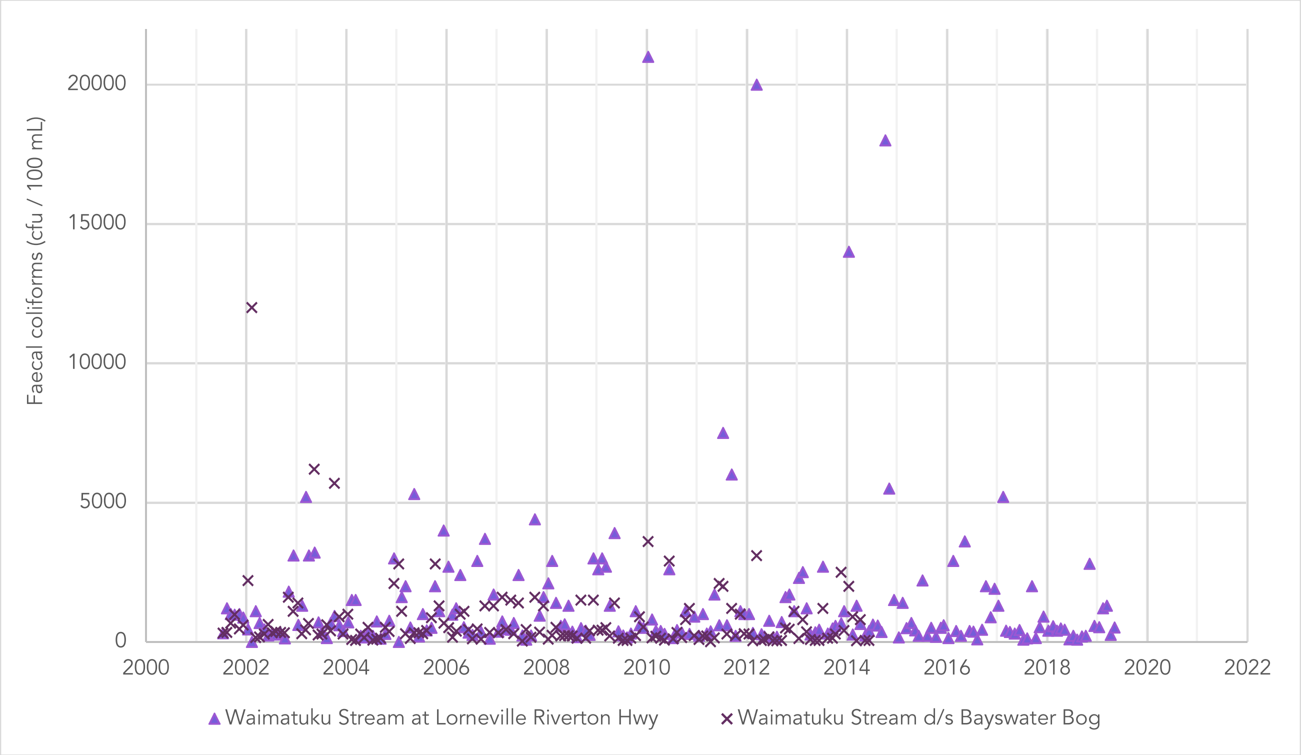


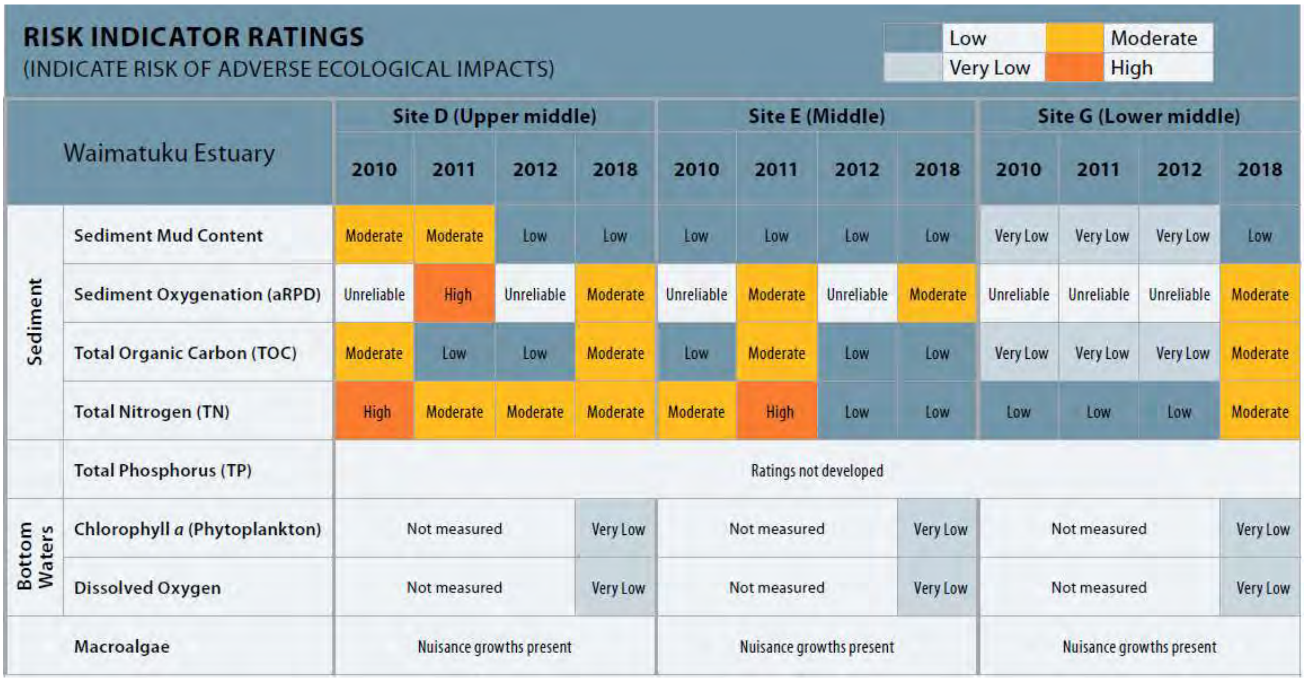
Figure 3.9: Concentration of Faecal Coliforms for the Waimatuku Stream monitoring sites at d/s Bayswater Bog (2201 – 2014) and Lorneville-Riverton Hwy. (2001 – 2019) (Environment Southland, 2019).

A hydrological study of the Waimatuku Stream undertaken by Hitchcock (2014) included identification of groundwater flow pathways, groundwater – surface water interaction, geochemical, and isotopic analyses. The primary conclusion of the study supports the above findings by stating "*… the Waimatuku Stream appears to be fed via groundwater flow derived from precipitation on the land surface, which infiltrates to the water table and then percolates to the stream*". In addition, it was found that the Waimatuku Stream is unlikely to receive surface water from the Aparima River. As a result, water quality in the Waimatuku Stream is predominantly controlled by land use processes in the catchment, and improved management of the nutrient loadings to the land surface is essential to maintain and/or improve water quality. This is supported by surface water quality results, which show that land use processes in the catchment have had a considerable impact on the water quality of Waimatuku Stream, including nutrients and bacteria. Waimatuku Stream has been impacted by bacterial contamination and that the impact increases in a downstream direction. The most likely source of bacterial contamination is from land use in the catchment, including dairy farming and sheep and beef grazing. The Waimatuku Stream monitoring location regularly does not meet the national bottom line for *E. coli* (< 1,000 cfu/100mL) indicating meaningful improvement in the water quality is required in the future if the National Objectives Framework (NOF) is to be achieved under the National Policy Statement for Freshwater management (MfE, 2014).

The Waimatuku groundwater level monitoring bore is located in the unconfined Waimatuku Aquifer which is characterised by high levels of rainfall (via land surface) and abstraction for irrigation, stock water, domestic, and public water supply uses. The observed seasonal variability in groundwater level is typical of a shallow aquifer that is predominantly recharged by rainfall and that undergoes abstraction. There does not appear to be an overall declining trend in groundwater levels for the aquifer at this stage. A decrease in rainfall volume (e.g., as predicted for the Central Plains) and/or increases in groundwater abstraction from the aquifer will result in decreases in groundwater level. These changes may affect current groundwater users. In addition, since shallow groundwater in the aquifer is understood to provide the primary source of baseflow of the Waimatuku Stream, then a reduction of groundwater levels in the aquifer will likely affect both water quality (e.g., less groundwater for dilution) and quantity of the Waimatuku Stream.

Waimatuku Estuary covers an area of 20 Ha (at high tide) and extends approximately 4.5 km inland. The estuary is characterised as a "*relatively long, moderately-highly flushed, shallow, short residence time, tidal river estuary*" that "*drains* *to the sea through a sand dominated barrier beach and modified marram grass duneland*" (Robertson and Robertson, 2018). The estuary mouth is periodically constricted by deposition of sediment, which results in a reduction of seawater intrusion. Waimatuku Estuary holds important cultural and spiritual values for Kai Tahu, ecological values including intertidal flats for avian and fish habitats. Land use in the 150 km^2 catchment is dominated by sheep, beef, and dairy farming. The estuary receives a high nutrient load from both surface and groundwaters sources (*c.* N loading of 2,877 mg/N/m^2/d^{-1}). When the estuary is in open exchange with the sea there is a relatively low susceptibility to eutrophication due to high channelisation, high flushing, and high freshwater inflow. In comparison, when the mouth is constricted, the assimilative capacity of nutrients in the estuary is very quickly exceeded. Changes in the mouth location can considerably influence water quality in the estuary, which appears to have decreased since initial monitoring in 2008 (Robertson and Robertson, 2018). "*Currently, nutrients retained in the estuary contribute to the growth of attached macrophytes and associated nuisance macroalgae, while the presence of elevated chlorophyll-a concentrations at times may be attributable to phytoplankton blooms in saline bottom waters and from freshwater sources upstream of the estuary. The estuary has relatively low vulnerability to muddiness issues based on the fact that most of the estuary is dominated by sands, particularly in lower and middle estuary reaches*" (Robertson and Robertson, 2018).

Results of subtidal channel condition and trophic status indicate that Waimatuku Estuary in a low-moderate state overall, and that conditions have deteriorated slightly since 2012 (Figure 3.10). A major contributing factor for the deterioration is exceedance of the catchment nutrient load (e.g., 2,877 mg/N/m^2/d^{-1}) as a result of land use in the catchment. In addition, (potential) increased constriction of the estuary, eutrophication (e.g., nuisance macroalgal production; reduced sediment oxygen), and to a lesser extent sedimentation are contributing factors.



RISK INDICATOR RATINGS
(INDICATE RISK OF ADVERSE ECOLOGICAL IMPACTS)

Low
Very Low
Moderate
High

Waimatuku Estuary		Site D (Upper middle)				Site E (Middle)				Site G (Lower middle)			
		2010	2011	2012	2018	2010	2011	2012	2018	2010	2011	2012	2018
Sediment	Sediment Mud Content	Moderate	Moderate	Low	Low	Low	Low	Low	Low	Very Low	Very Low	Very Low	Low
	Sediment Oxygenation (aRPD)	Unreliable	High	Unreliable	Moderate	Unreliable	Moderate	Unreliable	Moderate	Unreliable	Unreliable	Unreliable	Moderate
	Total Organic Carbon (TOC)	Moderate	Low	Low	Moderate	Low	Moderate	Low	Low	Very Low	Very Low	Very Low	Moderate
	Total Nitrogen (TN)	High	Moderate	Moderate	Moderate	Moderate	High	Low	Low	Low	Low	Low	Moderate
	Total Phosphorus (TP)	Ratings not developed											
Bottom Waters	Chlorophyll *a* (Phytoplankton)	Not measured			Very Low	Not measured			Very Low	Not measured			Very Low
	Dissolved Oxygen	Not measured			Very Low	Not measured			Very Low	Not measured			Very Low
	Macroalgae	Nuisance growths present				Nuisance growths present				Nuisance growths present			

Figure 3.10 Summary of risk indicator ratings for the Waimatuku Estuary fine scale monitoring and macrophyte mapping (Robertson and Robertson, 2018).

3.2 Oreti / Central Plains

The upper bounds of the Oreti Catchment are located in the Thomson Mountains in the north of the catchment. Water flows in a southward direction and discharges into the ocean via the New River Estuary adjacent to Invercargill. The Central Plains groundwater zone is constrained to the east by the alluvial terrace the recent floodplain of the Oreti River and to the west by Middle Creek and Waimatuku Stream Catchments. The northern boundary of the Central Plains GMZ is defined by alluvial terraces to the south of the Taringatura Mountains. Primary surface water bodies within the zone include partially incised first and second-order streams including Bog Burn and Terrace Creek catchments.

3.2.1 Groundwater

The Central Plains GMZ is characterized by moderately weathered alluvial gravels in a silt and clay matrix. The southern portion of the Central Plains GMZ is a remnant of the Q8 moderately weathered glacial outwash gravel terrace. Previous courses of the Aparima River have cut through to create terraces (e.g., North of Drain Road) and to re-work surficial gravel deposits (e.g., in the north) (Figure 3.10). Gravel deposit thickness varies across the Central Plains from 20 m thick near Waianiwa to > 50 m thick near Hundred Line Road. Underlying Tertiary sediments include mudstone, sandstone, and lignite, with a small limestone exposure near Dunearn which may extend elsewhere beneath the zone. The Central Plains GMZ receives predominant recharge via rainfall and land surface recharge (*c.* 470 mm/year), likely aided by some infiltration via runoff from lower slopes of the Taringatura Hills. Extensive mole, tile, and artificial drainage networks have been installed to intercept soil drainage and lower the water table. This drainage is routed into small streams (e.g., Bog Burn, Terrace Creek), along with local, shallow groundwater (Figure 3.10). These processes result in relatively rapidly transit of recharge through the surface water and shallow groundwater systems. Deeper groundwater forms a smaller component and follows the regional flow pathway towards the south, which is typical of a lowland aquifer setting (Figure 3.10).

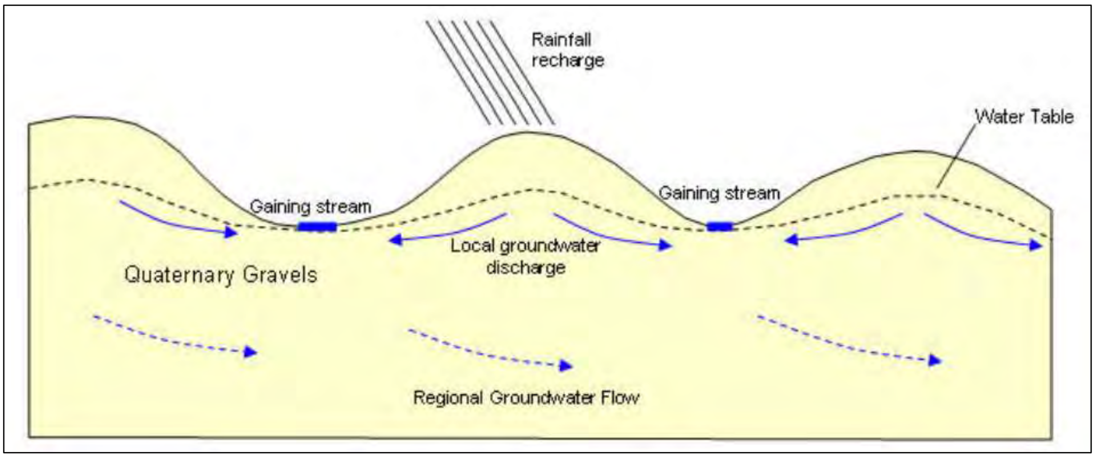


Figure 3.10: Schematic cross-section depicting the hydrogeological controls on the Central Plains GWZ (Environment Southland, 2019).

Groundwater quality in the Central Plains is generally of reasonable quality, although several nutrient "hotspot" areas occur with particularly high NO_3-N levels, often above the NZDWS MAV of 11.3 mg/L (Ministry of Health, 2018). Environment Southland installed a nested piezometer at Heddon Bush to sample groundwater from different depths in the aquifer. The aim of the monitoring was to better understand causes of nutrient hotspots; and to determine the relative influence from historic land use on water quality and likely impact of current and future land use. Of available groundwater quality samples from bores in the Central Plains GMZ, 538 results existed for NO_2-NO_3 (Environment Southland, 2019). Concentration of NO_2-NO_3 ranged from <0.002 – 25 mg/L. Of the 15 monitoring sites that contained the longest data records, 12 sites indicated an increasing trend in NO_2-NO_3, whereas 2 sites showed no increase, and 1 site showed a decreasing trend (Figure 3.11). Results from 218 *E. coli* samples indicated a range from 1 – 2,420 cfu/100 mL (Figure 3.12).

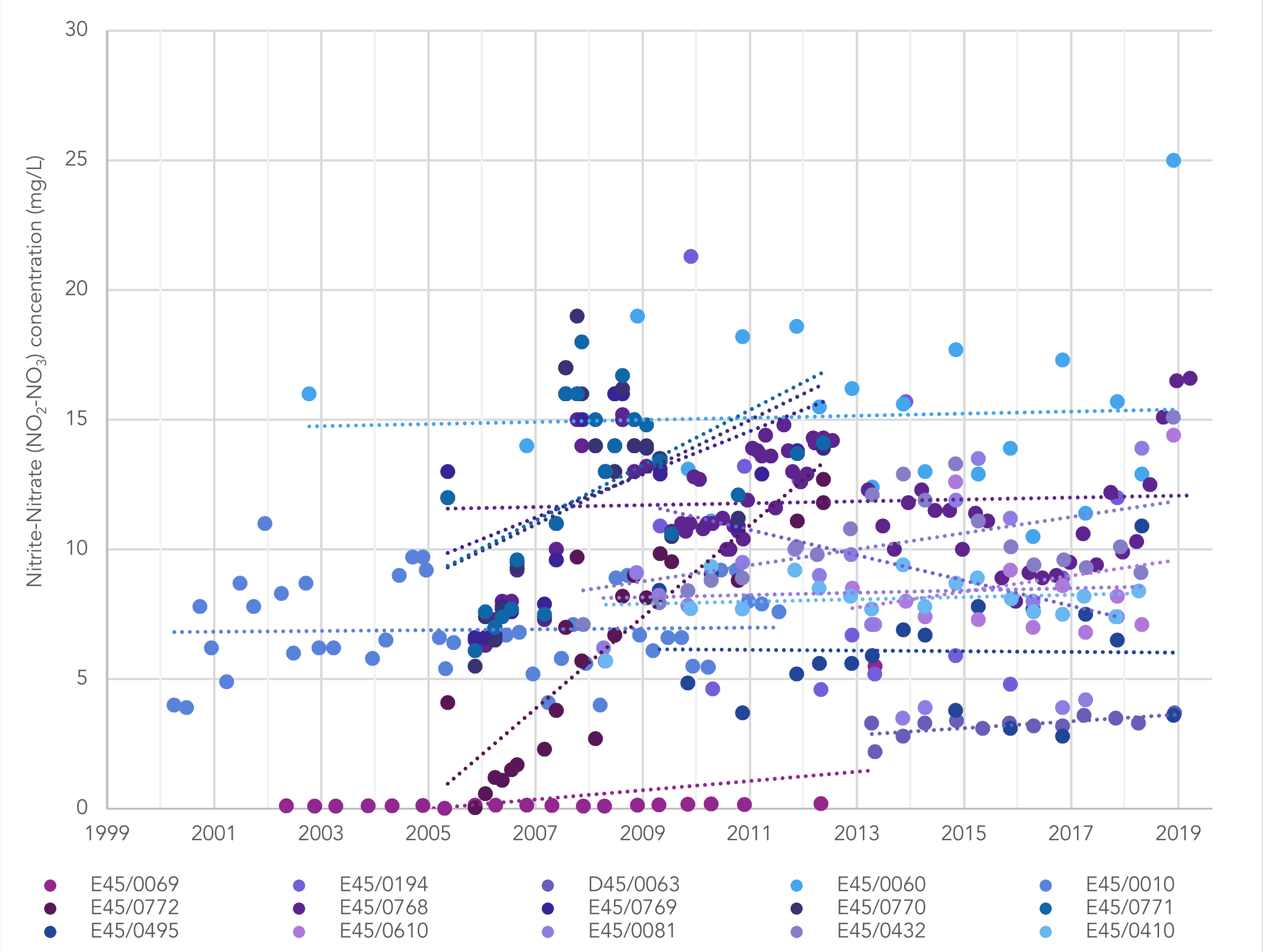


Figure 3.11: Nitrate-Nitrite nitrogen (NO_2-NO_3) concentration for selected groundwater monitoring bores with long term datasets from the Central Plains GMZ. Linear trendlines provide an indication of potential increase or decrease in concentration over time.

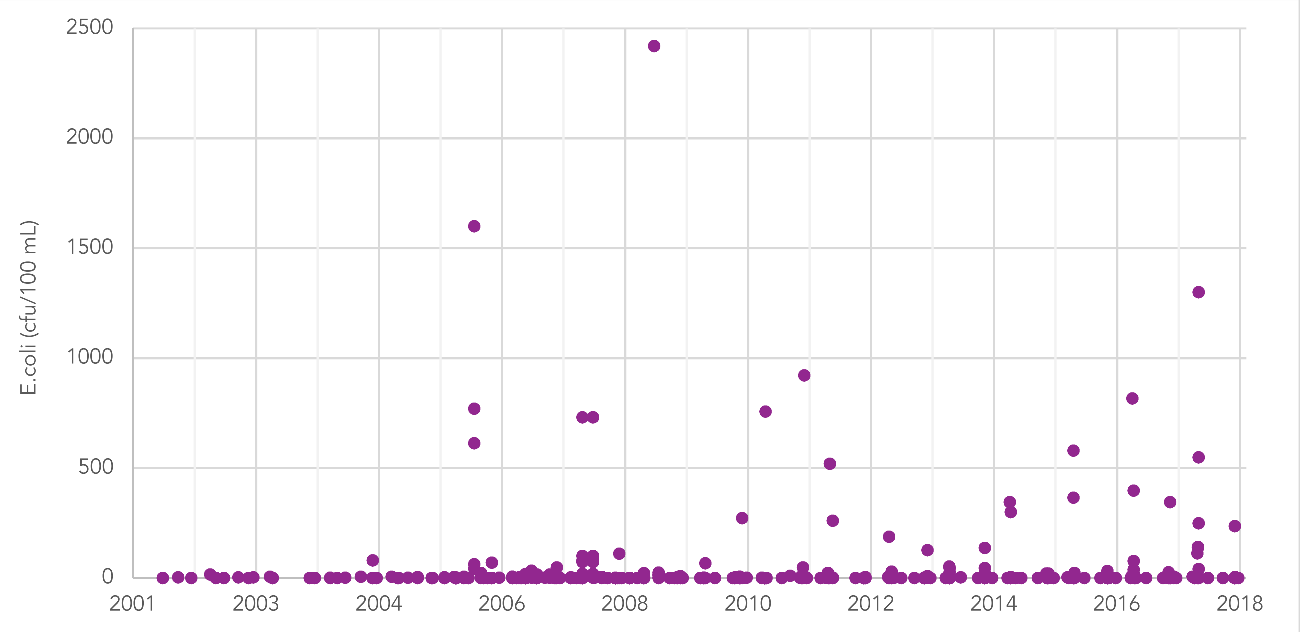


Figure 3.12: Concentration of E. Coli for the Central Plains aquifer (all groundwater monitoring sites), for samples greater than the detection level of 1 cfu/100 mL only (Environment Southland, 2019).

Groundwater level of the Central Plains Aquifer has been monitored using a continuous water level sensor at bore E45/0769, at Heddon Bush. Results of the daily average groundwater level for the period 2005 – present are presented in Figure 3.13. Seasonal changes include lower groundwater levels in summer and autumn (e.g., Jan-May) and higher groundwater levels during winter (e.g., Jun-Aug). The annual variability (range) for the period is approximately 1 – 1.5 m, with lowest groundwater levels occurring in May 2016 and 2017, and January 2018 (Figure 3.13). The monitoring bore is located in the unconfined Central Plains Aquifer which is characterised by predominantly rainfall recharge (via land surface) and abstraction for irrigation, stock water, domestic, and public water supply use. Observed seasonal variability in groundwater level is typical of a shallow aquifer that is predominantly recharged by rainfall. There does not appear to be an overall declining trend in groundwater levels for the aquifer at this stage. However, it is likely that any decrease in rainfall volume and/or increases in groundwater abstraction from the aquifer will result in decreases in groundwater level, which may affect current groundwater users. In addition, since shallow groundwater in the aquifer is understood to provide the primary source of baseflow of the primary order streams that confluence with the Oreti River, then a reduction of groundwater levels in the aquifer will likely affect both water quality and quantity of the Oreti River.

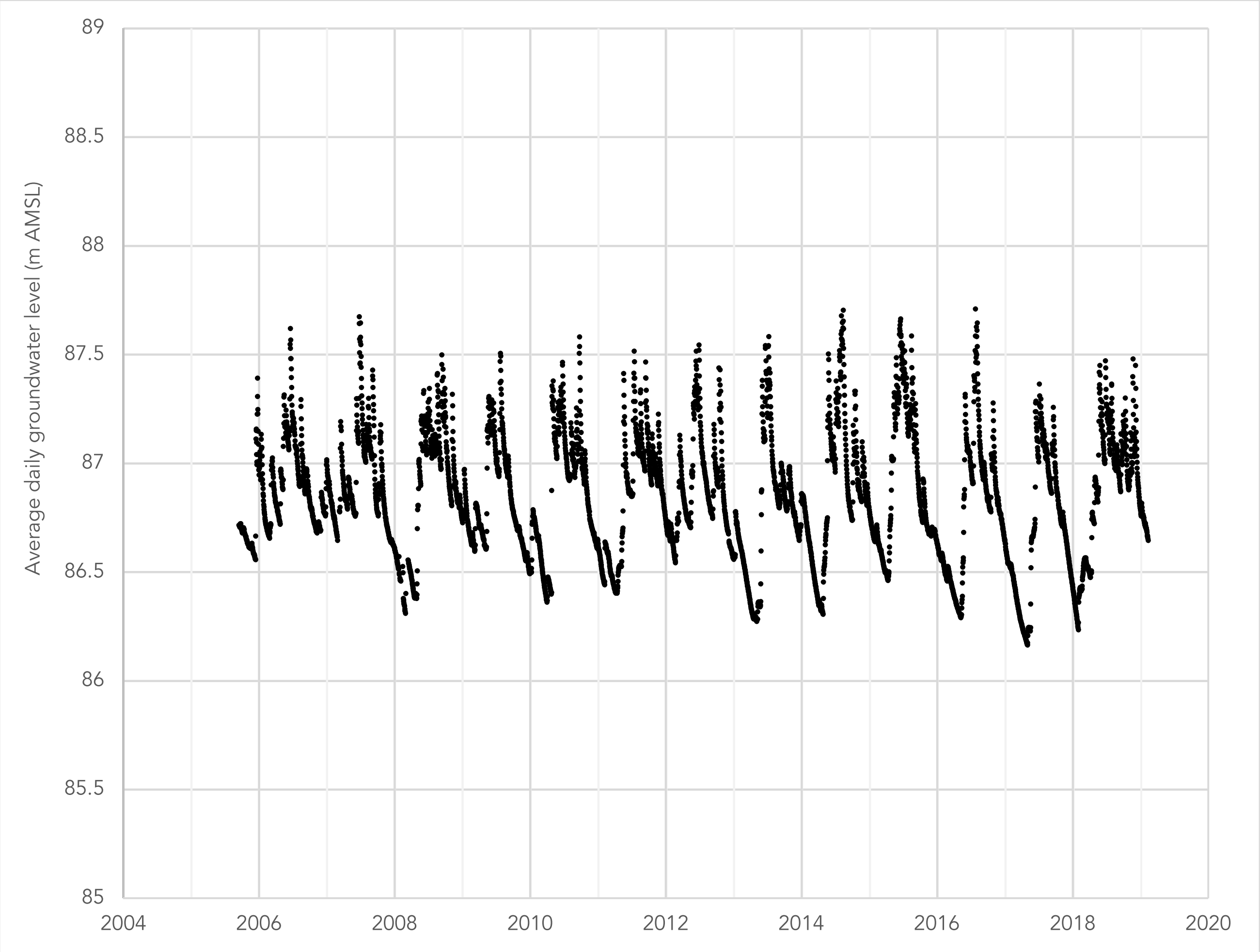


Figure 3.13: Average daily groundwater level for bore E45/0769 located in the Central Plains aquifer at the Heddon Bush monitoring site (Environment Southland, 2019).

3.2.2 Surface water

The upper catchment of the Oreti River maintains much of its natural qualities. In comparison, the mid and lower reaches of the catchment have been modified via drainage, flood control and channel clearance work. Impacts on water quality are likely due to tile drain and non-point source discharges, stock access to waterways, drainage maintenance and gravel extraction activities. SOE water quality monitoring sites in the Oreti River Catchment downstream of WW1, WW2,and Horner Block include Bog Burn d/s Hundred Line Road and Oreti River at Wallacetown (Table 3.2). Water quality monitoring is also undertaken at the Branxholme water supply, located *c.* 4.5 km upstream of the Wallacetown site (Table 3.2). Tributaries of the Oreti River (e.g., Winton Stream, Waikiwi Stream, Makarewa River) are subject to point-source discharges of effluent from industry and municipal sewage treatment. These tributaries confluence with the Oreti River downstream of the Wallacetown site.

*Table 3.2: Summary of key water quality parameters for the Oreti River and tributaries (Environment Southland, 2019). *numbers in brackets indicate the number of sample results below the detection level for the analysis method.*

	Parameter	*E. Coli*	Faecal Coliform	Nitrate	Nitrite	Dissolved Reactive Phosphorus	TP	Suspended Sediment
	Unit	cfu/100 mL	cfu/100 mL	mg/L	mg/L	mg/L	mg/L	mg/L
Bog Burn d/s Hundred Line Rd	Min	40	40	0.083	0.003	0.005	0.019	-
	Max	21,000	22,000	6.30	0.035	0.210	0.490	-
	Mean	*1,544*	*1,809*	*1.18*	*0.009*	*0.027*	*0.062*	-
	Median	*800*	*900*	*0.91*	*0.008*	*0.023*	*0.051*	-
	Count	213 (1)	192 (1)	82	81	207	206	-
Oreti River (Branxholme)	Min	10	10	0.36	0.002	0.004	0.004	11
	Max	5,000	7,000	3.10	0.020	0.13	0.58	4400
	Mean	*432*	*523*	*1.11*	*0.002*	*0.02*	*0.14*	*206*
	Median	*130*	*160*	*0.96*	*0.007*	*0.01*	*0.08*	*136*
	Count	52	52	274	258 (16)*	207 (67)*	273 (1)*	175 (66)*
Oreti River (Wallacetown)	Min	6	6	0.34	0.002	0.004	0.004	10
	Max	24,000	24,000	2.5	0.01	0.04	0.32	144
	Mean	*592*	*661*	*1.1*	*0.004*	*0.008*	*0.028*	*36*
	Median	*150*	*190*	*0.94*	*0.003*	*0.007*	*0.012*	*13*
	Count	240 (3)*	242 (3)*	75	69 (6)*	50 (26)*	73 (3)*	7 (42)*

Water quality at the Bog Burn d/s of Hundred Line Rd is the closest monitoring site to WW1, WW2, and Horner Block. *E. coli* concentration ranged from <10 – 21,000 cfu/100 mL and faecal coliform concentration ranged from 40 – 22,000 cfu/100 mL (Table 3.2, Figure 3.14). Bacterial presence was confirmed in almost 100% of the sampling events (e.g., 213 of 214 samples) (Table 3.2). Nutrient concentrations for Bog Burn ranged from 0.083 – 6.3 mg/L for NO_3-N and 0.003 – 0.035 mg/L for NO_2-N, whereas TP concentration was 0.02 – 0.49 mg/L (Figure 3.15). Water quality results clearly indicate impacts from land use in the immediate catchment, likely as a result of soil drainage and/or runoff events from intensive agriculture. A considerable dataset for surface water quality existed for the Invercargill Water Supply (Branxholme). Results showed high variability in bacterial concentration, including 10 – 5,000 cfu/100 mL for *E. coli* and 10 – 7,000 cfu/100 mL for faecal coliforms (Table 3.2). Nutrient concentration ranged from 0.36 – 3.10 mg/L NO_3-N and 0.53 – 4.8 mg/L for total nitrogen (Table 3.2). Water quality results for Oreti River at Wallacetown are comparable to those observed at Branxholme in terms of nutrients. Bacterial concentrations are higher for the Wallacetown site, potentially since a greater number of sampling events have been captured at this location. Overall, water quality in the Oreti River shows impacts from land use in the catchment, particularly bacterial contamination.

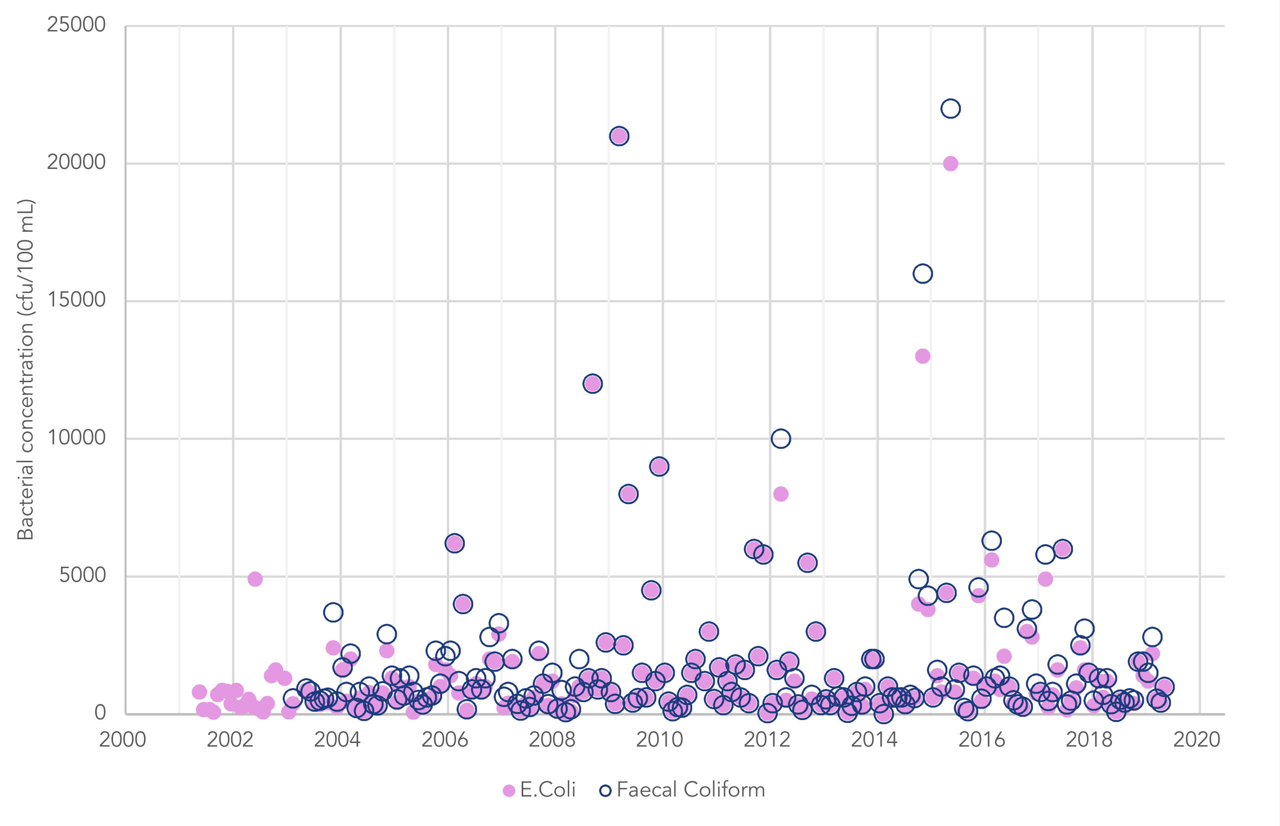


Figure 3.14: Summary of bacterial concentration at the Bog Burn monitoring site (Environment Southland, 2019).

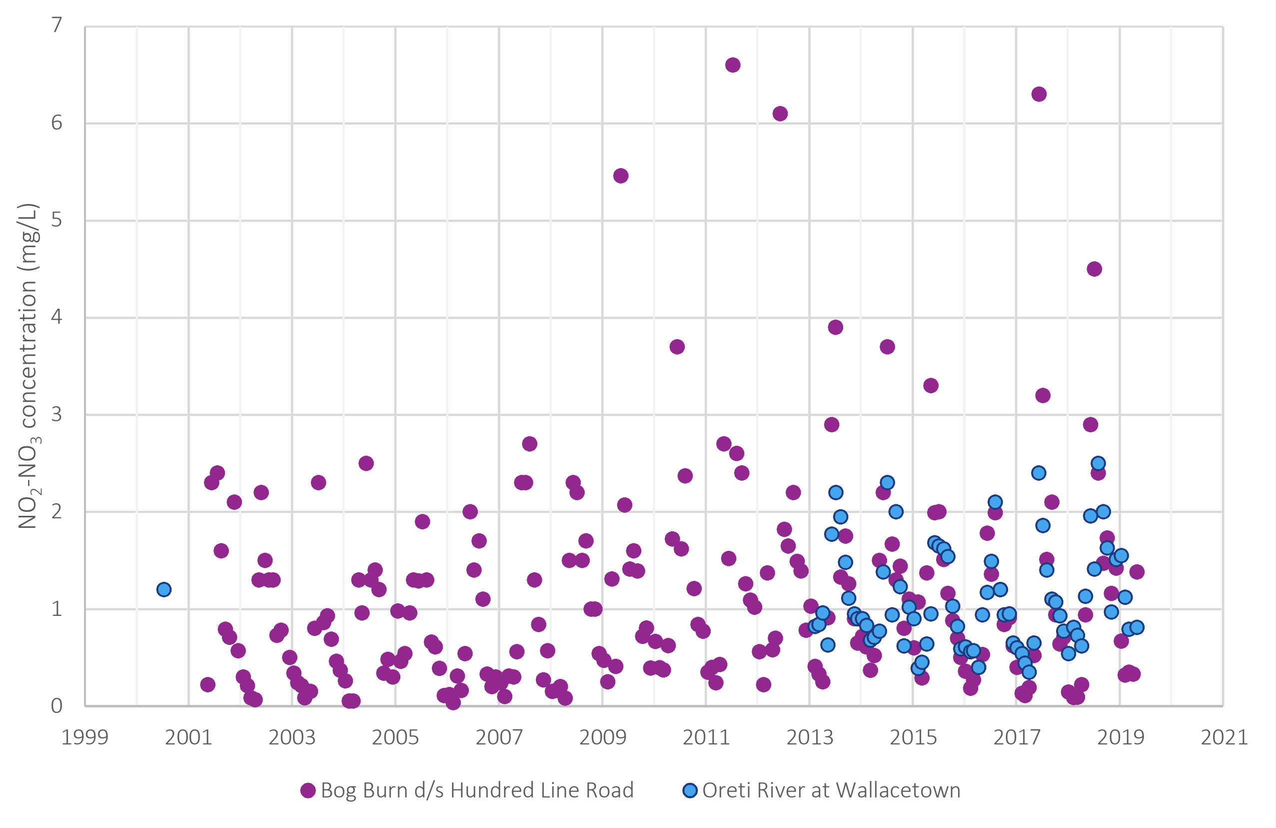


Figure 2.15: Nutrient concentrations for Bog Burn and Wallacetown monitoring site (Environment Southland, 2019).

3.3 Aparima Catchment

The Aparima Catchment extends from the Takitimu Mountains west of Mossburn and discharges >100 km south into the Jacobs River Estuary, Riverton. Headwaters of the Aparima Catchment drain alpine, native tussock and forest land, via tributaries including Hamilton Burn. Agricultural development dominates the middle and lower reaches of the catchment. The Upper Aparima groundwater zone is located within the low-topography area of the Upper Aparima River catchment. Western and northern boundaries of the Upper Aparima GMZ are demarcated by the approximate extent of Quaternary gravel deposits along the base of the Taringatura and Takitimu foothills. The southern boundary cuts across the Aparima River catchment upstream of Otautau and follows the approximate extent of the older Quaternary gravel surface.

3.3.1 Groundwater

Quaternary gravel deposits of the Upper Aparima groundwater zone occur in a series of broad alluvial terraces that flank the recent floodplain of the Aparima River (Figure 3.16). The gravel deposits underlying the higher terrace surfaces tend to be relatively clay-bound and weathered incorporating early to mid-Quaternary gravels deposited by the Aparima River, along with locally derived alluvial fan deposits sourced from the surrounding foothills. Estimated gravel depth is > 50 m over much of the area. A series of alluvial terraces are located upstream of Wreys Bush and form the setting for individual terrace aquifers through which groundwater flows sequentially to reach the floodplain deposits adjacent to the Aparima River. Gravel deposits in the Wairio area appear to be largely remnants of the weathered mid-Quaternary gravels that have been locally reworked by second and third order streams to form the rolling topography. These gravels are generally very tightly clay-bound forming a low yielding (e.g., < 1 L/s) unconfined aquifer. Terrace aquifers are recharged by direct rainfall recharge and infiltration of runoff from the surrounding hills and streams. Limited riparian recharge from the Aparima River occurs along the riparian margins. Mean annual land surface recharge in the Aparima groundwater zone is estimated to be 417 mm/year. Groundwater is discharged into the Aparima River via spring-fed streams or throughflow through the unconfined aquifer along the riparian margin of the river. The Aparima River is largely influent (e.g., loses surface water to groundwater) over much of the reach upstream of Wreys Bush reflecting drainage of groundwater from the surrounding terrace aquifers.

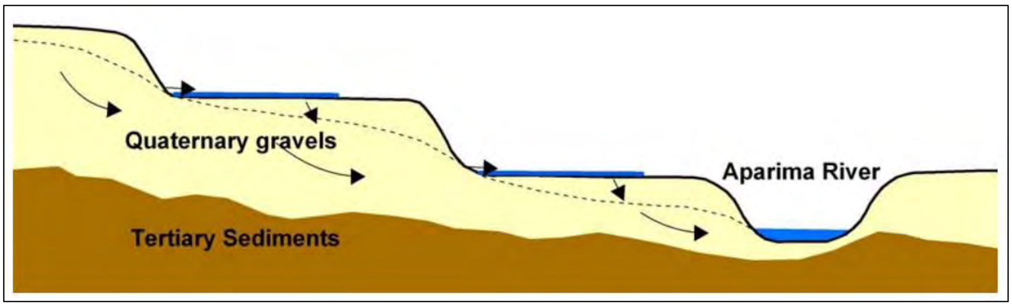


Figure 3.16: Schematic cross-section depicting hydrogeology of the Upper Aparima GWZ (Environment Southland, 2019).

Of available groundwater quality samples from bores in the Upper Aparima GMZ, 877 results existed for NO_2-NO_3 concentration (Environment Southland, 2019). Overall, concentration of NO_2-NO_3 ranged from <0.002 – 26 mg/L (Figure 3.17 and 3.18). In general, lower concentrations were measured during the period 1997 – 2007 (e.g., up to 12 mg/L) and higher concentrations observed during the period 2007 – 2019 (e.g., up to 26 mg/L). Longer-term data for 14 bores in the Upper Aparima GMZ showed visually similar trends to the full datasets (e.g., a general increase in concentration over time, albeit with greater ranges in concentration) (Figure 3.17 and 3.18). The majority of longer-term monitoring sites showed a relatively stable concentration of NO_2-NO_3 over time, with bores D45/0163 and E44/0448 being exceptions, both of which showed an increase in concentration over time (Figure 3.18). Of the 729 samples analysed for *E. coli*, 513 samples had a concentration less than the detection level of 1.00 cfu/100 mL. Of the 216 samples above the detection level, concentration ranged from 1 – 2,420 cfu/100 mL. The four highest levels of *E. coli* were from samples taken during March, all of which were >1,500 cfu/100mL (Figure 3.14). Of the 200 samples analysed for total coliforms, 61 samples had concentrations less than the detection level (1.00 cfu/100 mL), whereas 139 samples showed a concentration from 1.0 to > 2,400 cfu/100 mL). There was no observable trend in *E. coli* or total coliform levels over time (Figure 3.14). Groundwater level is manually measured four times a year at bore E45/0010 (1.1 – 3.8 m below top of casing). Groundwater is very shallow, and fluctuates seasonally with lower levels in summer compared to winter.

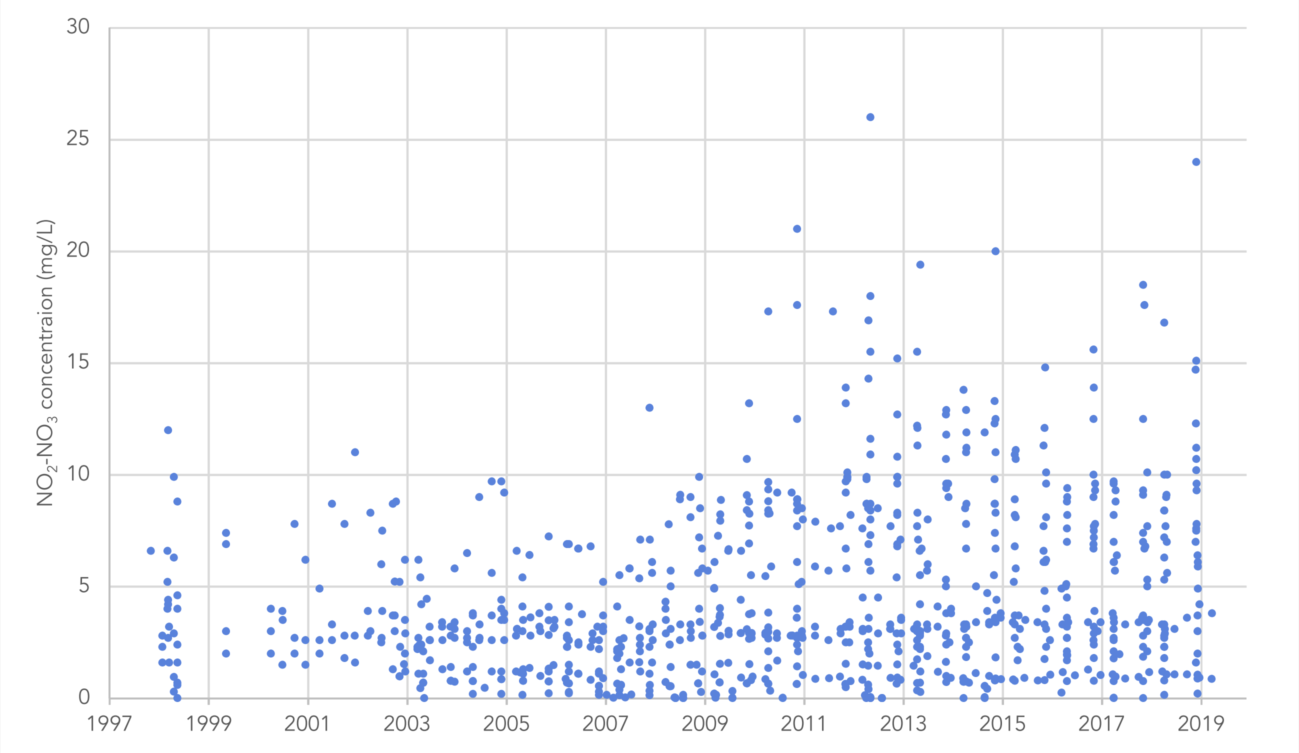


Figure 3.17: Nitrate-Nitrite (NO_2-NO_3) concentration for all groundwater water quality results from the Upper Aparima GMZ.

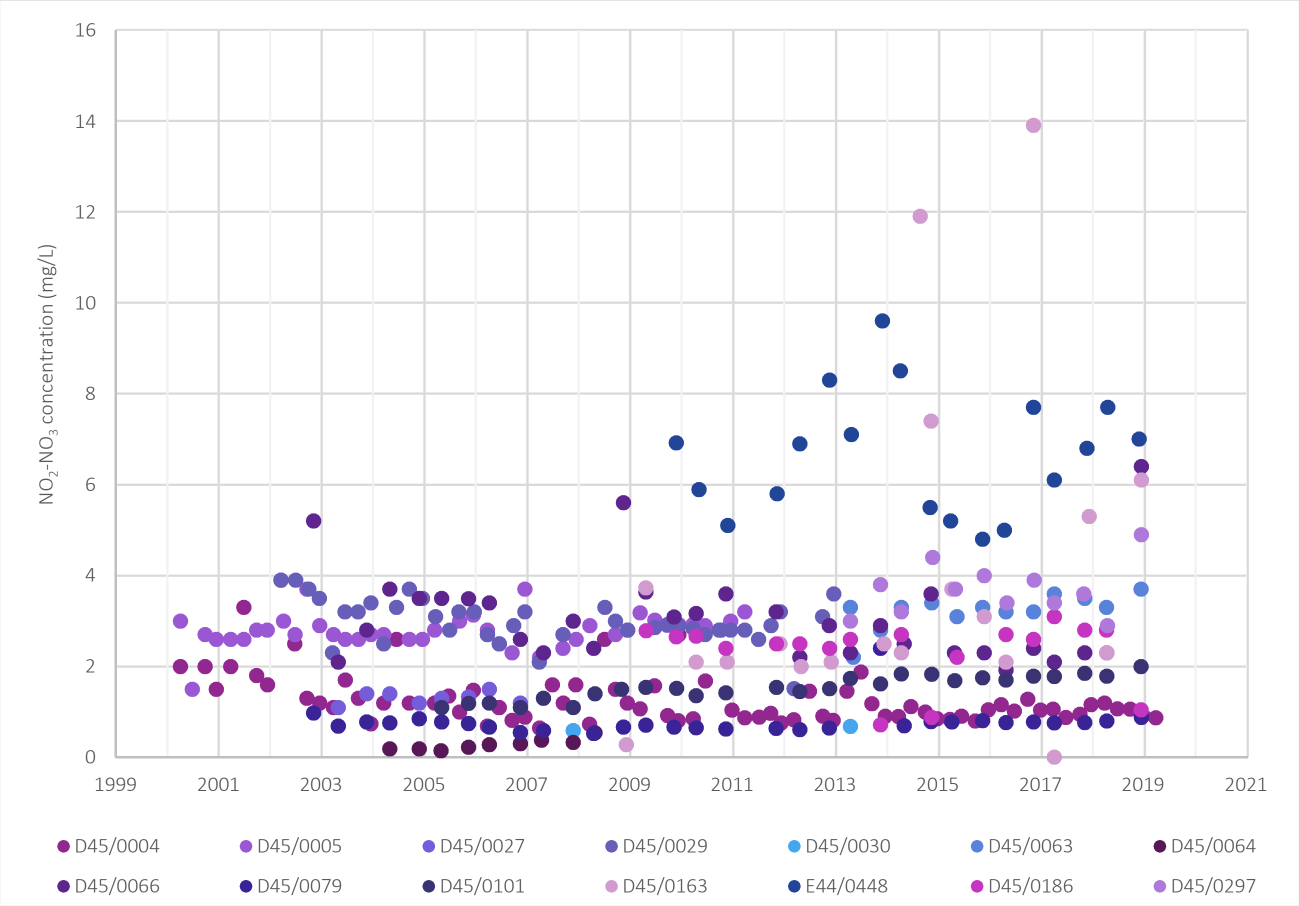


Figure 3.18: Nitrate-Nitrite (NO_2-NO_3) concentration for selected groundwater monitoring bores with long term datasets from the Upper Aparima GMZ.

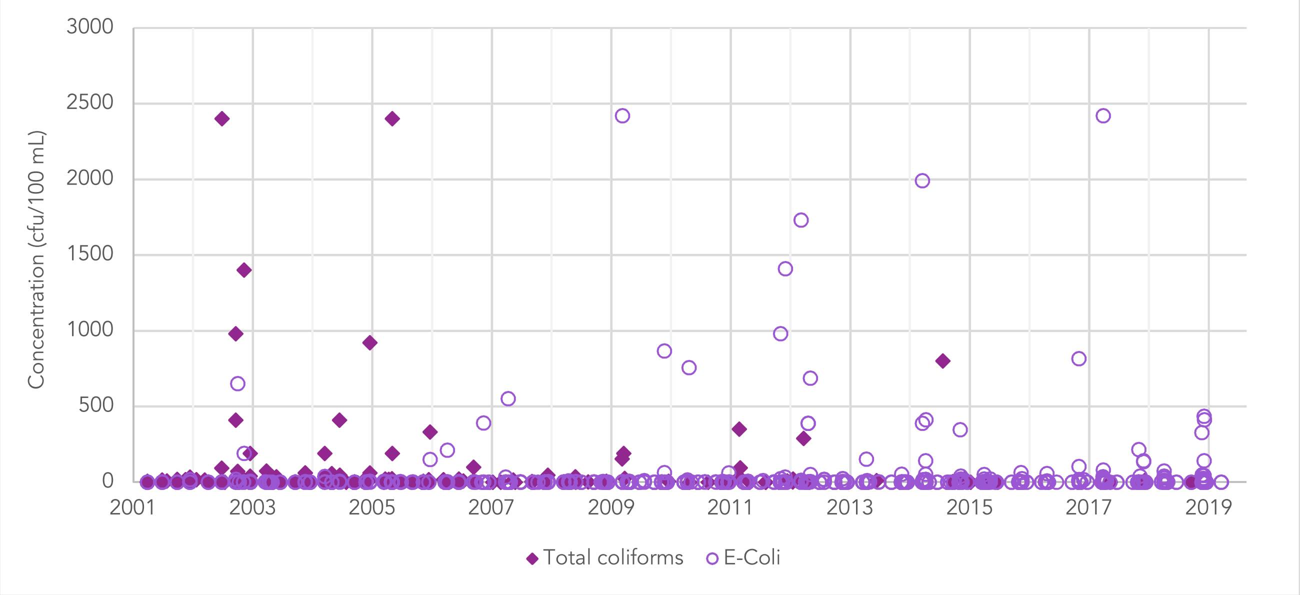


Figure 3.19: Bacterial concentration for available groundwater monitoring data in the Upper Aparima GMZ (Environment Southland, 2019).

3.2.2 Surface water

Surface water quality monitoring of the Aparima River has been undertaken at the upland Dunrobin (2000 – present) and at lowland Otautau (2000 - 2014) monitoring sites. Clear differences are in observed water quality between these two locations. NO_2-NO_3 concentration at Dunrobin is consistently < 0.5 mg/L indicating a low impacted state, whereas NO_2-NO_3 concentration at Otautau ranges from 0.2 – 1.8 mg/L (Figure 3.20). Similarly, TP concentrations at Dunrobin range from <0.004 – 0.43 mg/L, which are consistently lower in comparison to the Otautau monitoring site (<0.004 – 1.0 mg/L) (Figure 3.21). Although *E. coli* concentration shows high variability for both sites, exceedances of > 500 cfu/100 mL are more regular at the lowland Otautau monitoring site when compared to the upland Dunrobin site (Figure 3.22). Observed increases in nutrient and bacterial concentrations in a down-catchment direction is as a result of increased land use impacts. In particular, dairy farm intensification including re-routing of water (e.g., drain networks discharge degraded water to receiving streams), increases in overland flow and nutrient loss (e.g., as a result of wintering practices particularly when soils are saturated), and drainage of wetlands is likely to have contributed to these nutrient and bacterial contamination.

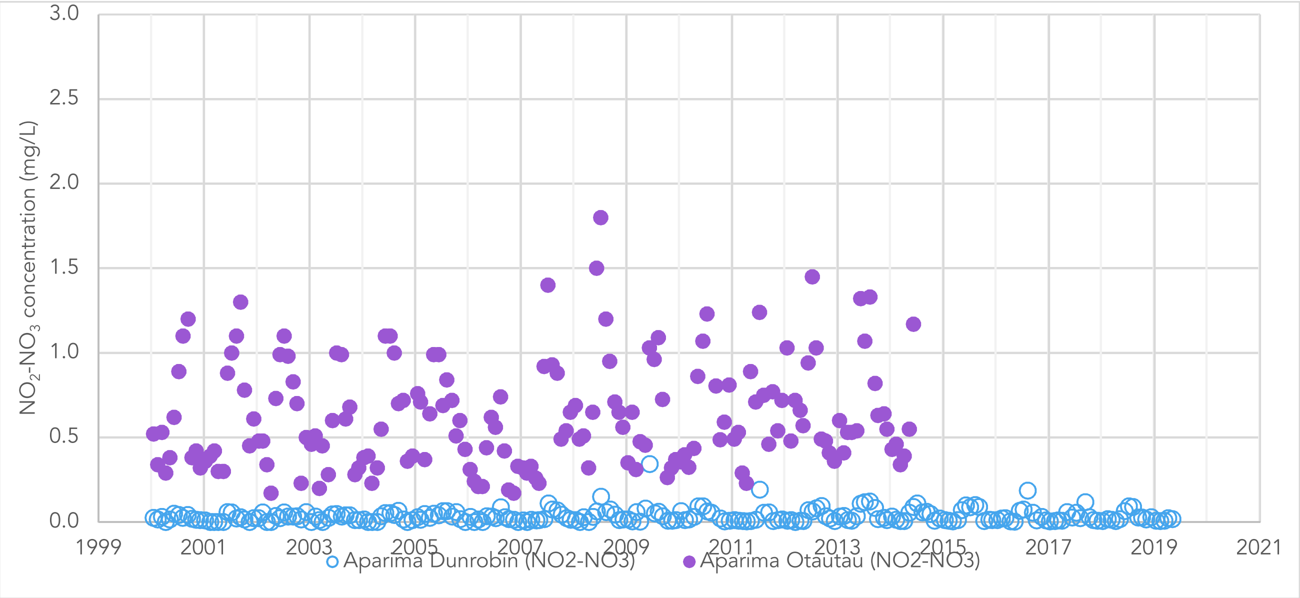


Figure 3.20: Nutrient concentration in the Aparima River at the upland (Dunrobin) and lowland (Otautau) surface water monitoring sites (Environment Southland, 2019)

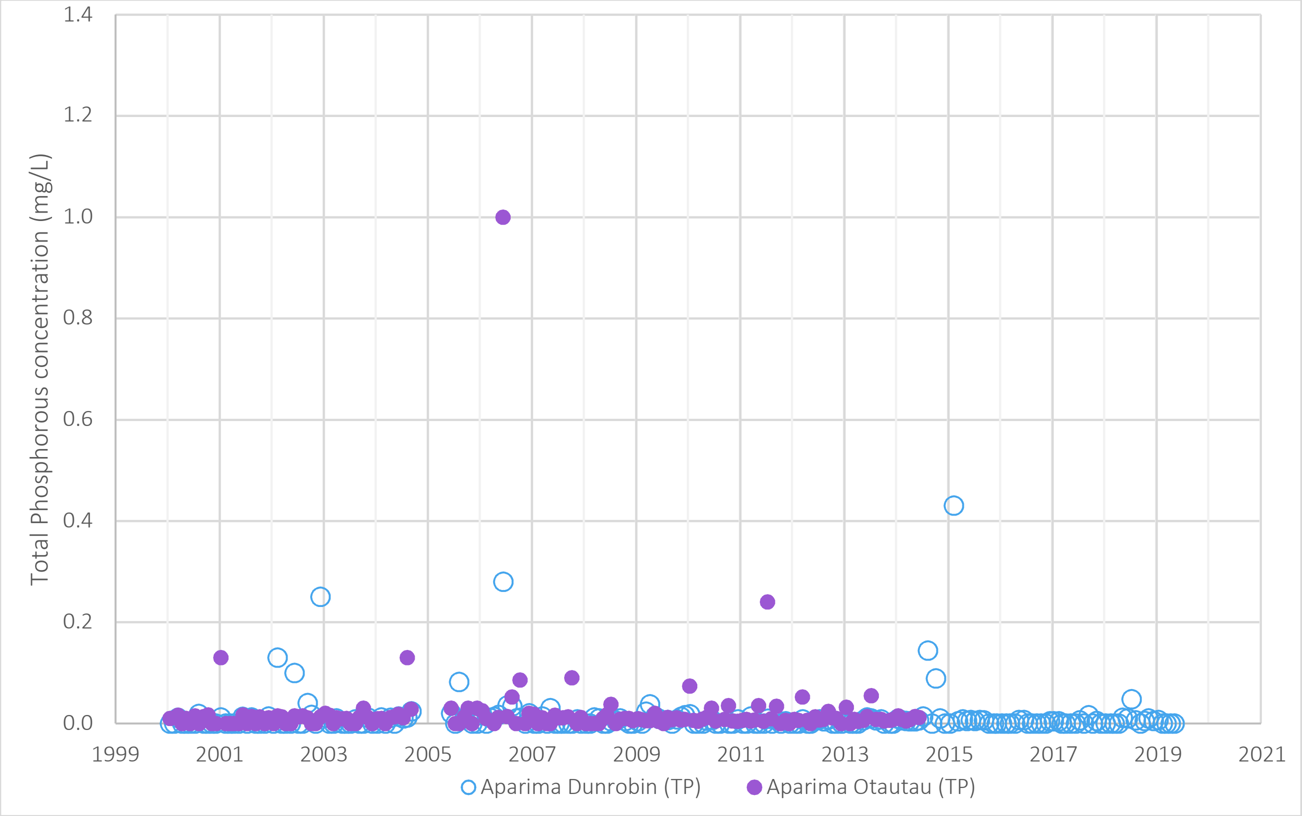


Figure 3.21: Total Phosphorous concentration in the Aparima River at the upland (Dunrobin) and lowland (Otautau) surface water monitoring sites (Environment Southland, 2019).

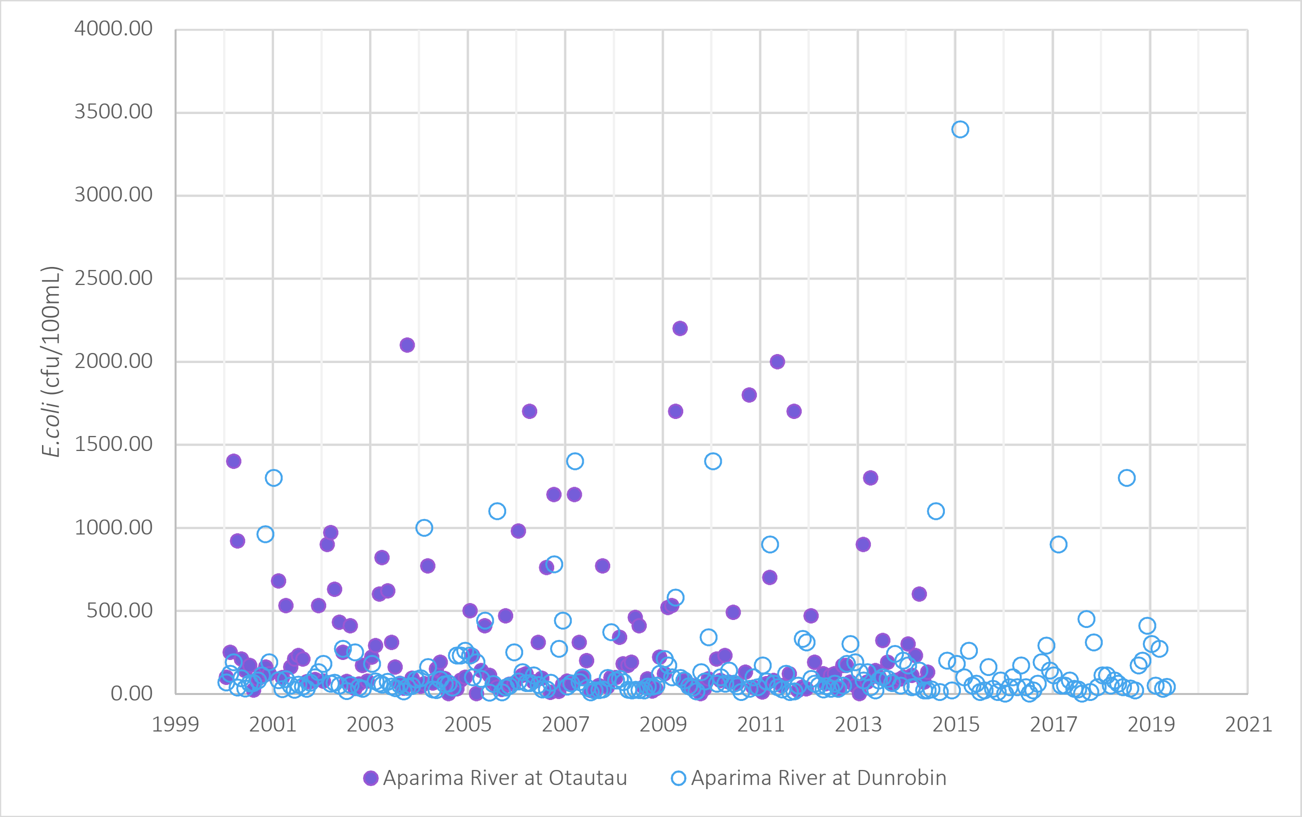


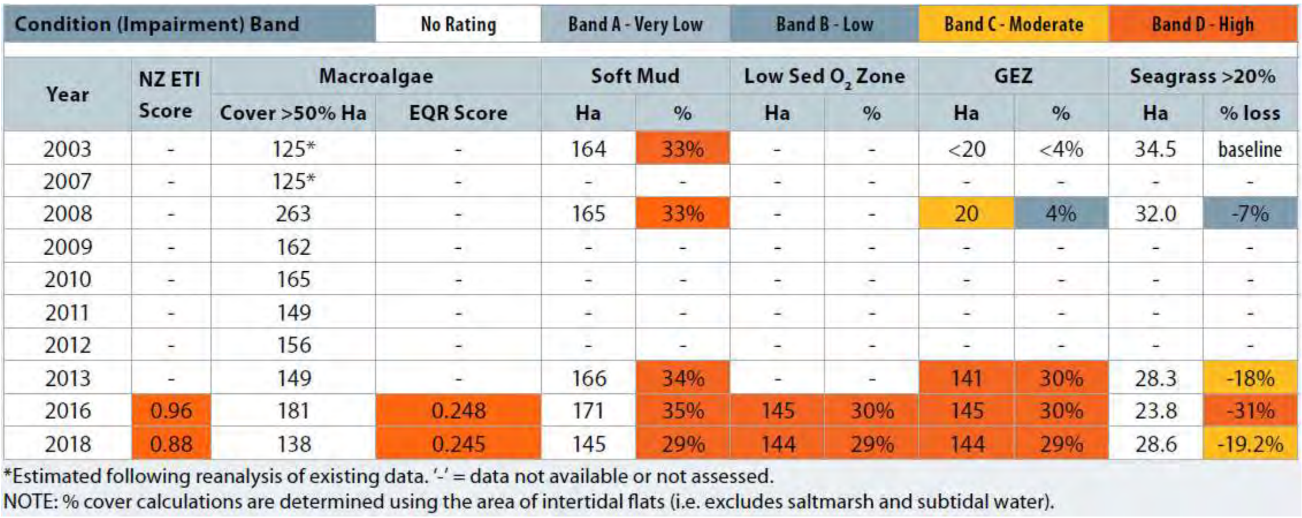
Figure 3.22: E. coli levels in the Aparima River at the upland (Dunrobin) and lowland (Otautau) surface water monitoring sites (Environment Southland, 2019).

The Aparima River is one of three main waterways (including the Pourakino River and Opouriki Stream) that discharges into the Jacobs River Estuary, Riverton. The estuary has a high level of environmental value associated with waterfowl and wading bird habitat and a high recreational value including for shooting, whitebaiting, fishing and boating activities (Stevens, 2018). Northern areas of Jacobs River Estuary include historical pa sites identified as of significance by Ngai Tahu. Water quality is sensitive to bacterial, nutrient, and sediment contamination, which negatively impacts on ecosystem health.

Broad scale mapping of Jacobs River Estuary has been undertaken in February 2003, 2008, 2013, 2016 (limited survey) and 2018, whereas macroalgal mapping was undertaken in February 2007, and annually 2008 - 2013 (inclusive) (Stevens, 2018). Overall, monitoring results presented in Stevens 92018) indicate deteriorating conditions in the estuary, including:

- Increasing macroalgal growth cover (including increasing biomass) has been observed. Macroalga cover increased from ~125 Ha (c. >50%) in 2003; to 263 Ha in 2008; and 149 – 165 Ha for the period 2009 – 2013. A small reduction in macroalgal cover has been observed within the northern Aparima Arm between 2016 – 2018.
- Continued decline in seagrass coverage from 34 Ha (2003), to 32 Ha (2008), to 28 Ha (2013), and to 24 Ha (2016). Seagrass was predominately displaced by dense macroalgal growth. Loss in seagrass coverage was equivalent to 31% of the habitat (2003 - 2016). In 2018, observations showed an increase in seagrass beds in the northern Aparima arm and re-establishment in an area previously dominated by macroalgae (eastern flats of Aparima River).
- Soft mud was prominent in 2003 covering 164 Ha (33%) of the estuary. Very little increase in soft mud was observed in 2008 and during the subsequent period to 2018.
- Gross eutrophic zones (GEZs) have increased considerably since 2003, when they were not a prominent feature in the estuary. In 2008 GEZ's covered 20 Ha (4%) of the estuary, increasing to 141ha (30%) by 2013, and 145 ha in 2016. In 2018, the extent of GEZs and reduced sediment oxygenation remained very extensive and macroalgal biomass remained very high, particularly in the Aparima Arm (~6,000 gm^{-2} wet wgt).
- An ETI score of 0.88 (Band D) shows the estuary is expressing significant adverse symptoms of nutrient enrichment.
- Overall, there has been a net trend of increasing GEZ and decreasing seagrass and saltmarsh for the period 2003 to 2018. The estuary is currently rated in a "poor" condition in relation to eutrophication and muddiness, and "moderate" in relation to habitat loss.

Conditions that cause displacement of seagrass beds also stress saltmarsh habitat, and cause significant adverse ecological impacts (e.g., to sediment dwelling organisms), and create conditions unfavorable for birds and fish. As a result, aesthetic and amenity values in these parts of the estuary are now also severely compromised. The primary driver of eutrophication in the Jacobs River Estuary is considered to be excessive catchment nutrient loads. More than 80% of the estuary nutrient load is likely to originate from the Aparima Arm. It is likely that the Aparima River nutrient loadings also impacts the Pourakino Arm.



Condition (Impairment) Band	No Rating	Band A - Very Low	Band B - Low	Band C - Moderate	Band D - High

Year	NZ ETI	Macroalgae		Soft Mud		Low Sed O_2 Zone		GEZ		Seagrass >20%	
	Score	Cover >50% Ha	EQR Score	Ha	%	Ha	%	Ha	%	Ha	% loss
2003	-	125*	-	164	33%	-	-	<20	<4%	34.5	baseline
2007	-	125*	-	-	-	-	-	-	-	-	-
2008	-	263	-	165	33%	-	-	20	4%	32.0	-7%
2009	-	162	-	-	-	-	-	-	-	-	-
2010	-	165	-	-	-	-	-	-	-	-	-
2011	-	149	-	-	-	-	-	-	-	-	-
2012	-	156	-	-	-	-	-	-	-	-	-
2013	-	149	-	166	34%	-	-	141	30%	28.3	-18%
2016	0.96	181	0.248	171	35%	145	30%	145	30%	23.8	-31%
2018	0.88	138	0.245	145	29%	144	29%	144	29%	28.6	-19.2%

*Estimated following reanalysis of existing data. '-' = data not available or not assessed.
NOTE: % cover calculations are determined using the area of intertidal flats (i.e. excludes saltmarsh and subtidal water).

Figure 3.23: Summary of macroalgal cover, macroalgal ecological quality rating (EQR), soft mud, oxygenation, gross eutrophic zones (GEZ), and seagrass, Jacobs River Estuary, 2003-2018 (Stevens, 2018).

3.4 Waiau

The Waiau FMU covers an area of approximately 862,700 hectares (27% of the region) and includes part of Fiordland National Park and the Takitumu Conservation area. The Waiau FMU includes Lake Te Anau, Lake Manapouri, Green Lake and Lake Monowai in the upper catchment, at Te Waewae Lagoon at the base of the catchment (Nicol and Robertson, 2018). Major tributaries of the Waiau River, below the Mararoa weir include Borland Burn, Lake Monowai and Monowai River, Dean, Lill and Alton Burns, and the Wairaki, and Orauea Rivers. Approximately 240,000 hectares (28%) of the land within Waiau FMU is developed, and of this land including primary land use includes sheep and beef (62%), dairy including dairy support (8%), urban (6%), and deer (7%) (Nicol and Robertson, 2018; Figure 2.7). There are approximately ten bores located in the Merrivale area within the vicinity of WRO, all of which are in an 'unclassified' groundwater management zone. Several bores are located in topographic depressions in close proximity to stream beds and likely abstract water that is connected to the surface waterways (e.g., riparian alluvial aquifers).

3.4.1 Groundwater

Very limited water quality results exist for four bores in the Merrivale area. NO_3-NO_2 concentration is very low in bore D45/0278, with a range of <0.002 – 0.053 mg/L, which is regarded as pristine to modern day background levels (Figure 3.24). In comparison, several other bores indicate increased NO_3-NO_2 including D45/0065 (3.8 mg/L), bore D45/0280 (6.01 mg/L), and bore D45/0108 (5.2 – 6.77 mg/L) (Figure 3.24). Aside from one occasion, *E. coli* levels have been very low (< 0.002 – 2 cfu/100 mL), with a maximum of 12 cfu/100 mL (D45/0278). Due to a combination of the topography, depth of groundwater and drainage channels it is thought that there is a low risk of nitrate accumulation in groundwater in this area. However, the limited number of groundwater quality results indicate that increased nutrient concentration is affecting water quality in several bores, none of which are located particularly close to surface waterways (Figure 2.5).

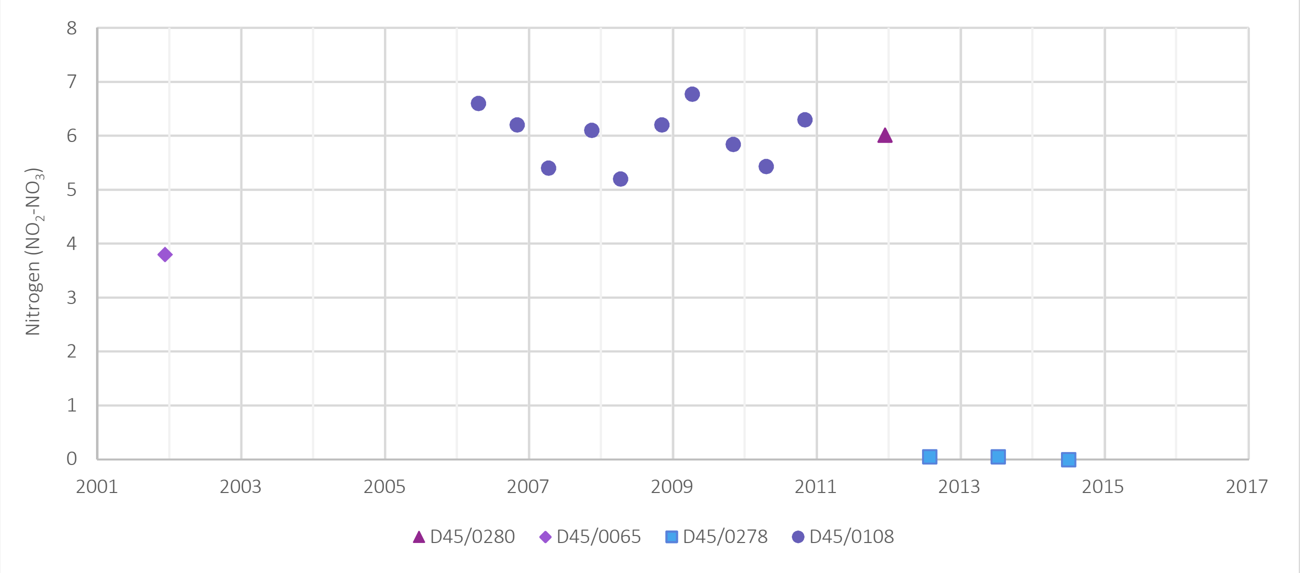


Figure 3.24: Nitrogen concentration in groundwater from 'unclassified' groundwater zone bores, Merrivale (Environment Southland, 2019).

3.4.2 Surface water

Surface water quality is monitored on the Orauea River at Orawia Pukemaori Road and on the Waiau River at Tuatapere. Results indicate high levels of *E. coli* and faecal coliforms in both rivers, with *E. coli* ranging from 20 - 54,000 cfu/100 mL in the Orauea River and 10 – 20,000 cfu/100 mL in the Waiau River at Tuatapere (Table 3.3; Figure 3.23). Bacterial levels are generally lower in the Waiau River (e.g., 94% of samples are < 300 cfu/100 mL) compared to the Orauea River where only 45% are < 300 cfu/100 mL. This is supported by greater median *E. coli* levels in the Orauea River (330 cfu/100 mL), compared to the Waiau River (82 cfu/100 mL). The Waiau River has comparatively lower NO_2-NO_3 concentrations compared to the Orauea River (e.g., 0.08 – 0.58 mg/L and <0.002 – 2.1 mg/L, respectively); and lower TP concentrations (e.g., <0.004 – 0.87 mg/L and 0.01 – 1.3 mg/L, respectively) (Table 3.3, Figure 3.24). Water quality at the Orauea monitoring site indicates nutrient concentrations and bacterial levels that are greater than background level, indicating some impacts from land use in the catchment. Due to the combination of the topography (moderate to steep in places), soil types, and drainage channels it is likely that overland flow into surface water ways is the most likely pathway for these contaminants to enter surface waters. It is likely that comparatively better water quality is observed in the Waiau River due to the extensive area of pristine land that it drains and a reduced level of land use intensification in the catchment above the monitoring site.

Table 3.3: Summary of selected water quality parameters for the Waiau FMU, including Orauea River at Orawia Pukemaori Road and the Waiau River at Tuatapere monitoring sites (Environment Southland, 2019).

Site	Orauea at Orawia Pukemaori Road				Waiau at Tuatapere			
Parameter	*E. coli*	Faecal coliforms	NO_2-NO_3	TP	*E. coli*	Faecal coliforms	NO_2-NO_3	TP
Unit	(cfu/100 mL)	(cfu/100 mL)	mg/L	mg/L	(cfu/100 mL)	(cfu/100 mL)	mg/L	mg/L
Minimum	20	20	0.002	0.01	10	10	0.08	0.004
Maximum	54,000	54,000	2.10	1.3	20,000	20,000	0.58	0.87
Average*	1,859	2,062	0.55	0.06	516	566	0.27	0.03
Median*	330	395	0.50	0.03	82	92	0.25	0.01
Count	201	202	198	195	193	195	77	66

* Values are calculated on samples above the detection level for each water quality parameter only.

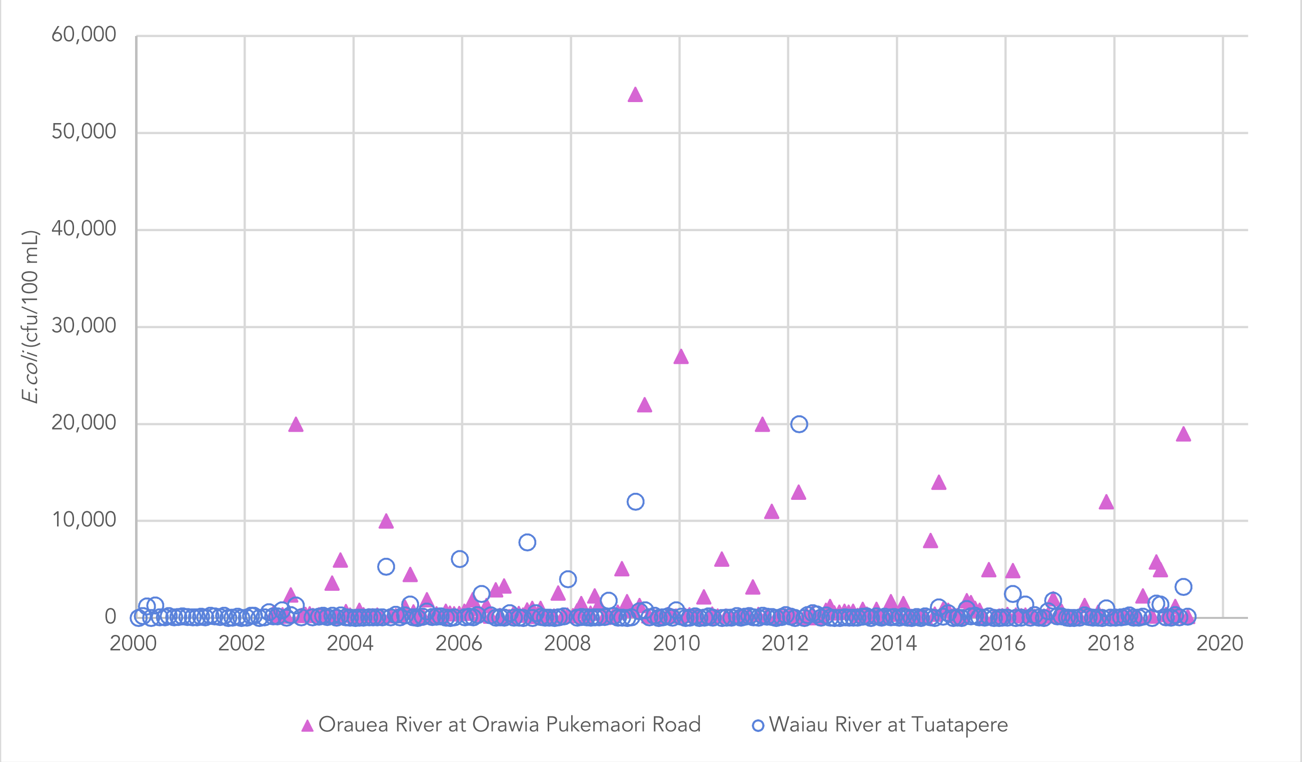


Figure 3.25: E. coli levels in the Orauea River and Waiau River monitoring sites (Environment Southland, 2019).

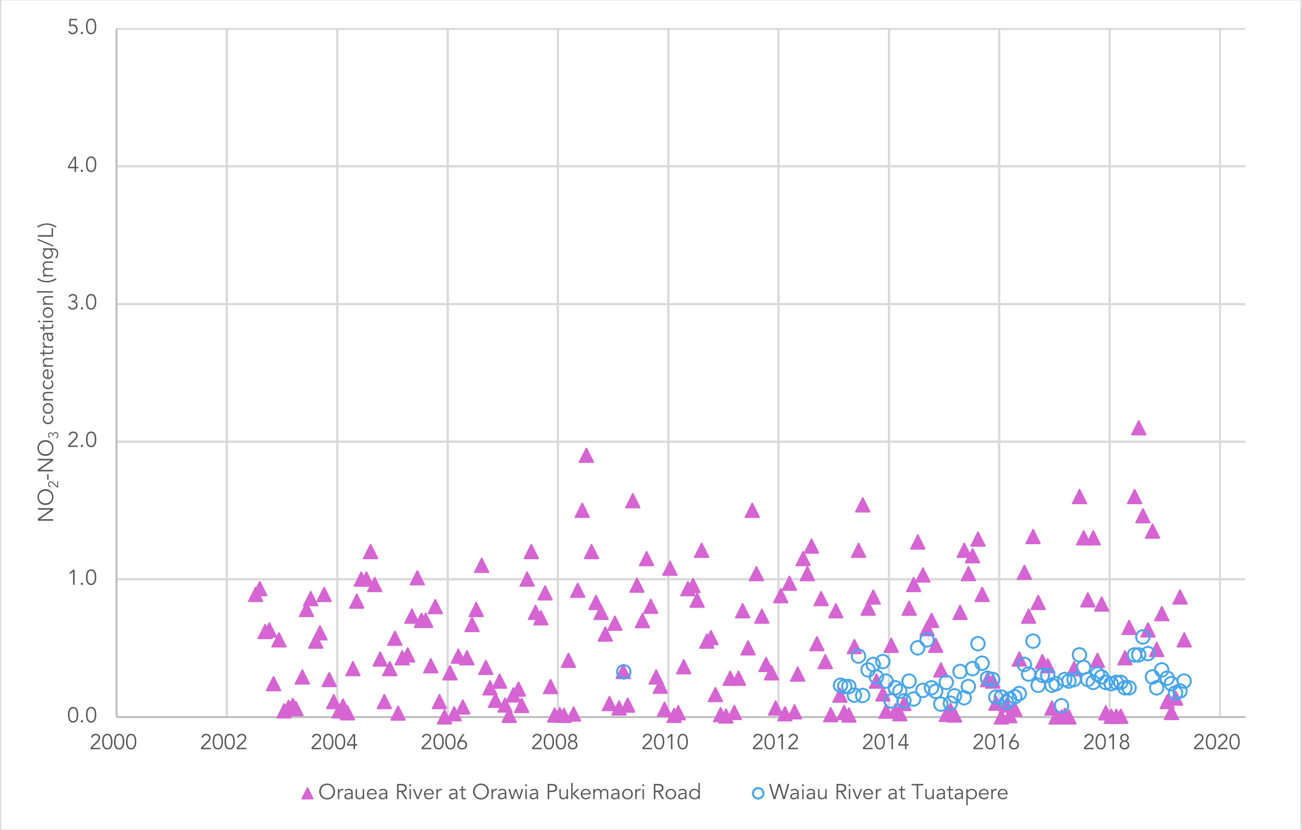


Figure 3.26: NO_2-NO_3 concentration in the Orauea River and Waiau River monitoring sites (Environment Southland, 2019).

3.5 Drinking water supplies

There are four known public drinking water supplies downstream and/or downgradient of WW1, WW2, and Horner Block farms and numerous private drinking water supplies. Two of these water supplies abstract groundwater from the Waimatuku GMZ to supply primary schools, including Heddon Bush School (*c.* 2.3 km to the south) and Drummond School (*c.* 12 km to the south). A further groundwater supply abstracts groundwater from the Upper Aparima GMZ for Otautau township *c.* 16 km to the south-west. One public water supply abstracts surface water to supply the township Invercargill City (Branxholme Plant) from the Oreti River.

Land use processes from WW1, WW2 and Horner Block properties have the potential to effect water quality of the groundwater supply for Heddon Bush School due to the abstraction from an unconfined aquifer, the (relatively) shallow depth of the bore (14.9 m), and close proximity (*c.* 2 km) to the properties. Land use process on WW1, WW2, and Horner Block properties have the potential to influence water quality at Drummond School and the Invercargill City Supply as both these sites are in downstream groundwater and surface water environments, respectively. Land use processes from the properties are unlikely to influence water quality of the Otautau supply since the bore is located in the Upper Aparima groundwater zone on the opposite of the Aparima River, and is not located down-gradient of the properties (e.g., 16 km to the south-west).

Heddon Bush School previously used a bore (unknown bore number) to abstract groundwater for the water supply (1995 – 2017). It is understood that water levels in the bore declined and the bore ran dry in 2017 (Hamilton, 2019). A replacement bore (E45/0718) was drilled in 2017 to 14.9 m below ground level (BGL) and was constructed with a 0.7 m screened interval from 14.2 – 14. 9 m BGL (Environment Southland, 2019). Available water quality results for the Heddon Bush School water supply were compiled, including one water quality sample (Environment Southland, 2019) and three water quality samples provided in the application. The results for bacterial analysis of 46 water samples were provided by the school (Hamilton, 2019), and 3 results were provided in the application. These samples had been collected from either the bore or 'kitchen tap' and were analysed by the Invercargill City Council water testing laboratory. Concentrations of bacterial parameters including *E. coli*, faecal coliforms, and enterococci were consistently reported as 'absent' or below detection level (<1.0 cfu/100 mL). The single groundwater quality sample showed likely impact from land use processes including elevated nutrients (NO_3-N) of 2.33 mg/L and a total coliform count of 3 cfu/100 mL (Table 3.3). Additional groundwater quality results for Heddon Bush School would be required to provide a more reliable determination of groundwater quality at the site.

Table 3.3: Summary of key water quality parameters for a single sample from the Heddon Bush School bore, collected on 02/06/2017 (Environment Southland, 2019) and three samples provided in Legg (2019).*

Parameter	Coliforms	E-Coli	Enterococci	Faecal Coliform	Iron	Manganese	Nitrate Nitrogen	Total Ammoniacal Nitrogen
Unit	cfu/100 mL	cfu/100 mL	cfu/100 mL	cfu/100 mL	mg/L	mg/L	mg/L	mg/L
E45/0718*	3	<1.00	<1.00	<1.00	0.29	0.23	2.33	0.01
E45/0718	-	<1.00	-	-	-	-	1.8 - 2.0	-

Overall, surface water quality results for the Invercargill Water Supply (Branxholme) showed impacts from land use within the catchment. In particular, there was high concentrations and high variability in bacterial presence, including 10 – 5,000 cfu/100 mL for *E. coli* and 10 – 7,000 cfu/100 mL for faecal coliforms (Table 3.3). In comparison, nutrient concentrations were lower, and ranged from 0.36 – 3.10 mg/L NO_3-N and 0.53 – 4.8 mg/L for total nitrogen (Table 3.3).

4.0 Soil hydrology considerations in the receiving environment

4.1 Physiographic zone contaminant pathways

WW1, WW2, and Horner Block are located on a combination of Central Plains and Oxidising PZ's. Central Plains soils are prone to waterlogging when wet, which has resulted in the installation of extensive artificial drainage networks. When dry, these soils are prone to shrinking and cracking, allowing drainage to bypass the soil to the underlying aquifer. Aquifers and streams in this zone are prone to contaminant build-up as they do not experience dilution by a major river. In comparison, soil water and groundwater in Oxidizing physiographic zone soils are well aerated, which allows nitrogen to accumulate. Oxidised soils are good at absorbing and storing water and any nitrogen it contains. During drier months, nitrogen accumulates in soil to high levels. During winter when soils are wet, any nitrogen not used by plants leaches down into the underlying aquifer (deep drainage). Artificial drainage is used where soils have low subsoil permeability to help to reduce waterlogging. Contaminant loss through artificial drains to nearby streams can be high during wetter months.

4.2 Soils

Topoclimate maps indicate that WW1 and WW2 primarily overlie Braxton soil with intergrades of Pukemutu soil, and areas of Glenelg soil on the east side (Table 4.1). The Horner Block overlies a combination of Braxton, Glenelg, Drummond, Pukemutu and Waiau soils. Soils on WRO include Waimatuku, Makarewa, and Malakoff. Soil vulnerability factors are presented in the application (Landpro, 2019). It is important to note that vulnerability ratings provided in Table 4.1 are generalised and should not be taken as absolutes for this soil type in all situations. Actual risks depend on the environmental and management conditions prevailing at a particular place and time.

Table 4.1: Summary of soil types, farm location and vulnerability factors. Modified from Duncan (2019).

Soil type	Location	Structural compaction	Nutrient leaching	Waterlogging
Braxton	WW1, WW2, HB	moderate	slight	severe
Drummond	WW1, WW2, HB	minimal	moderate	slight
Glenelg	WW1, WW2, HB	slight	very severe	nil
Pukemutu	WW1, WW2, HB	very severe	slight	severe
Waiau	HB	moderate	very severe	nil
Waimatuku	WRO	slight	moderate	slight
Makarewa	WRO	moderate	slight	severe
Malakoff	WRO	slight	severe	slight

4.3 Land surface recharge

The Aparima, Waimatuku, and Central Plains aquifers are predominantly recharged by land surface recharge (e.g., rainfall infiltrates through the soil profile into the groundwater system). Estimated rainfall recharge rates for these aquifers in a normal year range from 420 mm/yr (Aparima) to 470 mm/yr (Waimatuku and Central Plains) (Environment Southland, 2019). The closest soil moisture monitoring site to WW1, WW2, and Horner Block is at Heddon Bush (Figure 4.1, Figure 4.2, Table 4.2). Thirteen years of data exists for the monitoring site, which is located on Glenelg soils, which often occur in association with Braxton and Drummond soils. The percentage of water filled pores at Heddon Bush ranges from 40% - 85%. Drainage likely begins to occur at 50 - 60% water-filled pores and is expected to occur at >65% water filled pores. Soil moisture at Heddon Bush is generally >65% between May – September, indicating that drainage is likely to occur during this time (Figure 4.1, Figure 4.2, Figure 4.4). On occasion, differences in weather events results in an earlier onset (e.g., 2009, 2011) or later onset (e.g., 2013) of land surface recharge occurring (Table 4.2). Effluent irrigation should not be undertaken when a soil is at field capacity to minimize the risk of leaching and discharge of contaminants to groundwater and surface water. Soil moisture content during May – June has been high (e.g., consistently > 63% water filled pores) indicating that no irrigation of effluent should have been undertaken during this period, as demonstrated by recent conditions (May – June, 2019) (Figure 4.3, Figure 4.4).

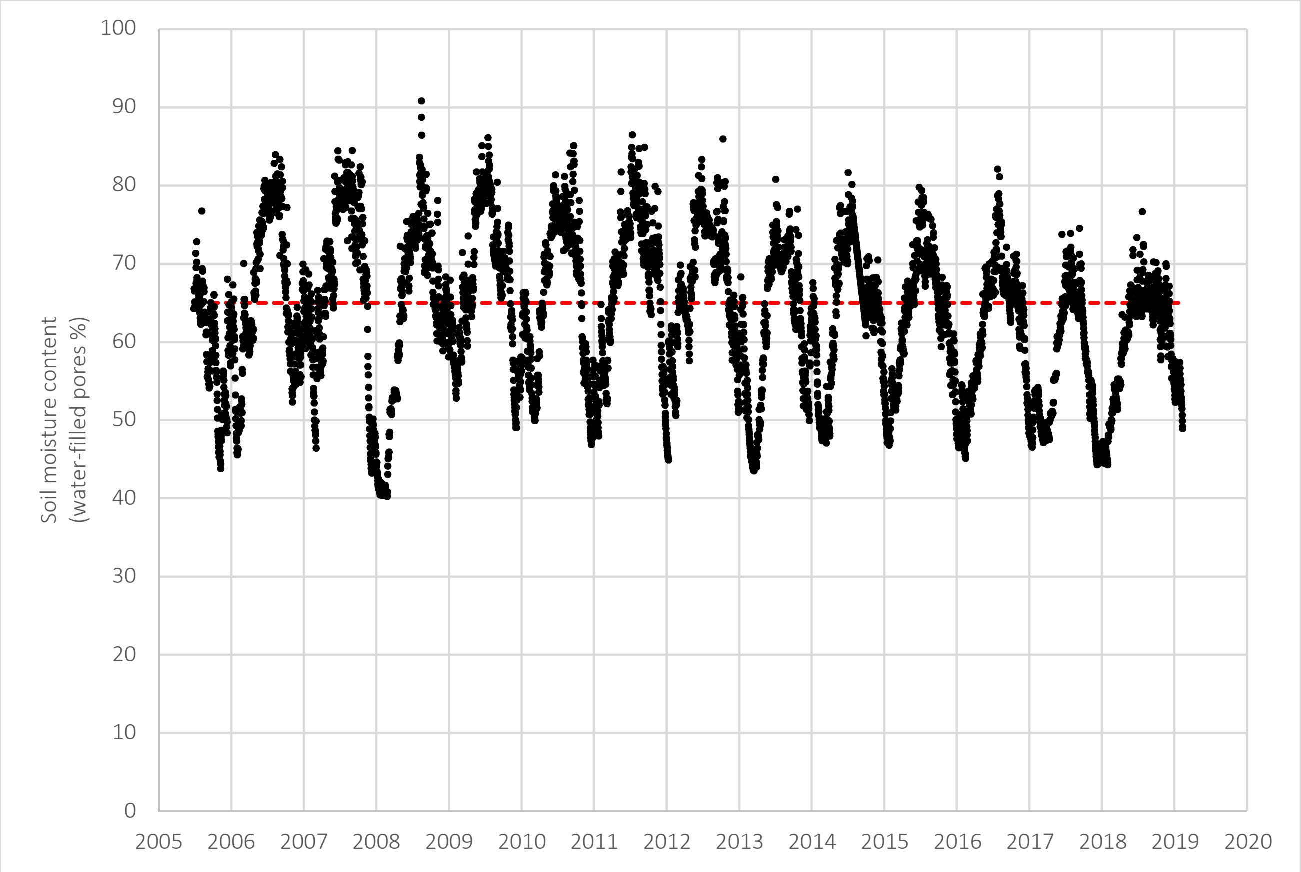


Figure 4.1: Daily average soil moisture content at the Heddon Bush monitoring site which is on Glenelg soil (Environment Southland, 2019). General trends indicate the lowest soil moisture content occurs in summer (e.g., Jan – Feb) and highest soil moisture content in winter (e.g., Jul – Aug).

Table 4.2: Summary of monthly average soil water filled pores for the Heddon Bush monitoring site. Months that have average soil water filled pores >60 % are highlighted, as land-surface recharge (e.g., drainage) is highly likely to be occurring during this period.

Month	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
January	-	58.5	64.1	42.4	60.8	62.7	52.1	53.3	60.3	61.5	49.6	49.6	49.5	45.7
February	-	49.7	58.5	41.2	57.2	56.2	57.8	55.3	51.2	49.8	53.1	49.0	51.9	49.9
March	-	61.7	57.7	-	64.1	52.6	58.8	66.3	44.9	50.0	55.9	53.3	48.3	53.7
April	-	62.0	64.1	55.8	64.9	64.3	67.9	62.6	50.2	58.1	62.6	57.1	49.8	58.6
May	-	71.6	69.8	-	75.0	70.8	71.2	71.9	63.0	70.5	66.4	63.8	57.3	62.9
June	-	76.9	75.6	-	-	76.9	74.4	78.2	-	71.5	71.8	67.1	64.0	65.8
July	66.8	77.9	78.5	-	80.9	75.9	79.3	75.7	72.3	-	73.2	72.8	69.0	67.4
August	64.9	79.0	79.6	79.5	74.0	76.4	77.7	73.6	70.6	72.0	72.1	71.3	66.7	66.4
September	58.8	75.2	75.8	72.7	70.1	-	75.3	72.4	71.3	65.4	69.3	-	66.0	65.4
October	57.4	63.5	76.5	67.8	70.5	70.9	68.9	73.9	67.2	66.1	64.1	67.8	57.5	64.3
November	50.1	57.4	63.3	64.9	61.2	58.2	71.3	64.3	58.9	64.9	63.0	63.8	51.4	64.4
December	56.8	61.2	47.0	63.4	54.0	51.2	56.1	-	55.3	60.9	55.8	55.6	45.7	59.5

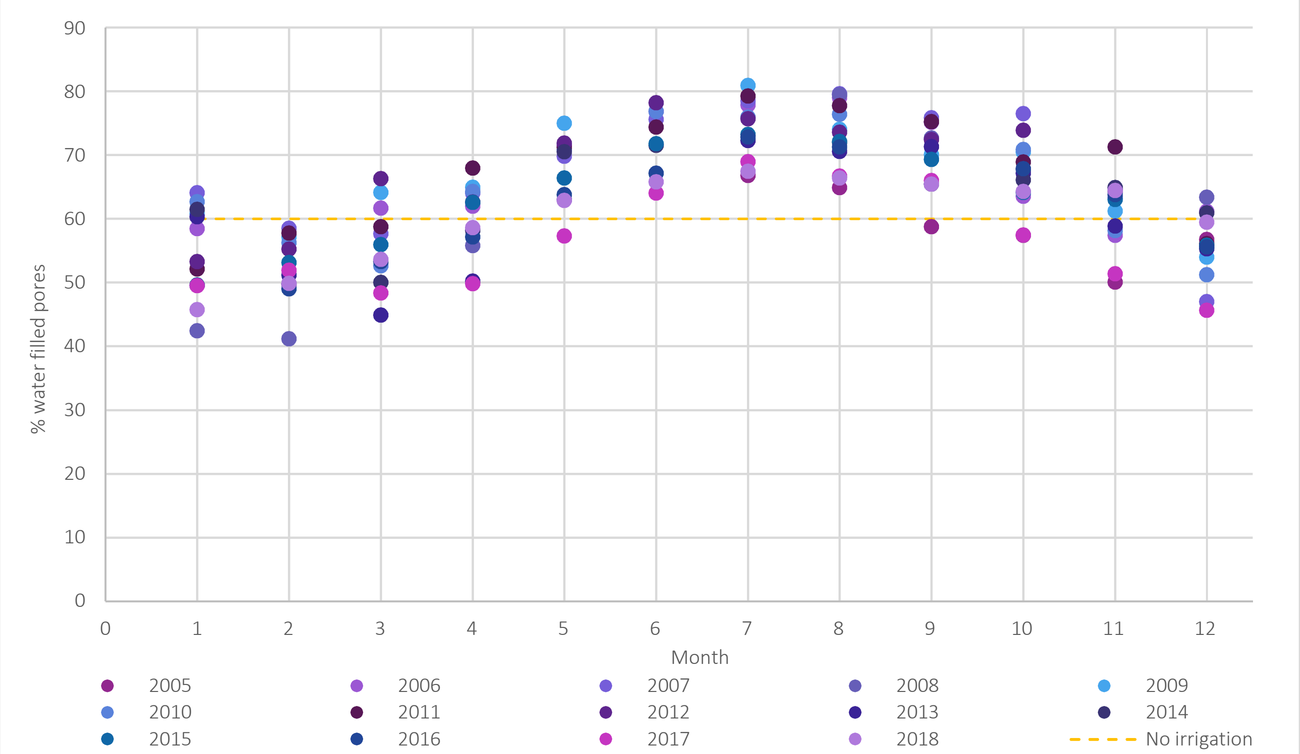
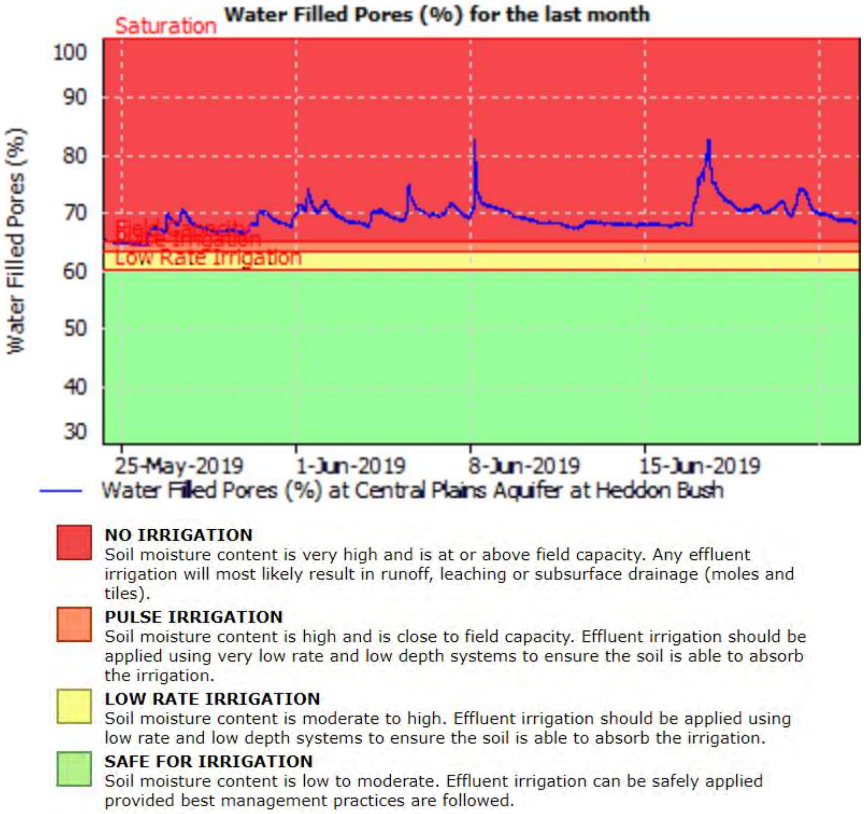


Figure 4.2: Summary of average monthly (January – December) soil moisture at Heddon Bush (2005 - 2019) and the recommended trigger (60%) for low-rate and low depth irrigation for FDE application (Environment Southland, 2019).



🟥 **NO IRRIGATION**
Soil moisture content is very high and is at or above field capacity. Any effluent irrigation will most likely result in runoff, leaching or subsurface drainage (moles and tiles).

🟧 **PULSE IRRIGATION**
Soil moisture content is high and is close to field capacity. Effluent irrigation should be applied using very low rate and low depth systems to ensure the soil is able to absorb the irrigation.

🟨 **LOW RATE IRRIGATION**
Soil moisture content is moderate to high. Effluent irrigation should be applied using low rate and low depth systems to ensure the soil is able to absorb the irrigation.

🟩 **SAFE FOR IRRIGATION**
Soil moisture content is low to moderate. Effluent irrigation can be safely applied provided best management practices are followed.

Figure 4.3: Heddon Bush soil moisture monitoring site "water filled pores %" for May 23 – June 23, 2019 (Environment Southland, 2019).

Figure 4.4: Summary of soil moisture (in % water filled pores) for the Heddon Bush monitoring site for the period 01 July 2018 – 30 June, 2019 (Environment Southland, 2019).

4.4 Farm Dairy Effluent Discharge, relevant to hydrology

Intensive dairy farming poses several potential risks to water quality including accelerated contamination of waterways by nutrients, sediment, and faecal microorganisms. Application of FDE is likely a major contributor to surface water quality degradation, as poorly managed FDE may generate nutrient-rich surface runoff and drainage waters with potential to pollute surface and groundwater (Houlbrooke and Monoghan, 2009). The following key points have been abstracted from Houlbrooke and Monoghan (2009) as context for implications of FDE application on surface and groundwater resources:

- *" The risk of direct contamination of water bodies associated with FDE application is dependent on the transport mechanism of water and, therefore, solutes and suspended solids. Three primary mechanisms exist for the transport of water (containing solutes and suspended solids) through soil: matrix flow, preferential flow and overland flow. Soils that exhibit preferential or overland flow are capable of considerable direct contamination loss of FDE when applications are made when soils are considered too wet (insufficient soil water deficit to store incoming moisture) and/or when the application rate of FDE is too high for the receiving soil's infiltration rate. Preferential or overland flow provides little soil contact time and decreased opportunity to attenuate the applied contaminants. Critical landscapes with a high degree of risk include soils with artificial drainage or coarse soil structure, soils with either an infiltration or drainage impediment, or soils on rolling/sloping country. Soils that exhibit matrix flow show a very low risk of direct contamination loss of FDE under wet soil moisture conditions. Matrix flow involves the relatively uniform migration of water through and around soil aggregates (so called 'piston' type displacement) and therefore provides a greater soil contact time and opportunity for nutrient attenuation and filtering of sediments and faecal micro-organisms. Such soils are typically well-drained with fine soil structure and high porosity. Research conducted in New Zealand suggests there is a low risk of direct contamination from FDE applied to well-drained soils. However, well drained soils typically have an inherently higher N leaching risk associated with the direct deposition of animal urine patches to land as a result of the smaller denitrification influence and smaller water holding capacities often associated with such soils. Therefore, the extent and impact from N inputs added as FDE to free draining soils that leach to ground water indirectly should be kept in context as FDE makes up approximately 10% of the daily nutrient load from cattle excreta. Therefore, effective mitigation techniques for N loss on these free draining soils should target the cumulative effects of autumn-applied urine patches during animal grazing. The effectiveness of current effluent best management practices (deferred irrigation and low application rate tools) varies between soil types depending on their inherent risk of direct contamination from land-applied FDE. Best practice management should therefore be targeted where it will be most effective."*

5.0 Consideration of Assessment of effects

5.1 Overall standard of environmental description

The description of the receiving environment provided in the application is relatively basic. The assessment largely relies on information extracted from Environment Southland databases and publications (e.g., Environmental Database "Beacon" mapping; groundwater zone factsheets), and limited SOE monitoring data presented on the Land Air Water Aotearoa (LAWA) database. Reference to a several relevant reports has been made. Reference is generally made to SOE monitoring sites in LAWA, including NOF categories and 5-year median trends which are based on data for the 2012 – 2017 period. Although considerable surface water datasets exist, very little, if any analysis of data has been considered or undertaken, including more recent data. Very little consideration of groundwater data has been incorporated into the assessment. In all instances, only monitoring sites downgradient of the farms have been considered. Comparison to upgradient monitoring sites could have been shown for completeness to better understand variation in land use impacts through the catchment. In some instances, the application discards datasets as being invalid, which is supported by insufficient reasoning (e.g., dismissal of groundwater quality results from bore E45/0622). The assessment of effects regularly indicates that although the application is seeking additional cow numbers and increased FDE application volume, water quality will be maintained or improved through mitigation of farming practices. It is proposed that these statements have been made with a lack of supporting information, and rely heavily on Overseer analysis (for WW1/WW2), for which the limitations are not adequately described. Overall, the analysis of potential effects on the receiving freshwater environments is not entirely robust. Additional information on the freshwater receiving environment has been compiled in Section 3 of this report.

5.2 Receiving surface water and groundwater environment

- The application initially states that WW1 & WW2 are located in the Oreti FMU, and that the Horner Block is located in the Aparima FMU. Based on boundaries for the FMU's this statement is incorrect.
    - Instead, WW1 and WW2 are located in the Aparima (via the Waimatuku sub-catchment) and Oreti FMU's; and the Horner Block is located in the Aparima Catchment (via the Waimatuku sub-catchment).
    - The application subsequently (correctly) states "*The dairy platform* (WW1 and WW2) *lies in both the Waimatuku Stream and Oreti River catchments… The Horner Block lies predominantly in the Waimatuku Stream catchment, with its westernmost area lying in the Aparima River catchment*" (Pg. 57).

- Other information provided in the application appears to be reasonable or correct, including:
    - A summary of drainage is provided "*Subsurface drainage is installed at the west with outfall to surface drains. Subsurface drainage is only installed in heavier Braxton type soils except for one tile drain at the north east of Wreys Bush Highway. Subsurface drains (tiles) generally underlie hollows, which may act as critical source areas close to surface drains in times of prolonged heavy rainfall.*"
    - The application correctly indicates the correct GMZ for each farm, including: WW1, WW2, and Horner Block overlie the Waimatuku GMZ; eastern areas of WW1 and WW2 are located on the Central Plains GMZ; eastern area of the Horner Block overlies the Upper Aparima GMZ; and WRO is unclassified.
    - The application provides a summary of the main surface waterways on the farms

- The application indicates that all waterways on WRO are fenced off (stock exclusion) and culverted. However, this needs to be verified as observations from Environment Southland indicate that this is not correct.

5.2.1 Waimatuku Catchment

- The application provides a basic assessment of water quality in the Waimatuku Stream Catchment, primarily based on (limited) information presented on LAWA (2019). Only basic water quality details are provided for the SOE monitoring site (Waimatuku Stream at Lorneville-Riverton Highway) and basic details of ecological parameters are provided for the Waimatuku Stream at Rance Road. The assessment largely presents 5-year median concentrations for the period 2012-2017. This approach provides limited scope to assess the actual impact of land use on water quality, which is best represented by actual concentration of contaminants rather than a recent 'trend'.

  - Results for Waimatuku Stream at Lorneville-Riverton Highway predominantly indicate that surface water has been impacted by land use in the catchment. 5-year median values for key water quality parameters of *E. coli* (450 n/100 mL), Total Nitrogen (3.65 mg/L), Total Oxidised Nitrogen (3 mg/L), and DRP (0.0425 mg/L) were in the worst 25% of like sites. Total Phosphorous concentration was 0.06 mg/L. 5-year median Total Nitrogen (3.65 g/m^3) was significantly above the ANZECC Guideline value (O.44 g/m^3). These impacts are supported by additional water quality analysis presented in Section 3.1. The majority of results for Waimatuku Stream at Rance Road indicate that surface waters have been impacted by land use in the catchment. 5-year medians included an MCI score of fair (with decreasing trend); Taxonomic Richness score of 20; and median %EPT score was 4O% (decreasing).
  - The application indicated that some 5-year trends are showing meaningful improvement (e.g., nitrogen) to support the following statement "*This is significant as it indicates that N losses and related effects in the catchment may recently have started to decrease*". Although it is positive that a water quality trend is showing improvement, trends do not provide the best indication of the actual effect on water quality. An indication of the effects of land use in the catchment is best represented by actual concentration of contaminants and reference to appropriate guidelines.
  - The cumulative negative impact of land use on water quality in the Waimatuku catchment is clearly demonstrated by the monitoring results, and further supported by the following statement in the application: "*The lower catchment SOE site for the Waimatuku Stream shows evidence of land use in the catchment with high levels nutrients and contaminants dominating. This relates to the intensity of land use in the catchment, local hydrology, attenuation of nutrients and the physiographic land types found in the catchment. Artificial drainage and deep drainage to shallow aquifers, as well as the low to moderate denitrification potential of some soils and aquifers, and the lack of a major river for diluting contaminants are factors that combine to produce this outcome.*"
  - In regards to surface water quality parameters, the application omitted to indicate:
    - relevant dates for water quality reporting (e.g., reporting period was 2013 – 2017);
    - the range associated with the median values (often indicating much poorer water quality); and
    - that DRP is very likely degrading at the site.

- The application provides a basic hydrogeological context including groundwater flow direction. However, very limited groundwater information is presented.
  - An estimated 'linear velocity' value is provided and used in the following statement "*Using the estimate for groundwater movement of 0.5 to 40 m/day, land use effects on groundwater due to the WW1 and WW2 dairy platforms and prior activities such as intensive winter grazing and cereal cropping, if they are present will have been seen at the Heddon Bush School area for some time.*" However, no context for this statement is provided. Furthermore, based on hydrogeological characterisation of the catchment presented in Section 3.1, it is suggested that shallow groundwater (e.g., < 8 m BGL) will show the greatest impact of land use. Comparatively deeper bores (e.g., bore E45/0718, Heddon Bush School, 14.9 m BGL) would show the impacts to a lesser extent due to the low transit times through the shallow groundwater system.
  - The application only presents groundwater quality information from a single well in the Waimatuku GMZ (E45/0622). Evaluation of additional monitoring data would have (Section 3.1) provided a better understanding of land use impacts on water quality including increased nutrients and bacterial concentrations.

- The application indicated that three wetlands occurred in the Waimatuku Catchment, including Dunern Wetland, Bayswater Bog, and Drummond Peat Swamp. The decision to not investigate these water bodies further is supported with available information, including the location and/or hydrological characteristics of the water bodies.

5.2.2 Oreti Catchment

- The application provides a basic assessment of water quality in the Oreti Catchment, centered around information presented on LAWA (2019). Only the Oreti River at Wallacetown monitoring site is included. For completeness and a better indication of contaminant pathways through the catchment, the nearby Bog Burn and the Oreti River at Branxholme (Invercargill City water supply) monitoring sites should have been considered.
    - A basic interpretation of water quality and ecological datasets is provided. Key information includes:
        - 5-year median E. coli (130 n/100 ml) is in the worst 50% of like sites, NOF Band D (MfE, 2016),
        - Median concentrations for Total Nitrogen (1.13 mg/L) and Total Oxidised Nitrogen (0.94 mg/L) are in the worst 25% of like sites; both above ANZECC GV's of 0.514 mg/L and 0.44 mg/L, respectively
        - annual median DRP (0.006 mg/L) is in the best 50% of like sites; and
        - water quality at this site is considered "suitable for the designated use" and is regarded to have high conservation values; it is likely to have some effect on growth of up to 5% of species

- Very limited information on hydrogeology is provided in the application, and information that is provided indicates evidence of land use impacts on water quality.
    - The application indicates that "… *groundwater nitrate levels regularly exceed New Zealand Drinking Water Standard's MAV of 11.3 ppm centered at Boyle Road/Heenans Corner immediately to the south east of WW1&2 and overlying the Central Plains Groundwater Zone (see figures 5.24,5.26, 5.27]*"
    - The application presents groundwater quality information bore E45/0622 and E45/0771 in the Central Plains GMZ.

- The application provides a very basic summary of current water quality in the New River Estuary, which indicated that estuary health and water quality was declining:
    - Importantly, the application states "*Unless nutrient inputs to the estuary are reduced significantly, it is expected that there will be a continuation of these difficult to reverse adverse impacts within the estuary*".

5.2.3 Upper Aparima Catchment

- The application provides a basic assessment of water quality in the Aparima Catchment, centered around information presented on LAWA (2019). Only the Aparima River at Thornbury monitoring site is included. For completeness and a better indication of contaminant pathways through the catchment, Aparima River at Dunrobin and Aparima River at Otautau and monitoring sites should have been considered.
    - A basic interpretation of water quality and ecological datasets is provided. Key information includes:
        - 5-year median *E. coli* (130 n/100 ml) is in the worst 50% of lowland rural sites, NOF Band D
        - 5-year median TP (0.014 mg/L) and DRP (0.005 mg/L) are below the ANZECC GV's of 0.033 mg/L and 0.01 mg/L, respectively
        - 5-year median TN (0.91 mg/L) and TON (0.665 mg/L) concentrations were in the worst 50% of all lowland rural sites and above the ANZECC GV of 0.64 mg/L, and O.444 mg/L

- The application provides no assessment of groundwater quality in the Upper Aparima GMZ, other than reference to outdated nitrate data (last updated 2012).
    - "*Groundwater nitrate levels in the vicinity of the Horner Block are lower on the east side (1.0 - 3.5 g/m^3) and higher on the west side (3.5 - 8.5 g/m^3) towards the Aparima River (see figure 5.31).*" The statement is actually referring to Figure 5.33.

- The application provides a very basic description of the Jacobs River Estuary, Riverton, which indicated that water quality and estuary health was declining.
    - The application states that in the most recent survey (2013) "*there has been a significant decline in estuary quality since 2003, and especially over the past five years*". In particular, estuary health was being

impacted by excessive mud, macroalgal growths, and poorly oxygenated sediments with toxic sulphides; meanwhile adversely affecting biodiversity, aesthetic, amenity and recreational values.

Overall, water quality of the receiving environments, including Waimatuku Stream, Oreti River, and Aparima River show impacts from land use processes, including increased nutrients (e.g., NO_2-NO_3, DRP, TP), bacteria (e.g., *E. coli*, faecal coliforms), and suspended sediment, likely from land use in the catchment.

5.2.4 Waiau Catchment

- The application provides a basic assessment of water quality in the Waiau Catchment. Presentation of data for the Orauea River at Orawia Pukemaori Road monitoring site is included.
    - For completeness and an improved indication of contaminant pathways through the catchment, Waiau River at Tuatapere monitoring data could have been considered.
    - The following is an assessment of water quality data presented in the application compared to that presented on LAWA (June, 2019).
        - Water quality datasets that corresponded to data presented on LAWA included 5-year median:
            - *E. coli* (315 n/100 ml) in the worst 25% of sites
            - clarity 1.13 m
            - TON (0.415 mg/L) in the worst 50% of sites
            - DRP (0.011 mg/L) in the worst 50% of sites
        - Data presented in the application did not match LAWA records included 5-year median:
            - ammoniacal-N 0.0005 mg/L, best 25% of sites (actual 0.005 mg/L)
        - The application failed to identify 5-year medians for the following (common) parameters:
            - TP (0.0275 mg/L), worst 50% of sites
            - TN (0.73 mg/L), worst 50% of sites
    - Reference to relevant water quality standards or guidelines (e.g., ANZECC 2008; NZDWS, 2018) would have helped to put the actual condition of the water quality results (5-year median) into a wider context:
        - TN (0.73 g/m^3) was above the ANZECC GV of 0.44 g/m^3
        - TP (0.0275 mg/L) was slightly below the ANZECC GV of 0.033 mg/L
        - DRP (0.011 mg/L) was above the ANZECC GV 0.01 mg/L
        - TON: the application indicated that "… national bottom line value is 6.9 mg/L which far exceeds the 0.415 mg/L median at this site"
    - The application incorrectly indicates the following:
        - "*The water quality medians indicate that the Orauea catchment is degraded in regards E. coli, however there is a definite trend of improvement*". Verification with LAWA indicated that the trend was 'likely improving'.
        - "*The median dissolved reactive phosphorus (DRP) is below ANZECC guideline levels and is not showing an evident trend*". Had the application provided the relevant ANZECC concentration (0.01 mg/L), this would have likely prevented the incorrect statement being made since actual 5-year median was reported as 0.11 mg/L.
    - Furthermore, the applicant indicates a somewhat contradictory explanation for why DRP levels were low by stating that "*The raw data shows that DRP is low on the majority of the sampling dates, with spikes most likely occurring during rainfall events where phosphorus can be transported to surface water bodies via runoff and erosion.*" On one hand this statement supports a reasoning for why DRP concentrations are occasionally high, however it could be turned around to indicate that often DRP concentrations will be considerably greater than presented, such as during any rainfall event. This statement leads to indicating one of the greater limitations around what quality sampling, which is that the result only captures 'one point in time', rather than providing support that DRP levels were usually 'low'.
    - It is positive that a water quality trend (e.g., TON) is showing improvement, however trends do not provide the best indication of the actual water quality.

    - A measure of the effect of land use on water quality in a catchment is better represented by actual concentration of contaminants and reference to guidelines (e.g., ANZECC).
  - **The cumulative negative impact of land use on water quality in the Orauea and Waiau Catchments is clearly demonstrated by the monitoring results, which high levels nutrients and bacterial contamination.**
    - However, that application indicates "*The overall impact of the trends in nutrient concentrations is not clear at this stage, however the receiving water is considered low in relation to nitrogen and phosphorus concentrations overall.*"
    - This statement is not supported by the water quality results presented above and in Section 3.3, which clearly show that surface water in the Orauea River has been impacted by land use in the catchment, including increased nutrient and bacterial contamination.
  - **The application indicates "*There is very limited published information on periphyton extent or macroinvetebrate community status in the Orauea River, so it is difficult to assess the current status or trend in biological quality of the stream.*"**
  - **Water quality results clearly indicate nutrient concentrations and bacterial levels in the Orauea River are greater than background levels. Key factors that influence water quality in the Orauea catchment include land use intensification (including sheep, beef, and dairy farming), topography (moderate-to steep- in places), and soil characteristics. As a result, the most likely pathway for contaminants to enter surface waters is via overland flow during rainfall events.**
  - Comparatively better water quality is observed in the Waiau River (Section 3.2), likely due the extensive area of native forestry that it drains and a reduced level of land use intensification in the catchment above the monitoring site.

- **Groundwater nutrient concentrations in the Merrivale area were found to be higher than that reported in the application, and are likely impacted by land use in the catchment.**
  - Groundwater NO_3-NO_2 concentration in the Merrivale was up to 6.8 mg/L (Figure 3.19) These concentrations are considerably higher than that presented in the application, which states "*Groundwater nitrate levels in the vicinity of WRO are in the range 0.01 - 1.0 g/m^3, regarded as pristine to modern day background levels.*"
  - NO_3-NO_2 concentrations that consistently around 6 mg/L (Figure 3.19) most likely area show impacts from land use in the catchment, which is contrasting to the following statement presented in the application "*Due to a combination of the topography, depth of groundwater and drainage channels there is a low risk of nitrate accumulation in groundwater in this area. This is supported by the very low mapped nitrate levels.*"
  - Furthermore, the mapped nitrate levels presented in the application are from a dataset which has been removed from the Environment Southland portal. Limitations associated with the interpolated layer included the 'outdated' age of the data (e.g., 2007 – 2012), coarse resolution, and the low number of data points in some areas.

Overall, water quality of the receiving environments, including Waimatuku Stream, Aparima River, Orauea River, and Waiau River show impacts from land use processes, including increased nutrients (e.g., NO_2-NO_3, DRP, TP), bacteria (e.g., *E. coli*, faecal coliforms), and suspended sediment. These contaminants are likely as a result of land use intensification in the catchment.

5.3 Effects of groundwater abstraction

The application proposes that existing water permits (AUTH-301664 and AUTH-20171278-02) be replaced with a single water permit for groundwater abstraction for WW1/WW2. The application is for a maximum take of 91 m^3/day (an increase of 31 m^3/day) from bore E45/0071 and a maximum daily abstraction of 96 m^3/day (unchanged) from bores E45/0083 and E45/0727, combined. Groundwater abstraction is for use in the dairy shed and for stock drinking water.

- **Insufficient information has been provided in the consent application regarding the assessment of effects on the freshwater resources associated with the proposed abstraction of groundwater.**

  - The total proposed abstraction of 187 m^3/day from bores E45/0071, E45/0083, and E45/0727 is greater than the Environment Southland guidelines (e.g., 120 L/cow/day = 180 m^3/day).
  - Importantly, the application states "*The rate of take does not exceed 2 L/sec and should not result in more than minimal stream depletion and interference effects*" (Pg. 40). Of significance, is that a stream depletion assessment (or demonstration that there are no nearby surface waters) has not been presented in the application, nor has any aquifer test assessment been presented.
  - An increase in the abstraction of groundwater is proposed, however there appears to be no provision of data or assessment of the effects of this abstraction presented in the application. Appendix 1 of the (pSWLP, 2016) states that "*Minimum aquifer test requirements to support resource consent applications to take groundwater, other than replacement consent applications for abstraction volumes that have been occurring with no adverse effects of a more than minor scale*". Therefore, an aquifer test may be required to show the effects of increased abstraction from bore E45/007. The pSWLP (2016) Aquifer Test Requirements for < 250 m^3/day specify that (at minimum) a standard yield test comprising 2 hours abstraction at the proposed maximum rate with drawdown and recovery of water levels in the pumped bore measured at regular intervals, is required.
  - Furthermore, groundwater level monitoring from bore E46/0110 (Figure 3.5) indicates lower groundwater levels in summer, likely as a result of increased abstraction and decreased rainfall recharge during this period. The effects of increased abstraction from the aquifer should be considered in the context of effects on other users and effects on the groundwater system. Furthermore, since groundwater from the aquifer discharges as baseflow into Waimatuku Stream, the effects of abstraction on surface water quality and quantity of the stream should eb considered.

5.4 Effects of increased dairy cows and associated increased effluent discharge

The application proposes that an existing land use consent (AUTH-20171278-03, land use for expanded Dairy Farming) be replaced with a land use consent for Dairy Farming at WW1/WW2 and WRO (to only include areas used for WW1/WW2 stock). The granting of the proposed consent includes a (30%) increase in cow numbers from 540 cows to 700 cows at WW1, which is equivalent to a 10% increase in WW1/WW2. This land use consent involves an increase number of cows to be held in wintering barns to 1,250 (from 1,140). The application proposes that existing discharge permits (AUTH-301663 and AUTH-20171278-01) are replaced with a single discharge permit for WW1/WW2 to discharge effluent to land from 1,500 cows (an increase of 160 cows), and to discharge slurry from 1,500 cows to the Horner Block. Furthermore, current cow numbers for WW1 and WW2 total 10.6% of all cows in the Middle Creek sub-catchment (noting the platforms span across multiple sub-catchments), and the proposed WW1/WW2 cow numbers will total 11.7% of the catchment. Total cow numbers in the Middle Creek sub-catchment will increase from 12,622 to 12,782. This review is limited to the impacts on groundwater and surface water and does not address appropriateness or capacity of on-farm systems (e.g., effluent systems, storage ponds, dewatering, composting, liquid effluent holding, spreading systems).

5.4.1 Groundwater and surface water quality

- **Potential effects on groundwater and surface water quality include an increase in total amount of effluent discharged into the receiving environment, due to the increase in cow numbers and the trade-offs between removal of diffuse source discharge from IWG to effluent discharge via FDE application.**
  - The applicant is proposing to house the current and additional cows in wintering barns. This operation results in the reduction of diffuse source contaminants (e.g., bacteria and nutrients from intensive winter grazing) since effluent (slurry) will now be collected at a point source (e.g., shed sump). Although collection of slurry (effluent) to a point source is an improved operational procedure likely to result in reduced effects on surface and groundwater quality, the applicant proposes to discharge this slurry (effluent) back onto land. Discharge of effluent and slurry creates a new diffuse source of potential nutrient and bacterial contamination and poses a risk to the shallow groundwater system and downstream surface water systems.
  - Houlbrooke and Monaghan (2009) report that results from a literature review on land-application of FDE and its effects on water quality, indicate between 2 - 20% of nitrogen and phosphorus applied in FDE is lost either in runoff or via leaching. Therefore, it is likely that (even if BMP's are followed) an increase in the nitrogen and phosphorus in the receiving environment is likely to occur. The proposed increase in

    cow numbers will result in an increased total volume of effluent to be discharged, and an increase in the application rate (e.g., from 166 kg/N/ha/yr to 250 kg/N/ha/yr). Therefore, this will result in an increase in the total nutrients applied to the catchment with associated impacts on surface water and groundwater. Groundwater quality of the Waimatuku and Central Plains aquifers show impacts from land use processes, including increased nutrients (e.g., NO_2-NO_3, TP) and bacteria (e.g., *E. coli*, faecal coliforms).
    - Careful consideration as to whether the removal of IWG (and associated urine patches, strip grazing) outweighs the effects of additional cow numbers (particularly on waterlogged soils) is required. To have a positive impact on water quality, the applicant must adhere to all relevant BMP's, particularly around application of effluent. Additional effluent will be generated from April/May to September when soils in the region are generally at or above field capacity. Systems to store all of the liquid effluent/sludge and apply it only once the soils have fallen below field capacity are essential.

- **Nutrient losses from WRO operations have not been calculated, so the actual effects on Fenham and Merry Creeks and local groundwater systems is unable to be determined based on information presented in the application. Farming activities on WRO include intensive winter grazing, which the applicant states are "…*responsible for more than 90% of the water quality issues in Southland*". Therefore, there will be adverse water quality effects on local surface water, including bacterial and nutrient contamination, and likely increased sediment, which will flow downstream into the Waiau River. Of significance, is that the application indicates IWG at WRO will increase from 52 ha (2018) to a maximum of 100 Ha. The local groundwater is showing impacts from land use including increased nutrients (Section 3.3).**
    - Due to limitations of Overseer, the estimated nutrient loss values should be considered as conservative. It is unknown what proportion of N loading will contribute impacts on surface waters or groundwater, which will be a combination of effects of weather events (e.g., rainfall intensity, total rainfall, and land management). In addition, the Overseer model takes into consideration all mitigation measures and management practices undertaken on-farm. If any of these measures are not followed or a breached, then the actual nutrient losses to the environment are likely to be greater than estimated.

- **FDE (effluent and slurry) discharge will increase cumulative effects on surface and groundwater quality in the receiving environments through predicted nitrogen losses of between 19 – 40 kg/N/Ha/yr (*c.* 23,400 kg/N/yr), and 0.1 – 0.7 kg/P/Ha/yr (380 kg/P) (Duncan, 2019).**
    - Discharge of 150 kg/N/Ha/yr to WW1 and WW2 discharge areas; and 250 kg/N/Ha/yr on Horner Block result in an estimated nutrient loss of 40 kg/Ha/yr and 19 kg/Ha yr, respectively, of nitrogen to the receiving environment (Duncan, 2019). Due to limitations of Overseer, this value should be considered as conservative. It is unknown what proportion of N loading will contribute impacts on surface waters or groundwater, which will be a combination of effects of weather events (e.g., rainfall intensity, total rainfall, and land management).
    - The application does not provide an effluent discharge area from WW1 to the Horner Block, it simply states "*WW1's discharge area includes most of the milking platform and another part of the Horner Block.*" The actual area of discharge should be identified, particularly considering discharge of FDE from additional farms (e.g., WW3) is undertaken on Horner Block.

- **The local groundwater shows evidence of land use impact on water quality, particularly nitrate-nitrogen (NO_3-N) of 0.1- 11.3 mg/L.**
    - The application states "*A series of nitrate concentration bands are mapped with the lowest groundwater nitrate levels at the west side (0.1 - 0.4 mg/L) and the highest to the south east (modelled >11.3 mg/L). Most groundwater underlying WW1&2 has nitrate levels of 3.5 - 8.5 mg/L, indicative of moderate to high land use impacts.*" Given that the farms are in the very north of the Waimatuku GMZ, it is likely that the land use of the property has contributed to the observed increased NO_3 in the local groundwater system.
    - The following statement provided in the application is contradictory "*The applicants believe that their presence at this location since 1992 (over 25 years) has not had a detrimental effect on the local environment, and that the proposed changes will mean a further reduction of that impact.*"

- Water quality results for bore E45/0622 indicates land use impacts on water quality, including elevated NO_3-N and bacterial contamination.
    - NO_3-N concentration in natural water is generally very low (e.g., < 0.5 mg/L). The application indicates that "… *Except for one outlying result, groundwater nitrate levels at the WW1 bore (E45/06221 are generally low (< 3.5 g/m^3) since 2015*". Actual, NO_3-N concentration ranges from 0.003 - 15.40 mg/L with an average concentration of 3.6 mg/L (Figure 2.4). A NO_3-N concentration of 3.5 mg/L should not be considered "low".
    - *E. coli* levels in bore E45/0622 has ranged from < 1 – 350 MPN (Figure 2.4).
    - Overall, the water quality results from bore E45/0622 indicate that land use processes are affecting shallow groundwater quality at this location.
    - The following statement in the application is not supported "*The E.coli data from the WW1 bore (E45/0622) are flawed due to localised contamination relating to poor well design; this may have been the case for some other bores in the area also. In these situations, rainfall washes organic material including microbes, close to the bore site down into the well. This causes localised contamination and disappears beyond the zone of reasonable mixing. In the case of the WW1 bore, some decaying birds/rodents in the well may also be responsible for some contamination, which has been observed by the applicants in the past. Since the WW1 bore is likely to suffer frequent localised microbial contamination, E.coli data from samples collected at the well are dubious and unlikely to reflect wider groundwater quality. For this reason, the WW1 bore has been excluded form figure 5.34*"

- The application indicates "*Groundwater nitrate levels south of WW1&2, overlying the Waimatuku Groundwater Zone, are generally low, in the range of 0.01- 8.5 g/m^3*". It is inappropriate to indicate that nitrate levels up to 8.5 mg/L are to be considered "low" since: background nitrate concentrations for the Waimatuku Aquifer are likely to have been < 0.5 mg/L, as demonstrated by bore E46/0110 (Figure 3.2); and these values are close to the MAV for drinking water of 11.3 mg/L (MoH, 2018).

5.4.2 Soil moisture

- The application presents insufficient information on how soil moisture levels are determined. Furthermore, actual soil moisture datasets from Heddon Bush (Glenelg soils), indicate soil is predominantly above field capacity (*c.* 65% water filled pores) during the period June – August. If discharge occurs during these months, there is a likelihood of impact on surface and/or groundwater receiving environments as runoff and leaching processes will likely occur.
    - The application states that "*Effluent application, including both liquid effluent and slurry, is deferred if soil moisture levels are too high to safely and correctly apply effluent. Effluent is only applied when there is a ground moisture deficit and when effluent application will not induce drainage.*" There is no indication of; the number of days that deferred application (e.g., continued storage) can be accounted for, or for how soil moisture levels and/or ground moisture deficit are determined. The application simply refers to use of 'Environment Southland soil moisture levels' but does not account for how these are used to determine application rates and/or timing.
    - The application states, with regards to discharge at Horner Block "*Slurry is applied at very low depth using slurry tanker with trailing shoe (less than or equal to 2.5 millimetres per application), when there is sufficient soil moisture deficit and nil risk of drainage*". When applying FDE (effluent and/or slurry) there is always some risk of drainage and/or overland flow occurring, so it would be inappropriate to say "nil risk". In addition, no indication of what is 'sufficient soil moisture' or how that is measured, has been provided.
    - Soil moisture levels for the Heddon Bush monitoring site indicate that the soil is predominantly above field capacity (*c.* 65% water filled pores) during the period June – August (Table 4.1; Figures 4.1 and 4.2). During this period, any irrigation of effluent or discharge of slurry is likely to promote soil drainage to shallow groundwater and/or surface water runoff to occur.
    - The application states "*The authorised discharge method at WW1 includes land disposal methods limited to maximum application depths of 10 mm and 5 mm per application*". If the discharge occurs

during winter, when soil moisture content is high, it is likely that surface runoff and/or leaching to groundwater will occur.

- Regarding discharge of slurry at the Horner Block, the application indicates that for 243 kg/Ha/N/yr, Overseer predicts an annual N-loss of 19 kg N/hectare. This loading would be considerably greater if soil cracking occurs (e.g., in Braxton soils), if any leaching was promoted through high soil moisture content, and if any overland flow occurred. The 19 kg N/Ha should be considered as a minimum N loss for the Horner Block.
- The application states "*It is unlikely that the discharge of slurry at the Horner Block will result in elevated groundwater nitrate levels. Due to soil types (Drummond and Waiau) and their drainage properties (matrix flow), much of the HB classed as low risk for effluent discharge. So long as slurry is applied at a depth lower than the soil moisture deficit and at less than 50% of PAW, there is minimal risk of nitrate loss to groundwater from low risk soils, as supported by Houlbrooke et al. (2006).*" However, water quality results from bore E45/0622 directly downgradient of the property show impacted groundwater. NO_3-N concentration ranges from 0.003 - 15.40 mg/L, with an average concentration of 3.6 mg/L (Figure 3.4). *E. coli* levels in bore E45/0622 has ranged from <1 – 350 MPN (Figure 2.4). Overall, the water quality results from bore E45/0622 indicate that land use is affecting shallow groundwater quality at this location. The impact is to an extent that NO_3-N is considerably above the NZDWS MAV of 11.3 mg/L (Ministry of Health, 2018).

5.5 Potential effect on drinking water supplies

- **The groundwater supply at Heddon Bush School is currently of sufficient quality to meet the New Zealand Drinking Water Standards and currently shows no bacterial contamination.**
  - As indicated in the application, regular water quality results for Heddon Bush School show that bacterial parameters including *E. coli*, faecal coliforms, and enterococci were consistently reported as 'absent' or below detection level (<1.0 cfu/100 mL).
  - However, groundwater samples for Heddon Bush School show likely impacts from land use processes including elevated nutrients (e.g., NO_3-N) of 2.33 mg/L and a total coliform count of 3 cfu/100 mL (Table 2.5). It is important to note that the bore depth has been increased (2017) and is relatively deep for the area. Concentration of NO_3-N is expected to be considerably higher in the shallow groundwater system due to greater connectivity to the land surface.
  - Although the NO_3-N concentration is considerably below the NZDWS MAV of 11.3 mg/L (Ministry of Health, 2018), it is recommended that water quality monitoring be undertaken (e.g., annually, quarterly) to determine if there is an increasing trend in NO_3-N concentration. Furthermore, capture zone modelling of the bore could be undertaken to determine the likely land surface area that is contributing recharge to the bore. Appropriate land use practices and mitigations could be implemented to ensure on-going security of the groundwater supply.

- **Groundwater supplies including Otautau township and Drummond School are unlikely to be affected by the proposed consent activities due to the distant location of these abstractions.**

- **Activities proposed in the consent application will result in a cumulative effect on surface water quality in the Oreti River catchment. Therefore, the proposed activities will cumulatively effect water quality of the Invercargill City water supply from the Oreti River.**
  - Water quality results for the Branxholme Water Supply (Oreti River) were highly variable, with (at times) considerable bacterial contamination, albeit with relatively low nutrient concentrations (Table 3.3). Contamination of surface water, particularly by *E. coli* and faecal coliforms, is the result of cumulative land use processes in the upper catchment, including land where the applicant proposes to discharge FDE. It is understood that the treatment provided at the plant is sufficient to remove bacterial contamination.

5.6 Insecure wellhead

The applicant should secure the wellhead of bore E45/0622 to prevent any further (potential) contamination of the local groundwater system. The current state of the wellhead may also have implications for operation of the bore under Environment Southland policy.

- Poor wellhead protection is a significant issue in the Southland Region. Inappropriate location, construction and maintenance of bores and wells can lead to localised groundwater contamination, particularly in regards to bacterial and nutrient concentrations.
- The application states "*The WW1 bore* (E45/0622) … *used to monitor WW1's groundwater quality was not drilled as a monitoring bore; it is an old domestic well. It comprises a 90 cm vertical concrete pipe with a hole in the side to let the alkathene through. It is possible for birds or rodents to enter the well along the pipe, fall in and drown, which has happened in the past. Furthermore, the well's top pipe is flush with ground level, and soil in the vicinity has high organic matter content from long grass and woody shrubs in the area. Due to its design and unprotected nature, it is likely to experience frequent localised contamination especially during/following heavy rainfall, as surface water can flow down into the wellhead carrying organic material with it. If decaying birds (starlings) or rodents are in the well, these also will cause localised contamination.*"
- Minimum recommended protection features include installation of a bore casing (e.g., 500 mm above land surface) a sloping concrete pad (e.g., 1 m x 1 m); and fencing off the well head (e.g., 2 m x 2 m animal-proof fence).

Results for bore E45/0622 should continue to be used as representative of land use impacts in the vicinity of WW1 and WW2 within the upper Waimatuku Catchment.

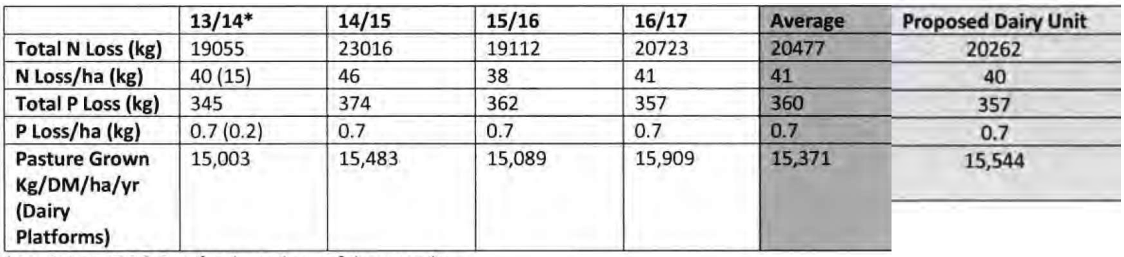
- The application states the following regarding bore E45/0622: "*Given these factors* (regarding wellhead protection mentioned above)*, the WWI bore is unsuitable for use as a monitoring bore, and data collected from the well may be unlikely to reflect wider groundwater quality. This is particularly the case for E.coli data, which will be more corrupted than nitrate data from localised contamination.*"
- However, A step-by-step protocol for the collection of groundwater samples in New Zealand applies to SOE monitoring (MfE, 2006). Although the protocol is a best practice tool rather than a mandatory requirement, Environment Southland follow the protocol for all groundwater sampling in the region. A key requirement of the sampling protocol is to purge (e.g., pump groundwater from) the sampling bore until three times the (casing) storage volume has been removed. The aim of this procedure is to ensure that the groundwater sample collected is representative of groundwater in the local aquifer, rather than any 'sitting' or 'stagnant' water held in the bore screen and/or casing. Even if bore E45/0622 potentially receives contamination water quality results will likely represent the aquifer from which the sample was taken (e.g., Waimatuku).
- Furthermore, irrespective of consideration of wellhead security and sampling protocols, the water quality results are still likely to be representative of the localised effects of the farming activity on the shallow groundwater system.

6.0 Assessment of cumulative effects

The assessment of cumulative effects largely relies on modelled outputs from Overseer. Limitations of the model with relevance to the accuracy of the output are not adequately described, which places a far greater uncertainty on the modelled results reflecting actual losses from the proposed activities. These results are then used to calculate the proportional percent of loading onto the New River Estuary, follow a reasonable method. However, the conclusion that there will be 'minimal' effects is not supported in regards to consideration of the current (very poor) condition of the New River Estuary. Again, the calculation of loading to Waimatuku catchment is based on Overseer outputs, but follows a poor method with a high level of uncertainty. The conclusion that there will be 'minimal effect or improved water quality' is not factually supported. A significant omission from the cumulative effects' assessment is that there is no consideration of the effects from proposed activities at the Horner Block. A considerable amount of effluent/sludge is discharged at this Horner Block (250 kg/N/Ha/yr) which is likely to have significant impact on surface and groundwater environments. In addition, there is no assessment of cumulative effects mentioned regarding the proposed increase in groundwater abstraction.

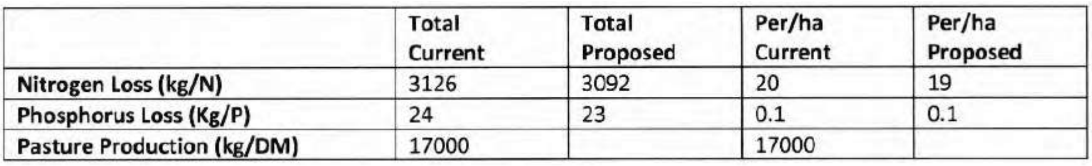
6.1 Overseer modelling

The assessment off effects presented in the application largely relies on results of Overseer modelling which showed a decrease in nutrient loss under the proposed consent activities on WW1 and WW2, when compared to the current activities (Figure 6.1). The primary drivers for the decrease in nitrogen loading included: removal of winter and summer crop; removal of cows wintered outside on crop or grass; expansion of the size and use of the wintering barn facilities; more efficient use of nitrogen fertiliser (Duncan, 2019). Primary drivers for a reduction in P loading included: decrease in winter crop area; maintaining Olsen P at a target level of 30; expansion in the size and use of the wintering barn facilities (less wintering) (Duncan, 2019). The Overseer modelled outputs are provided for WW1 and WW2 (Figure 6.1) and for the Horner Block (Figure 6.2).



	13/14*	14/15	15/16	16/17	Average	Proposed Dairy Unit
Total N Loss (kg)	19055	23016	19112	20723	20477	20262
N Loss/ha (kg)	40 (15)	46	38	41	41	40
Total P Loss (kg)	345	374	362	357	360	357
P Loss/ha (kg)	0.7 (0.2)	0.7	0.7	0.7	0.7	0.7
Pasture Grown Kg/DM/ha/yr (Dairy Platforms)	15,003	15,483	15,089	15,909	15,371	15,544

Figure 6.1: Modelled results for five scenarios of Overseer nutrient budget for the proposed activities on WW1 and WW2. Source: Duncan (2019)



	Total Current	Total Proposed	Per/ha Current	Per/ha Proposed
Nitrogen Loss (kg/N)	3126	3092	20	19
Phosphorus Loss (Kg/P)	24	23	0.1	0.1
Pasture Production (kg/DM)	17000		17000	

Figure 6.2: Modelled results for current and proposed Overseer nutrient budget scenarios for the proposed activities on Horner Block. Source: Duncan (2019)

Although Overseer is useful at modelling long-term average nutrient losses of farming systems there are several important limitations relevant to this assessment. These include, but are not limited to, the ability of the model to: indicate the routing of (or percentage) of nutrient loss to water resources (e.g., to surface water or groundwater); to predict transformations, attenuation or dilution of nutrients between the root zone and the receiving water body; and represent particular soil types (e.g., Braxton soils) due to the macropore flow pathways. As a result, the following statement in the application is supported:

- The application states "*By quantifying nutrient losses below the root zone Overseer is a starting point, with knowledge of soil processes, drainage, hydrology, receiving waters and various farming practices also used to assess effects from additional cows over and above what is in place*."
- The applicant continues with the following explanation "*By using the same tool (Overseer) to quantify nutrient losses below the root zone for the proposed and pre-expansion systems, consistency is maintained across the analysis and associated assessment of effects. Any limitations of Overseer, such as potentially underestimating N loss from Braxton soils, will occur in all nutrient budgets. This should ensure that comparisons made between respective systems are valid and relative differences are real.*"
- This statement is correct for both instances where the actual loss from the activity is greater than modelled, and also for instances where the actual loss from the activity is less than modelled. In the instance the Overseer has underrepresented the nutrient loss, the effects on the receiving environment could (potentially) be considerably greater than predicted.

6.2 Receiving environment

The approximate location of WW1, WW2, and Horner Block are shown in the context of the main river catchments in Southland (Figure 6.3). Snelder and Ledgard (2014) used a combination of land use distribution, land use intensity, and physiographic information to estimate nutrient losses to water for much of the agricultural land in Southland.

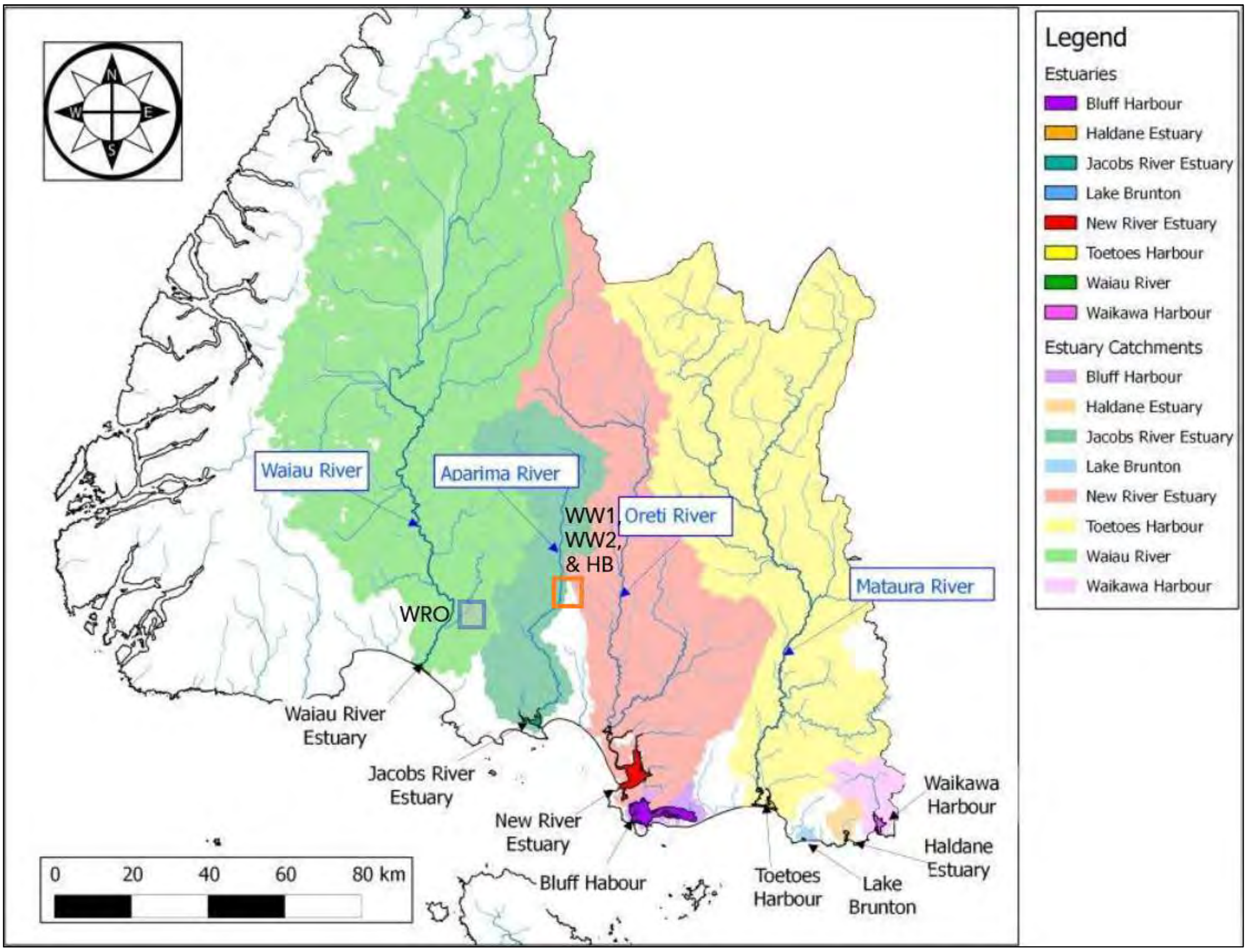


Figure 6.3: Approximate location of WW1, WW2, and Horner Block (orange box) and WRO (blue box) in the context of the main Southland surface water catchments and estuaries. Source: modified from Snelder and Ledgard (2014).

Overall, the approach taken with the assessment of cumulative effects, following information presented in Snelder and Ledgard (2014) is relatively sound. Calculation of loading is based on a method that is likely to provide a reasonable estimate of the actual effects of the activities on the receiving environment, based on current knowledge. However, limitations of the approach are not taken into consideration.

- The application has based the calculation of percentage loading into the Oreti / New River Estuary using catchment area (4,314 km^2); land use (55% intensive pasture, 14% low producing pasture, 20% native forest, and 9% exotic forest); land area of the properties (e.g., 194 Ha WW1 and WW2 in the Lower Oreti catchment); to determine that the farm covers *c.* 0.04% of the total catchment area.
- The application subsequently estimates N and P loading based on Overseer analysis:
    - "*Approximately 8,959 kg N/year may be lost from 194 hectares of land at WW1&2 mapped in the Lower Oreti catchment…". "Assuming an attenuation rate of 33% from the above table, approximately 5,967 kg N/year could over time end up in receiving waters. This amounts to <u>0.16%</u> of the estimated realised N load for New River Estuary catchment."*
    - "*126 kg of P … may be lost annually from 194 hectares of WW1&2 that lie in the Oreti/New River Estuary catchment…. This amounts to <u>0.09%</u> of the current catchment agricultural source P load in New River Estuary catchment.*"
    - Limitations with this approach are considerable, including those previous described regarding the Overseer nutrient budget. In addition, the calculations used above are not likely to be conservative.

The assessment conclusion for New River Estuary (e.g., effects will be 'minimal') is not supported by facts. The activities proposed in the application will certainly impact on water quality in the New River Estuary, and due to the poor condition of the estuary, potentially have considerable impact. Any nutrient loading into the estuary is likely to have an adverse effect on the receiving environment, particularly based on the current state of the estuaries.

- The assessment concludes with the following "*Both estimates show that the farming activity at WW1&2 contributes a very small proportion of the nutrient (N and P) loading to New River Estuary catchment and represents a very small proportion of total nutrient load in that catchment. It follows that cumulative effects from the activity will be minimal."*
- It is essential that the condition of New River Estuary be considered before determining the level of effect from the proposed activities to be 'minimal'. New River Estuary is in a poor condition due to major nutrient enrichment and sedimentation issues which effect water quality and ecological condition. Given that the estuary is in poor condition and a primary stressor is nutrient enrichment (e.g., from freshwater inflow), the contribution of both N and P from WW1 and WW2 farming operations (although comprising a small %) could be considered as significant and exacerbating in their contribution to the poor condition status.
- Furthermore, the estimated nutrient loadings of 0.16% (N) and 0.09% (P) are considerably greater than the proportion of landcover 0.04% of the farm within the catchment. This indicates that that WW1 and WW2 are having a greater effect on the receiving environment than other land uses within the catchment.

The approach taken for assessment of cumulative effects on the Waimatuku Estuary is unreliable, due to there being no known 'total load estimate' available. An estimate of 1.2% was provided (based on farm area within the catchment), however the limitations of which are extensive and have not been addressed in the application.

- The following method was used to estimate nutrient loss for the Waimatuku Catchment:
    - "*..approximately 10,420 kg N/year may be lost from 306 hectares of land at WW1&2 mapped in the Waimatuku catchment*" … "*Assuming an N attenuation rate of between 33% (New River catchment) and 39% (Aparima catchment) somewhere in the region of 6,775 kg of N/year may end up in the Waimatuku, either directly from drainage to surfacewaters or via groundwater discharge*".
    - "*230 kg of P … may be lost annually from 306 hectares of WW1&2… Due to adsorption and attenuation of P, much of this will be taken out of solution.*"

The application concluded that the actual N and P losses to the Waimatuku catchment are unknown (since they have not been calculated), but that since the farm covers 1.2% of the catchment, then this would be an approximate percentage loading. However, it is likely that the actual loading to the estuary could be greater than this when considering the results of estimated nutrient losses for the other farms.

- *"What contribution this makes to the total N load in the Waimatuku catchment is unknown (since the total N load has not been calculated) but it may be similar or somewhat greater than 1.2%, which is an estimate of WW1&2's proportion of the total catchment land area."*
- When compared to the proportional farm area of the catchment (0.04%), estimated nutrient losses from the farming activities to New River Estuary were approximately four times greater (than the proportional area) for nitrogen (e.g., 0.16%), and just over two times greater (than the proportional area) for phosphorous (0.09%). Based on similar land use coverages in the Oreti and Waimatuku catchments, it is unlikely that nutrient loss from the farming activities in the Waimatuku Catchment will contribute less than 1.2% of the total (unknown) nutrient loss to Waimatuku Estuary.

The conclusion of the assessment does not accurately present the condition of the receiving environment. Rather, farming practices on WW1 and WW2 are likely to contribute a considerable impact on water quality in the Waimatuku Stream, due to the demonstrated losses of N and P from Overseer analysis.

- The assessment conclusion that "*water quality in Waimatuku catchment to be maintained if not improved… supported by an improving trend over the last two consecutive years for N in the lower Waimatuku catchment".*
  - This statement is not supported by water quality results presented in Section 3.1, which indicate that land use processes in the catchment have had a considerable impact on the water quality of Waimatuku Stream and shallow groundwater, with elevated N and P concentrations.
  - Furthermore, Waimatuku Stream has been impacted by bacterial contamination, which increases in a downstream direction. The most likely source of bacterial contamination is from land use in the catchment, including dairy farming and sheep and beef grazing. The Waimatuku Stream monitoring location regularly does not meet the national bottom line for *E. coli* (<1,000 cfu/100mL) indicating meaningful improvement in the water quality is required in the future if the NOF is to be achieved under the NPS-FM (2014).

- **A significant omission in the application is that there is no demonstration of the cumulative effects of the proposed activities on the Horner Block. Proposed activities include discharge of 250 kg/N/Ha/yr of slurry/effluent onto the Horner Block. Since this volume is significantly greater than the 150 kg/Ha/yr identified as GMP, the nutrient loss from the application of slurry/effluent is more than likely to impact on the receiving environment. An assessment of the effects on water quality in the Waimatuku Catchment, Aparima River, and downstream environment from effluent discharge on the Horner Block should be presented.**
  - The application proposes to discharge slurry from WW1/WW2 onto 97 ha of the Horner Block at a rate of 250 kg/N/ha/yr, which equates to a total discharge of 24.25 t/N/yr.
  - An assessment of the N and P loss would need to be calculated using Overseer.

7.0 Limitations and assumptions

The application states that WW1, WW2, Horner Block and WRO are operating (where available) under current Best Management Practices and at Mitigation Level 3. Any instance where these mitigation measures are not followed will result in an increase of nutrient, sediment, and/or bacterial loss to the receiving environment. As a result, the effects of the activities on water quality of groundwater and surface water resources will be increased. Furthermore, any breach of these measures will considerably affect the modelling nutrient loadings estimated using Overseer.

There is inconsistency in the peak stocking numbers used for WRO. It is suggested that stocking numbers be presented with more clarity and justification so that variation (or lack of) in stocking rates could be accounted for:

  - Pg. 18: peak stocking numbers are described (in the table) for 2018/2019 as 1265 R1 and 1265 R2;
  - Pg. 22, "*The grazing of 1255 R1 and 1265 R2 stock plus a small number of additional mating bulls in the 2017/2018 season*"

The following should be addressed by a suitably qualified professional as part of the consent application review process as they are outside the area of expertise of the author.

- The effect of effluent discharge on physical soil properties.

- Whether effluent storage is sufficient to support expected durations of 'deferred irrigation' based on high soil moisture levels and necessity to store effluent for longer time periods (e.g., until suitable soil conditions). The application states "*No change in effluent storage is proposed. According to the Massey DESC, the 90% probability volume for 1,500 cows including wintering barn effluent and silage leachate is 6,460 m*^{3}*. The existing storage capacity is 8,032 m*^{3}*, so is sufficient to meet the above requirements. The wintering barns will house a maximum of 1,25O cows despite having capacity for 1,28O. Two separate DESC reports have been run, one each for the WW1 and WW2 units respectively. This ensures that each unit has enough storage for its operation.*"
- The approach used in modelling nutrient losses with Overseer, in particular selection of farm management scenarios. Overseer has been applied in this application in some instances (e.g., WW1 and WW2) and omitted in others (e.g., WRO), without reasonable justification (even though IWG is increasing from *c.* 52 – 100 Ha at WRO.

8.0 Closing statement

The consent application is substantial in magnitude, comprising 165 pages + appendices including nutrient budget analysis, farm environmental management plans, and water quality results. However, actual content provided in the application is limited in addressing the actual effects of the proposed activities. For example, description of current water quality in the receiving environment is very limited and although substantial datasets are available these are not presented or considered. The lack of background information on the receiving environment allows for a weak discussion of how the proposed activities will affect the receiving environment. Even so, the limited data presented clearly indicated that the current water bodies have been impacted by land use, yet the application repeatedly stated that there would be less than minor impact, or even an improvement in water quality. Environmental data presented in the application and supplementary datasets presented in Section 3.0 of this report clearly indicate that the groundwater, surface water, and estuarine environments have been impacted by land use in these catchments. On occasion, the application uses flawed logic (e.g., to dismiss water quality results) meanwhile indicating that an (known) insecure wellhead causing groundwater contamination exists on the property (E45/0622).

The application relies heaving on the modelling estimated from Overseer and omits to place a level of uncertainty around the estimated nutrient loadings, which could be considerable. Even so, operation of proposed activities on WW1, WW2, and Horner Block will likely result in a minimum of 23,300 kg/N and 390 kg/P lost to the environment. Based on the hydrology of the catchments, these nutrient loadings are likely to affect a combination of surface water and shallow groundwater resources. Some extent of bacterial and sediment contamination of surface water is likely to occur due to shallow drainage and rainfall intensity. The application states that WW1, WW2, and Horner Block are operating under current BMP's and at Mitigation Level 3 (the highest level). Any instance where these mitigation measures are not followed will result in an increase of nutrient, sediment, and/or bacterial loss to the receiving environment. As a result, the negative effects of farm operations and activities on groundwater and surface water resources will be increased.

In addition to the above, significant omissions in the application include:
- No assessment of the effect of increased abstraction from bore E45/007;
- No cumulative effects assessment on the receiving environment for proposed activities on the Horner Block;
- No cumulative effects assessment on the receiving environment for exported activities on WRO; and
- No description of how soil moisture management is actually implemented or how relevant soil moisture data is used to determine current soil conditions to ensure effects of FDE application are minimised.

9.0 References

Beyer, M., 2017. Improved regional recharge estimates through updated (Rushton) model. Report prepared for Environment Southland Regional Council.

Duncan, C., 2019. Nutrient Budgets/Analysis, WW1, WW2, SH96 & Marcel Block (Supplementary Report - Horner Block). Cain Duncan, Farm Source, Sustainable Dairying. 100p.

Environment Southland, 2019. Environment Southland Regional Council. Corner North Rd &, Price St, Waikiwi, Invercargill 9810. Data requests submitted to datarequest@es.govt.nz and information obtained from the www.eis.es.govt.nz.

Hitchcock, M. 2014. Characterising the surface and groundwater interactions in the Waimatuku Stream, Southland (Thesis, Master of Science). University of Otago. Retrieved from http://hdl.handle.net/10523/5087

Hamilton, E., 2019. Esther Hamilton, Principal, Heddon Bush School. Personal communication, phone call (03-236-1144) and email (principal@heddonbush.schoool.nz). Last contacted, 25 June, 2019.

Legg, N., 2019. Woldwide Farming Group: Woldwide One Limited and Woldwide Two Limited Resource Consent Application, submitted to Southland Regional Council. Application prepared on behalf of applicant by: Dairy Green Ltd., 10 Kinloch Street, PO Box 5003, Waikiwi, Invercargill, 9843. 164p + Appendices.

Lovett, A., 2019. Review of Resource Consent Application by Woldwide Four Ltd. and Woldwide Five Ltd. Earth & Environmental Science Report 2019/03, prepared for Environment Southland Regional Council. 51p.

Ministry for the Environment, 2006. A National Protocol for State of the Environment Groundwater Sampling in New Zealand. Ministry for the Environment, Manatū Mō Te Taiao PO Box 10-362, Wellington, New Zealand ISBN: 0-478-30112-X, ME number: 781.

Ministry for the Environment, 2016. A Guide to Identifying Freshwater Management Units Under the national Policy Statement for Freshwater Management 2014. Wellington: Ministry for the Environment. Manatū Mō Te Taiao, Wellington.

Ministry for the Environment, 2019. Climate change projections for the Southland region. Home > Climate change > Likely impacts of climate change > How could climate change affect my region? http://www.mfe.govt.nz/climate-change/how-climate-change-affects-nz/how-might-climate-change-affect-my-region/southland. Accessed 04/07/2019.

Ministry of Health, 2018 Drinking-water Standards for New Zealand 2005 (revised 2018). Wellington, Ministry of Health. 120p.

Nicol, S., and Robertson R., 2018. The Regional Forum - Southland Context. Report prepared by Southern Land and Water Planning Ltd for Environment Southland. 92p.

NIWA, 2017. Climate change scenarios for New Zealand. Our-science > climate > information and resources https://www.niwa.co.nz/our-science/climate/information-and-resources/clivar/scenarios. Accessed 04/07/2019.

NPSFM, 2014. National Policy Statement for Freshwater management 2014 (updated 2017). Ministry for the Environment, Wellington. 47p.

pSWLP 2018. Proposed Southland Water and Land Plan, Decisions Version, 4 April 2018. Environment Southland Regional Council.https://www.es.govt.nz/Document%20Library/Plans,%20policies%20and%20strategies/Regional%20plans/Southland%20Water%20and%20Land%20Plan/Proposed%20Southland%20Water%20and%20Land%20Plan%20-%20Part%20A%20-%20Decisions%20Version%20(4%20April%202018)%20PDF.pdf

Robertson, B.P. and Robertson, B.M. 2018. Waimatuku Estuary: Fine Scale Monitoring and Macrophyte Mapping 2018. Report prepared by Wriggle Coastal Management for Environment Southland. 29p.

Snelder, T and Ledgard, G. (2014). Assessment of Farm Mitigation Options and Land Use Change on Catchment Nutrient Contaminant Loads in the Southland Region. Prepared for Southland Regional Council, Report No C13055/04, March 2014, Christchurch / Invercargill.

Stevens, and Robertson, 2013. Jacobs River Estuary Broad Scale Habitat Mapping 2012/13. Wiggle Coastal Management.

Stevens, L.M. 2018. Jacobs River Estuary: Broad Scale Habitat Mapping 2018. Report prepared by Wriggle Coastal Management for Environment Southland 53p.

BEFORE THE COMISSIONER APPOINTED BY

THE SOUTHLAND REGIONAL COUNCIL

In the matter	The Resource Management Act (RMA, 1991)
And	
In the matter of	A Resource Consent Application to include land use, water use, and discharge permits
By	Woldwide One Limited and Woldwide Two Limited (Applicant)

STATEMENT OF EVIDENCE OF ABIGAIL PATRICIA LOVETT

FOR SOUTHLAND REGIONAL COUNCIL

9 September 2019 (revised)

INTRODUCTION

1. My name is Abigail Lovett and I am the Lead Scientist and Director of Earth & Environmental Science Limited.

2. I have obtained a Bachelor of Science Honours Degree (BSc Hons) awarded in First Class and a Master of Science Degree (MSc) completed with Distinction from the University of Otago, New Zealand.

3. I have more than 10 years' experience working in hydrogeology and hydrology research and consulting, predominantly in New Zealand.

4. I have spent a considerable amount of that time researching and applying methods for characterisation of water resources, including water quality and water quantity. These investigations have predominantly been initiated to understand the hydrological environment to allow for improved resource management, including water allocation, impacts of land use (e.g., waste water treatment plants disposal, intensification of agriculture), and groundwater – surface water interaction.

5. I have been a member of the New Zealand Hydrological Society since 2010 and I am currently serving as an executive member. I am an Associate member of the New Zealand Institute of Primary Industry Management (NIZIPIM).

SCOPE OF EVIDENCE

6. I have developed this evidence based on a review report that I prepared for the Woldwide One Ltd. and Woldwide Two Ltd. consent application (Lovett, 2019a). In several instances, additional information was presented in my review to better inform the assessment of effects from the proposed activities.

7. The applicant lodged new information with Environment Southland on 23 August in a document titled "Water quality assessments: Woldwide One Limited and Woldwide Two Limited & Woldwide Four Limited and Woldwide Five Limited" (Freeman, 2019). Overall, Freeman (2019) provided a much-improved assessment of water quality. A supplementary report was prepared to address any new information provided by Freeman (2019) in the context of the review previously prepared by Lovett (2019a). This statement has been then been revised to address additional information that was lodged.

8. All information referred to in this statement has been presented in the appended reports:
   Lovett A., 2019a. Review of Resource Consent Application by Woldwide One Ltd. and Woldwide Two Ltd. Earth & Environmental Science Report 2019/02, prepared for Environment Southland Regional Council. 55p.
   Lovett, A., 2019b. Supplementary response report for Woldwide One Ltd. and Woldwide Two Ltd., and Woldwide Four Ltd. and Woldwide Five Ltd. consent applications. Earth & Environmental Science Report 2019/02, prepared for Environment Southland Regional Council. 12p.

9. This evidence is specifically related to the impacts of the proposed consent application from Woldwide One Limited and Woldwide Two Limited on the receiving environment, with a focus on surface water and groundwater resources. The following primary topics will be covered in regards to the proposed activities:
    a. Impacts of an increase in cow numbers
    b. Impacts of increased effluent/sludge discharge
    c. Impacts of increased groundwater abstraction

KEY FINDINGS

10. The application sought consents to allow for continued operation of Woldwide One and Woldwide Two dairy farms, located *c*. 10 km to the north of Otautau at Heddon Bush. Support for these farms is provided by Horner Block and Woldwide Runoff (Merrivale, Western Southland), which are also used as support blocks for other farms. Woldwide Runoff consists of Merrivale and Merriburn Blocks, which are located on rolling lowland hill country approximately 20 km west of Otautau.

11. Existing consents for Woldwide One and Woldwide Two included Effluent Discharge Permits for discharge of farm dairy effluent and Water Permits for abstraction of groundwater. An existing permit for Land-use for expanded Dairy Farming was held by WW2. The application proposed amalgamation of current effluent discharge and water permits for a single farm unit Woldwide One and Woldwide Two; and that the Land-use for expanded Dairy Farming permit be replaced by a consent for Dairy Farming, to include an additional 160 cows. The land use permit was to include a designated area of Woldwide Runoff used for stock from Woldwide One, and Woldwide Two. The applicant sought a consent period of 15 years.

12. Woldwide One and Woldwide Two are located in the Waimatuku, Central Plains, and Upper Aparima Groundwater Management Zones; and in the Waimatuku Stream, Oreti River, and Upper Aparima Freshwater Management Units. Woldwide Runoff is located in the Waiau catchment, in an unclassified groundwater zone. Primary surface waterways in the vicinity of Woldwide Runoff include Merry Creek and Fenham Creeks (and their minor tributaries) which flow through the farms before converging with the Orauea River, all of which are in the Waiau Catchment.

13. Woldwide One and Woldwide Two are located on Central Plains and Oxidising physiographic zones, and are characterised by a high level of soil variability including contrasting physical and chemical properties. Underlying soils include Braxton, Drummond, Glenelg, Waiau, and Tuatapere. Woldwide Runoff soil classes include Orawia, Waimatuku, Malakoff, Riverine, and Aparima + Papatotara.

14. Groundwater for WW1 is abstracted from bore E45/0071 and groundwater for WW2 is abstracted from bores E45/0083 and E45/0727.

15. Background information and results of dataset analysis were presented to characterise the receiving environment. Surface water quality results showed that land use in the catchment/s had a considerable impact on the water quality of Waimatuku Stream, Oreti River, Aparima River, Waiau River, and Orauea River - including nutrient, bacterial, and sediment contamination. Although a minor number of trends presented in LAWA indicate potential

improvement in water quality for the period 2012-2017, the overall state of the surface water is degraded.

16. Groundwater results indicated that groundwater in the Waimatuku and Upper Aparima aquifers had been impacted from land use processes, including elevated nitrate in hotspots and bacterial contamination. The most likely source of bacterial contamination and increased nitrate and phosphorous is land use in the catchment, including dairy farming and sheep and beef grazing as values are considerably above the baseline (pre-European) concentration of < 1 mg/L.

17. Groundwater levels in the Waimatuku Aquifer showed strong seasonal signals due to the influence of rainfall, land surface recharge, and abstraction. There was no evidence of a long-term decline in groundwater level over time. Since the Waimatuku and Central Plains aquifers are predominantly recharged via rainfall, they are particularly vulnerable to changes in climate (such as predicted lower rainfall in summer) and increased abstraction.

18. Soil moisture datasets indicate that drainage is likely to occur during the period May – September, with differences in weather promoting earlier or later onset of land surface recharge. Soil moisture is a controlling factor in the timing and rate of effluent irrigation, since application of effluent can lead to leaching of nutrient and bacteria to groundwater and discharge of contaminants (including sediment) to surface water.

19. Land use on Woldwide One, Woldwide Two, and Horner Block has the potential to affect the Heddon Bush School drinking water supply due the close proximity (c. 2 km) to the properties. Although shallow, the bore is at a (comparatively) deep depth (14.9 m), currently shows no bacterial contamination, and slightly elevated nitrate concentration (2.3 mg/L).

20. The description of the receiving environment provided in Legg (2019) is basic and relies on limited data sources. Although considerable surface water and groundwater datasets exist, very little, if any analysis of data was undertaken. Information presented in Freeman (2019) was a considerable improvement on that presented in Legg (2019). In particular, water quality information presented in Freeman (2019): was easier to read and interpret; appeared to lack previous errors in reporting of water quality results; more clearly identified time periods for data (e.g., 2008 – 2017); made use of additional data publicly available through Environment Southland; and more clearly referenced appropriate standards and guidelines.

21. Overall conclusions regarding surface water quality presented in Freeman (2019) largely conform with that presented and discussed in Lovett (2019a) (e.g., surface water is clearly degraded in all surface water catchments). Identification of the difficulty in assessment of water quality against relevant standards is valid, including inconsistencies in sampling and assessment approaches. However, when the data is interpreted using a scientific approach, there is no doubting that there are clear negative impacts on water quality as a result of land use. The dominant coverage of Woldwide farms (WW1/WW2) in the upper Waimatuku Catchment (in particular) indicates that a considerable amount of this degradation may be caused directly by practices occurring on these farms.

22. Overall conclusions regarding groundwater quality presented in Freeman (2019) largely align with that presented and discussed in Lovett (2019a) (e.g., groundwater is clearly degraded in

regards to nitrate nitrogen). However, there is a heavy reliance on nitrate nitrogen data and it is suggested that additional data (e.g., phosphorous, bacterial contamination) would have added value in the interpretation by Freeman (2019). The primary conclusions associated with nitrate nitrogen data are that:

a. Groundwater quality reflects the predominant rural land use in the catchment contributing to nitrate nitrogen leaching through to groundwater;
b. Groundwater with elevated nitrate nitrogen concentrations subsequently discharges to surface waters;
c. The relatively high nitrate nitrogen concentrations are also a potential concern due to groundwater use as a source of drinking water, particularly since many are greater than the NZDWS, MAV of 11.3 mg/L;
d. Deeper groundwater (e.g., that abstracted by Heddon Bush School) in this area may be older groundwater less affected by the effects of the recent decades of land use;
e. Groundwater nitrate nitrogen concentrations appear to be generally higher than 2007 - 2012;
f. Some high nitrate nitrogen potentially reflects localised effects of dairy shed effluent disposal. On one hand this may over-emphasise the high nitrate concentration in some areas and on the other this may represent a large issue being overall deterioration of localised groundwater quality from many FDE applications.

23. Although Freeman (2019) presented additional surface water quality in downstream environments of the Heddon Bush, there was very limited additional information for WRO (e.g., Merrivale area; Orauea River). Further, the additional water quality information was largely limited to nitrate nitrogen, with little consideration of other water quality parameters (e.g., phosphorous, E. coli, total coliforms).

24. Overall, data presented in both reports clearly indicates that surface water, groundwater, and estuarine environments have been impacted by land use in the catchments. In contrast, Legg (2019) repeatedly states that there will be 'less than minor' or even an 'improvement' in water quality as a result of the proposed activities. These statements have been made with a lack of supporting information and rely heavily on Overseer analysis, for which the limitations or uncertainty are not adequately described. Freeman (2019) addresses this by presenting a more detailed analysis of the uncertainty associated with Overseer analysis.

25. Based on information provided in the entirety of application documents, it is agreed that there is <u>potential</u> for the proposed activities and mitigation measures to slightly reduce the losses of sediment, nutrients, and bacterial contaminants from WW1/WW2 and WRO farms. However, this reduction in nutrient loss is not guaranteed, largely due to a combination of natural complexity in the hydrological system and inherent uncertainties in modelling. Key limitations include: reliance on estimates from Overseer; that the estimate is based on the assumption the best management Practices and the highest level of Mitigation measures will be undertaken at all times (which may not be possible operationally); and since the proposed increase in number of cows will result in (an overall) increased effluent application to land. There is a considerably higher probability that a reduction in nutrient losses would occur if all mitigation measures were employed and cow numbers remained the same as they are currently.

26. It is agreed that a catchment-wide effort to reduce contaminant losses would likely be required to considerably reduce losses to surface water and groundwater (and therefore result in a meaningful improvement in water quality). However, it is also recognised that the area covered by WW1/WW2, WW4, WW5, and WRO farms and the actual losses from these properties to play an important role in overall loadings to the local and regional groundwater and surface water catchments

27. Initially, operation of proposed activities on Woldwide One and Woldwide Two was initially a minimum of 23,300 kg/N/yr and 390 kg/P/yr being lost to the environment (Legg, 2019). These figures were revised after additional information was presented (Duncan, 2019).
    a. WW1/WW2 nitrogen loss 18,932 kg/N/yr equivalent to 38 kg/N/Ha; and
    b. WW1/WW2 phosphorous loss 352 kg/P/yr equivalent to 0.7 kg/P/Ha

    It is interpreted that these estimates <u>do not</u> include effluent/sludge applied to Horner Block.

28. There have been several nutrient budget estimates presented for the application, which has created some confusion in interpretation. Overall, these nutrient loadings are likely to affect surface water, groundwater, and estuarine environments. Bacterial and sediment contamination of surface water is likely to occur due to shallow drainage and overland flow.

29. An important omission is that the application (seemingly) fails to provide estimated nutrient losses from WRO, despite intensive winter grazing being predicted to increase from 52 Ha – 100 Ha. Therefore, the full effects of farming operations of Woldwide One and Woldwide Two are incomplete.

30. The application states that the farms (with reference to Aqualinc report) are operating under current BMP's and at Mitigation Level 3 (the highest level). Any instance where these mitigation measures or those presented in the FEMP's are not followed will result in an increase of nutrient, sediment, and/or bacterial loss to the receiving environment. As a result, the negative effects of farm operations and activities on groundwater and surface water resources will be increased above that considered.

31. The conclusion of the AEE is that water quality will be maintained. However, in the opinion of the reviewer this assessment is not supported by water quality results presented in the application or within the technical report (Lovett, 2019a). Maintenance of water quality would rely heavily on all additional mitigation measures proposed by the applicant being implemented successfully.

32. The assessment of bores undertaken by Scandrett (Freeman, 2019; Attachment A) lacks basic information including location and hydrogeological context and is based on a largely cryptic and indefinite assessment criteria. Without additional hydrogeological information (e.g., bore location, depth, material, screened interval), the importance of water quality results in terms of interpreting impacts of land use on nitrate concentration the Heddon Bush area is no further informed. However, of significance, is that the Scandrett report primarily implicates all bore owners who have either incorrectly sited, and/or constructed, and/or maintained bores (in relation to Rule 53). In all instance's, improvements to well head security for the three bores and three wells should be undertaken for them to conform to Rule 53. Furthermore, wherever appropriate purging and sampling of the bore or well is practiced, the risk of unrepresentative interference to the water quality result is mostly avoided since

adequate purging ensures that an external groundwater sample is obtained. To some extent the Scandrett report confirms the challenges in obtaining consistent water quality results due to the inherent hydrogeological and land use influences on the composition of groundwater samples taken. If contamination of the aquifer has occurred through the preferential pathway provided by the bore and if this condition is ubiquitous for the area's bores, it could be argued that this is a fair representation of the impacts of local land use (e.g., intensive agriculture) on the underlying aquifer.

33. Potential omissions in the application include:
    a. An assessment of the effect of increased abstraction from bore E45/007 has not been undertaken;
    b. A description of how soil moisture management is actually implemented or how relevant soil moisture data is used to determine current soil conditions to ensure effects of FDE application are minimised has not been provided; and
    c. The cumulative effects assessment on the receiving environment for exported activities on Woldwide Runoff is limited with very little water quality data presented.

APPENDIX 1

34. Lovett A., 2019a. Review of Resource Consent Application by Woldwide One Ltd. and Woldwide Two Ltd. Earth & Environmental Science Report 2019/02, prepared for Environment Southland Regional Council. 55p.

APPENDIX 2

35. Lovett, A., 2019b. Supplementary response report for Woldwide One Ltd. and Woldwide Two Ltd., and Woldwide Four Ltd. and Woldwide Five Ltd. consent applications. Earth & Environmental Science Report 2019/03, prepared for Environment Southland Regional Council. 12p

REFERENCES

Freeman, M., 2019. Water quality assessments. Woldwide One Limited and Woldwide Two Limited & Woldwide Four Limited and Woldwide Five Limited. Report prepared for Woldwide One Limited, Woldwide Two Limited, Woldwide Four Limited and Woldwide Five Limited.

Legg, N., 2019. Woldwide Farming Group: Woldwide One Limited and Woldwide Two Limited Resource Consent Application, submitted to Southland Regional Council. Application prepared on behalf of applicant by: Dairy Green Ltd., 10 Kinloch Street, PO Box 5003, Waikiwi, Invercargill, 9843. 164p + Appendices.

BEFORE ENVIRONMENT SOUTHLAND

In the matter Proposed Southland Water & Land Plan

And

In the matter Woldwide Farming Group Resource Consent applications

---

STATEMENT OF EVIDENCE OF BELINDA MEARES

04 SEPTEMBER 2019

FINAL

INTRODUCTION

1. My name is Belinda Meares.

2. I have been engaged by Environment Southland **(ES)** to give evidence, regarding some soil management issues and their representation in the nutrient budgeting model Overseer, in relation to the resource consent applications received from Woldwide Farming Group Ltd **(Application).**

3. I hold a bachelor's degree in Environmental Management & Planning (BEMP) minoring in Soil Science from the Lincoln University. I have successfully completed both the intermediate and advanced Sustainable Nutrient Management courses at Massey University. I am presently in the process of finalising my Certified Nutrient Management Advisor (CNMA) qualification. I am a member of the New Zealand Institute of Primary Industry Management (NZIPIM).

4. I have four years' experience as a Farm Environmental Coordinator in Ashburton working with Mid-Canterbury farmers at the Irrigo Centre Ltd. At the Irrigo Centre I had a broad range of responsibilities for farmers in the following irrigation schemes: Barrhill Chertsey Irrigation Ltd, Acton Farmers Irrigation Co-operative Ltd, Ashburton Lyndhurst Irrigation Ltd and MHV Water Ltd, where I;

    a. Co-ordinated the implementation of Audited Self-Management Programmes,
    b. Provided one-on-one assistance to shareholder farmers to assist them with implementing good management practices (GMP).
    c. Worked with shareholders to ensure every shareholder annually updated their Farm Environment Plan,
    d. Co-ordinated and reported on scheme N losses as a part of compliance reporting,
    e. Coordinated and provided support for the external FEP auditing program,
    f. Contributed to development of an online Farm Environment Plan (FEP) Template that was compliant with Schedule 7 of the Canterbury Land and Water Regional Plan,

g. Co-ordinated workshop training sessions and resources to help improve their practices.

5. Most recently, in May 2019 I joined Pattle Delamore Partners Ltd (PDP) an engineering and environmental consultancy as a Farm Environmental Consultant.

6. I confirm that I have read and agree to comply with the Code of Conduct for expert witnesses contained in the Environment Court Practice Note (dated 1 December 2014). I confirm that the issues addressed in the statement of evidence are within my area of expertise. I have not knowingly omitted to consider facts or information that might alter or detract from the opinions expressed.

SCOPE OF EVIDENCE

7. In my evidence I provide a summary of:

7.1 Contaminant Movement Through Soil Types, particularly Clay rich soils;
7.2 Adverse effects of the proposed activities related to soil and;
7.3 Limitations in Overseer with modelling soils with shrink-swell tendencies and what this means for the consideration of the consent applications by the Woldwide Farming Group Ltd.

BACKGROUND

8. ES has received two consent applications from Woldwide Farming Group for change of land use and for discharges to land. The first application relates to Woldwide One Limited (WW1) and Woldwide Two Limited (WW2) farms, while the second application relates to Woldwide Four Limited (WW4) and Woldwide Five Limited (WW5) farms. Both applications reference the use of the property Woldwide Runoff Limited (WRO) as a dairy support property for supplement production and drystock grazing. Brief summaries of the two applications are included below.

9. Maps showing the location and physiographic zones of these properties is presented in Appendix 2, Figure 3-5 attached to my evidence.

10. **WW1 and WW2 application**

10.1 Increase cow numbers by 160 milking cows (current total of 1,340 cows increasing to 1,500 cows across both dairy platforms). This change is proposed to occur on WW1 where the herd size will go from 540 to 700 cows.

10.2 Reduce intensive winter grazing. Proposal is for all cows and some heifers to be wintered in two wintering barns during June and July.

10.3 Physiographic zones (as defined in the Proposed Southland Water and Land Plan) for WW1 and WW2 include Central Plains and Oxidising. These zones have the following key features:

- (a) Central Plains:
  - (i) Clay-rich soils which exhibit shrink-swell characteristics,
  - (ii) Soils shrink and crack when dry allowing drainage to bypass the soil matrix to the underlying aquifer,
  - (iii) Wet soils which are prone to waterlogging therefore requiring artificial drainage network. (Environment Southland, n.d)
- (b) Oxidising:
  - (i) Soils are well aerated and have a low denitrification potential,
  - (ii) High risk of nitrogen build-up in groundwater. (Environment Southland, n.d)

10.4 Overseer modelling was prepared by Cain Duncan (CNMA) from Farm Source Sustainable Dairying. The average pre-expansion N loss was 41 kg N/ha/yr, taken from the average N losses from the 2013-2014 to 2016-2017 (inclusive) seasons, and the proposed N loss (after the expansion) is 38 kg N/ha/yr.

11. **WW4 and WW5 application**

11.1 Convert a 136-ha sheep farm (the Cochran's block) to dairy platform. The Cochran's block will be split between WW4 and WW5: 63 ha added to WW4 and 73 ha added to WW5.

11.2 Increase WW4 cow numbers by 150 milking cows (herd size will go from 850 to 1,000 cows).

11.3 Increase WW5 cow numbers by 130 milking cows (herd size will go from 800 to 930 cows).

11.4 Utilise wintering pads to stand off mobs of cows during high risk wet weather months.

11.5 In time, construct a 1,050-cow wintering shed on each farm in order to remove intensive winter grazing from the Central Plains area.

12. Physiographic zones for WW4 and WW5 include Central Plains, Oxidising and Riverine. The characteristics of the Central Plains and Oxidising zones are described in paragraph 10.3 above. The characteristics of the Riverine zone are:

(a) Riverine:
  (i) Freely drained soils, on mostly flat undulating land located on alluvial terraces and floodplains adjacent to main rivers, steeper slopes can occur in the headwaters,
  (ii) severe risk of nitrogen leaching due to the free draining soils,
  (iii) Low denitrifying potential in soils and aquifers.

13. Overseer modelling for WW4 and WW5 was prepared by Mark Crawford (CNMA) from Ravensdown. For WW4, the pre-expansion N loss was 27 kg N/ha/yr and the proposed N loss was 23 kg N/ha/yr. For WW5, the pre-expansion average N loss was 47 kg N/ha/yr and the proposed N loss was 43 kg N/ha/yr. For the Central Plains, Oxidising and Riverine zone proposed Policies 5, 10, 12, respectively, in the pSWLP state that “decision makers generally not granting resource consents for additional dairy farming of cows or additional intensive winter grazing where contaminant losses will increase as a result of the proposed activity.” (pSWLP. 2018)

14. The soils within the Central Plains zone tend to be heavy, clay-rich soils with a propensity for shrink-swell processes, resulting in cracking at the soil surface and within the soil profile. All the dairy platform farms in these applications (i.e. WW1, WW2, WW4 and WW5) include Braxton soils.

15. The Topoclimate Southland Soil Information Sheet No. 31 describes Braxton soils as a soil that is formed in a mixture of fine alluvium and loess that is derived from tuffaceous greywacke and volcanic rocks of the Takitimu

Mountains. These soils are deep to moderately deep, poorly drained, and have silty clay to heavy silt loam textures. (Crops for Southland 2002)

16. It is the clay component of the soil, that consequently makes them particularly prone to shrink-swell properties that lead to the formation of cracks in the soil.

CONTAMINANT MOVEMENT THROUGH SOIL TYPES

17. There are three mechanisms for the movement of excess water[1] from a soil; these are matrix flow, preferential flow and overland flow (overland flow is commonly referred to as run-off).

18. When water moves through soil it generally transports solutes, such as fertilisers and native soil components with it. (McLaren and Cameron, 1996). Solute movement is an important process for soil development; however, it can introduce pollution to groundwater and surface water.

Matrix Flow

19. Drainage from the soil matrix occurs when the soil moisture levels exceed field capacity. A soil's drainage capacity when a soil is saturated is largely governed by soil density, macroporosity and soil structure. (Houlbrooke. D, Monaghan. R 2009). Land management practices can have a significant impact on the preservation or enhancement of a soil's structure, therefore influencing the hydraulic conductivity of the soil and solute transport.

20. When a soil is at field capacity (or below) water will be transmitted through the soil's matrix via the micropores. Field capacity is defined as the stabilisation of soil water content after rapid drainage (McLaren and Cameron, 1996).

21. The soils across the WW1&2 and WW4&5 are largely a silty loam or clay texture; these soils are common to the area. These soils have a large Profile Available Water (PAW) capacity (ranging from 100 – 149 mm, over a depth range of 0-600 mm) and a moderate to slow drainage profile. Examples of these soils are Braxton and Tuatapere soils, both are moderately deep soils,

---

[1] Excess water is water that exceeds the capacity of the soil to infiltrate and hold the water.

with a silty loam over clay and silty loam textures. There are also areas of soils which are lighter in nature, freer draining with sandy, silt textures such as the Upukerora and Waiau soils.

22. Because of the ability of the heavier soils to hold onto water, and the low permeability of the soil, they typically, as a whole present a low nitrate nitrogen leaching risk due to matrix flow. Instead, when waterlogged, movement of moisture through the soil matrix tends to facilitate denitrification of the soil nitrate nitrogen content, resulting in gaseous losses to the atmosphere as opposed to leaching to water (McLaren and Cameron, 1996).

Preferential Flow (also known as bypass flow)

23. Clay rich soils, such as the Braxton series are inherently prone to shrink-swell behaviour. This characteristic often results in cracks and fissures forming at the soil surface and within the soil profile during dry periods. The cracks from the shrink-swell behaviour in the heavier, clay rich soils can provide a pathway within the soil profile which enables drainage water to by-pass; (water moving rapidly through the soil profile via macropores or channels) the soil matrix resulting in the possible transmittance of contaminants to a receiving waterbody. The regularity of these cracks is highly situational and depends on a number of factors; such as the soil’s texture, structure and pore characteristics.

24. Irregularity in the size and depth of cracking was visually observed and is discussed in the report “Investigation of cracking soils: Heddon Bush, January 2018” written by Michael Killick accompanying the application for WW4 and WW5. The report confirmed that the cracks were unique in depth, length & regularity. The cracking and structure of the soil profiles are likely to have been heavily influenced by the processes of the land management, cultivation, grazing, pastoral and crop rotations. Photos of the cracked soils from his report are attached to my evidence as Appendix 1, Figure 1.

25. Some blocks on the farms with heavier, poorly drained Braxton soils have artificial drainage installed in the form of tile and mole systems. Artificial drainage systems are typically installed to remove excess water from below

the soil surface. Drainage systems will usually run when a soil moisture content exceeds field capacity.

26. By increasing macropore flow and reduced residence times for matrix adsorption (Landcare Research, 2015) the presence of tile drainage networks has an inherent risk of increased nutrient losses. Areas of a farm with subsurface drainage should be identified and managed to minimise the risk. It is noted that the FEMPs for WW1 &2 state that where the tile drain lines are present irrigation of FDE should not be carried out directly over them if there is any risk of the irrigation creating drainage. The FEMPs for WW4 & 5 state that low rate effluent discharge will occur to reduce the risk of through-drainage in the tile or mole drains.

Overland Flow

27. Overland flow occurs when rainfall and/or irrigation rates exceed the infiltration capacity of the soil.

28. In addition to some of the low infiltration rates on the soils of these farms, the fine texture of heavier soils creates an increased propensity for compaction. Compaction at the soil surface is a common reason why a soil's infiltration rate of water received at the surface will be slowed, this can cause surface ponding. The fine texture of silt and clay soils and their high-water holding capacity can make them particularly prone to compaction, particularly during periods of saturation (i.e. winter). This in turn leads to increased ponding and risk of overland flow. As discussed in paragraph 55 the introduction of the heavier stock class (Cattle from sheep) to the Cochrane block will inherently increase the compaction risk to the soil structure

29. An essential part of effective management is keeping soil nutrient values within the agronomic optimums to limit the available pool of nutrients for leaching. Soils can be kept within the agronomic optimums by ensuring best practise nutrient management is applied.

ADVERSE EFFECTS OF THE PROPOSED ACTIVITES RELATED TO SOIL

30. The primary potential adverse effects related to soil I identified in the WW1 & 2 and WW 4 & 5 applications were:

30.1 Preferential or bypass flow of surface contaminants, such as Farm Dairy Effluent, fertiliser or other surface contaminants and nutrients transmitted directly to the groundwater by field tile drains or via the cracks.

30.2 A lack of on farm quantifiable soil moisture data when making FDE scheduling decisions, particularly given the acknowledgement of variable soil types.

30.3 Possible increase in effluent loading rate on remaining FDE application area after soils with cracks are excluded. Of concern particularly on the Horner block where the effluent loading rate is already high.

30.4 Possible increase to the Nitrogen surplus present in the soil, resulting from an increase in stocking rate and the associated inputs required.

30.5 Potential for soil structure damage: Surface damage to the soil resulting in increased occurrence of runoff, or surface ponding which induces matrix flow through saturation of the soil.

PREFERENTIAL OR BYPASS FLOW

31. The increase in stocking rate and introduction of wintering barns will result in an increased generation of farm dairy effluent (FDE), the management of the additional FDE generated will be critical in terms of the effects on the receiving environment.

32. The cracks and fissures created when the clay-rich soils are dry, provide a direct pathway for contaminants in FDE, fertilisers or any other surface contaminant to drain directly to the groundwater, without the natural attenuation the soil matrix typically provides. This practically means that the application of FDE to cracked soil will very likely result in the FDE being rapidly transmitted through the soil matrix. The amount of FDE transmitted will depend on the depth of application as discussed in paragraph 34, and the severity & depth of the cracks present.

33. To minimise the risk of FDE being rapidly transmitted it essential that there is effective scheduling of FDE spreading. Applications must coincide with soil

moisture deficits (discussed in paragraph 36) and appropriate applications rates for the soil.

34. Houlbrooke. D, Monaghan. R (2009) discuss the McLeod et al (1998) study of the effectiveness of irrigation application rate on the incidence of preferential flow. This is relevant in the instance of any preferential flow created by the cracks in the Braxton soils. The study related to drainage events at different application rates of FDE on both well and poorly drained soils, where the poorly drained soils had preferential flow pathways. They report that for both soil types, applications rates of <10 mm/hr resulted in the applied 25 mm depth of FDE remaining within the top 200mm of soil. The Overseer modelling provided model the FDE applications as <12mm applications, with an actual applied depth of 10 mm (WW 4 & 5 Nutrient Budgets).

35. The FEMP for both WW1 & 2 state that FDE will be discharged little and often, particularly in the summer or during dry periods to ensure the soil moisture is kept as high as possible to prevent the soil from drying and cracking. While this is an effective strategy at minimising the occurrence of soil cracking, without quantitative (on-farm) soil moisture data, discussed in Paragraph 36-40, there is no quantifiable measure to show that this practise is not causing an exceedance of field capacity resulting in leaching. It is noted that the FEMPs for WW 4 & 5 don't detail specific management practices for the discharge of FDE when cracks are present.

SOIL MOISTURE MONITORING

36. A key management practice is to ensure that FDE is applied to a soil profile that has a soil moisture deficit – i.e. deferred irrigation. Houlbrooke. D, Monaghan. R (2009) define deferred irrigation - storing effluent in a pond then irrigating it strategically when there is a suitable soil water deficit, thus avoiding the risk of generating surface runoff or direct drainage of effluent.

37. The applicant's FEMP for WW1 & 2 states that when undertaking a visual soil moisture assessment prior to the application of FDE, that FDE can be applied closer to Field Capacity if using the slurry tanker, due to the lower application rate. This practice increases the risk that in the days following the application that an event such as rainfall causes the soil to exceed Field Capacity and

therefore the FDE is leached. Particularly if the FDE is being used as the FEMP states to keep the soil moist to avoid the drying processes causing cracking.

38. A common management practice when irrigating FDE is to have a quantitative tool to measure soil moisture. A quantitative tool is useful in ensuring that the soil moisture & temperature that are visually assessed are in fact appropriate for an FDE application, it also helps assist in application depth decisions. There appears to be no quantitative method, or tool in place (within the farm gates) for assessing the soil moisture on any of the farms.

39. The FEMPs for WW1 & 2 and 4 & 5 all state that online soil moisture monitoring data from the network of instruments is sought from Environment Southland to assist with effluent scheduling. WW1 & 2 FEMPs specifically state that the Heddon Bush site is used, and the FEMPs for WW 4 & 5 state "monitoring of soil moisture using ES website." Presumably this statement refers to the Heddon Bush site, which is also the closest site in proximity to WW 4 & 5.

40. While I endorse the use of the ES soil moisture site to monitor soil moisture and temperature in consideration of FDE applications, the soil assessments undertaken by both Mr. Killick (January 2018) and Mr. Scandrett (2017) confirm the presence of variable soils, each soil with unique PAW values and therefore management requirements. Mr. Killick reports that the soil moisture monitoring instrument at the Heddon Bush site is located in Glenelg soils, but is mapped in Topoclimate as Braxton + Pukemutu. The variable soils across WW1 & 2 mean that the soil moisture & temperature data being used from Heddon bush to inform decisions may not necessarily be representative of the soil being scheduled for an FDE application.

41. The variation in soil is particularly relevant for WW 4 & 5, the nutrient budgets show that WW4 & 5 have a higher proportion of Braxton soils than WW 1 & 2, as discussed in paragraph 39 it is assumed that the Heddon bush site is being used for soil moisture data, which is located in the Glene_4a.1 soil, this is relevant with regard to the vastly different PAWs of the soils. To illustrate the difference in soil moisture requirements the Glenelg (Glene_4a.1) soil, has a PAW 0-60cm of 53mm, whereas the Braxton (Brax_4a.1) soil has a PAW of 149mm. WW 4 & 5's soils have PAW which range from 38 – 149mm (0-60cm).

42. When effluent application records are matched against soil moisture and temperature records, for the soil to which it is applied, it enables a quantifiable measure of the management practices. It would be valuable to see some quantification of the FDE scheduling and management on the different soils relative to their PAW, particularly given the practice to use FDE to keep the soil moisture high, avoiding cracking on the heavier soils. The temperature values will also assist in not only FDE applications but also fertiliser.

43. The FEMPs for WW1 & 2 state that effluent application is to be avoided when soil temperature is less than 5ºC. Best application practice for Nitrogen fertiliser is that it is not applied when the 10cm soil temperature at 9am is less than 6ºC and falling (at these low soil temperatures plant nitrogen uptake is slow and there is greater risk of leaching loss). (Fertiliser Association 2018) This practice can also be applied to FDE as plant uptake is required to avoid leaching.

EFFLUENT LOADING RATE

44. It is noted, that in the Farm Environmental Management Plans (FEMPs) for WW1 & 2 it states *"Do not apply effluent to areas prone to cracking in dry summer periods. Braxton soils, with swell crack characteristics, are found in a small area at the south western-most part of WW2 and at the Horner Block" (*Duncan, 2019) This mitigation would avoid the risk of FDE travelling via by-pass flow through the cracks. However, the removal of the cracked area, may increase the calculated N loading rate in other areas due to the reduction in the overall FDE application area.

45. The revision of applications to extend the period, and numbers of cows being wintered in the barn will increase the period that FDE is captured from barns, increasing the overall volume of FDE to be discharged over the year. The additional FDE generated from the barns has the potential to increase the effluent loading rate if not carefully managed.

46. The proposed Overseer modelling for the Horner block, completed by Cain Duncan supporting the application indicates an effluent N loading rate on one of the two blocks of 243 kg N/ha/yr on the block "Grass silage – 97Ha (WOL &

WTL Slurry Area)." The nutrient budget for the Horner block shows 75 Ha is Braxton soil, which has shrink-swell and cracking characteristics. It is stated in the FEMPs soil showing evidence of cracking will be removed from the FDE application area. If, in an extreme situation the entire of the 75Ha, or a good proportion was removed due to cracking this would increase the likelihood of an increased loading rate on the remaining area.

47. As discussed earlier, the appearance of the soil cracking is highly situational, therefore it's unlikely that the entire 75 Ha would need to be excluded from FDE due to cracking at one time. However, it would be prudent to consider the possible impact on the loading rate of removing application area during periods of cracking.

48. Given the high N loading rate from FDE, it will be essential that the applicant carefully considers the nutrient inputs on the Horner block, particularly if the 207 kg N/ha/yr modelled of N fertiliser is applied. Cumulative (fertiliser & FDE) N loading rates 450 and 459 kg N/ha/yr on the management blocks would likely surpass plant requirements and would be at risk of leaching.

NITROGEN SURPLUS

49. Nitrogen surplus is the amount of N input into the farm less the output. N enters the system through nitrogen fertiliser, legume N fixation, animal manure and imported supplementary feeds. The surplus is the N that is not converted to product; therefore, it is at risk of loss through leaching, volatilisation and gaseous loss. An increase in the N surplus, usually represents a reduction in the N efficiency on a property.

50. Dairy NZ (2018) report that Soil N in surplus is at an increased risk of loss from the system via leaching; the whole-farm risk of leaching increases by 0.2 to 0.4kg N/ha for every kg increase in the N surplus. The N surplus must therefore be managed as such to reduce the risk of N loss.

51. The increased stocking rate, the associated feed demand through pasture or supplementation and the increased effluent generation has the potential to increase the N surplus. Particularly, if other inputs such as fertiliser are not managed carefully. The revised nutrient budgets for WW1 & 2 and 4 & 5 state

that fertiliser inputs have been slightly reduced to account for the additional FDE application needed due to extending the period the cows are in the barn. It is essential that this is managed carefully to ensure that the efficiencies are maintained, avoiding an increase in N surplus.

SOIL STRUCTURE

52. Overland flow (run-off) occurs when the infiltration rate of the soil is exceeded and there is enough slope to enable lateral water movement. The energy generated by the run-off can pick up exposed sediment or contaminants sitting at the soil surface, the mobilised soil particulates typically will have soil nutrients, such as Phosphorus (P) bound to the colloids.

53. Clay-rich soils tend to be prone to pugging, particularly with heavy stock classes; pugging can increase the occurrences of runoff by reducing infiltration rates. Reduced infiltration rates then exacerbate any overland flow processes occurring, this coupled with an exposed soil surface after winter grazing can increase the susceptibility for nutrients bound to sediment to runoff. It is noted that in the documentation supporting the applications the topography is largely flat, to very flat with some depressions. Flat topography will reduce the risk of runoff, by allowing water time to pond and infiltrate down to groundwater through the soil profile.

54. The application for WW4 & WW5 proposes to convert a 136-ha sheep farm (the Cochran's block) to dairy. The Cochran's block will be split between WW4 and WW5: 63 ha added to WW4 and 73 ha added to WW5. It fair to assume that the change in the land use, conversion from dryland sheep to dryland dairy farming is likely to have an impact on the soil structure. The change in stock class from sheep to cattle will introduce heavier animals, as such land management practices need to implement a strategy for managing a higher compaction risk.

55. Cattle, being heavier animals create more downwards pressure at hoof contact with the soil surface. Houlbrooke. D *et al* (2011) discusses the impact of the land-use intensification on soil structure; a key conclusion was that the soil's moisture content (SMC) at the time of any animal grazing dominates any subsequent changes in soil structure.

56. The proposal is to remove cattle from the paddock during the months when the SMC is high, for the period of destocking, off paddock wintering will reduce the occurrence of treading damage to the vulnerable soils. During periods of typically lower SMC, when stock are on-paddock, a risk of treading damage while reduced, will still inherently be present. Without a full understanding of the intended conversion from sheep to dairy, and management practices to be applied to the Cochran's block, it is challenging to comment on the extent on any impact to the soil of the introduction of a heavier stock class, beyond that any impact is inherent and is largely dependent on management.

LIMITATIONS IN OVERSEER WITH MODELLING SHRINK-SWELL SOILS

57. Overseer is a nutrient management model which is designed to provide decision support for farms. There are key assumptions which underpin the model (Overseer 2019);

57.1 The farm is in a steady-state ('quasi-equilibrium') condition,
57.2 Actual and reasonable inputs are entered into the farm file,
57.3 Annual average outputs,
57.4 Good management practices are followed,
57.5 Animal production inputs are a factor in pasture production estimates.

58. The applicant has provided Nutrient Budgets using Overseer to support the two applications, for WW1 and WW2; the modelling prepared by Cain Duncan (CNMA) from Farm Source Sustainable Dairying. The average pre-expansion N loss was 41 kg N/ha/yr and the proposed N loss (after the expansion) was 38 kg N/ha/yr. For the WW4 and WW5 application, modelling was prepared by Mark Crawford (CNMA) from Ravensdown Environmental. For WW4, the pre-expansion N loss was 27 kg N/ha/yr and the proposed post expansion N loss was 23 kg N/ha/yr. For WW5, the pre-expansion average N loss was 47 kg N/ha/yr and the post expansion N loss was 43 kg N/ha/yr.

59. An important factor to note when considering an Overseer nutrient budget is that the model is a long-term average and is a theoretical model informed by on-going science advancements. Being a model, it is unable to capture with detail all the intricacies of a farm, it's management and the nutrient cycles

occurring. It is the relativities opposed to the hard number resulting from the modelling that is essential to consider.

60. Overseer has not been validated against every combination of environment and farm enterprise (Overseer 2019), therefore one of the areas that the model lacks in is modelling bypass flow in soils, the model does consider a soil types propensity for run-off and bypass flow, however, it does not reflect the site-specific nature of that soil moisture pathway. This is because bypass flow has a direct dependence on the land use and nature of the individual soil.

61. Much of the research and experimental data on bypass flow has been in overseas trials and in the North Island, meaning to date there has been limited, robust and field calibrated science to inform an improvement in the Overseer model (Landcare Research, 2015).

62. Another area of the Overseer model with limitations is when modelling nutrient losses, particularly P losses as an occurrence of runoff. Some of these limitations are the model does not consider; slope processes (with a fine grain), or temporal effects or the impact of land management on a soil's infiltration capacity (Landcare Research, 2015).

63. Overseer also has limitations in modelling some common management practises which are applied to both mitigate nutrient losses and utilise surplus nutrients. Mitigation measures such as sowing oats after fodder crops to capture excess nutrients, and diverse pastures species such as plantain. Many of these limitations in the model relate to a lag between farmer innovation, scientist studies and the development to inform the model.

64. While the assumptions and limitations of the model apply generally to all farms modelled. The consideration of the bypass flow is particularly important for these applications given the large proportion of clay-rich soils that have been modelled.

CONCLUSIONS

KEY POTENTIAL EFFECTS

65. Bypass flow allows surface contaminants such as Farm Dairy Effluent, fertiliser or other surface contaminants and nutrients to be transmitted directly to the groundwater via the cracks.

66. If an area is excluded from FDE applications due to cracking, without compensating for this with other inputs there is potential to increase the effluent loading rate on remaining FDE application area, resulint in an increase in N surplus and therefore N leaching. An increase in effluent loading rate is of particular concern on the Horner block due to the already high effluent loading rate.

67. Presently, soil moisture data is used from a single site outside the farm gates of all the farms, the applications confirm the presence of variable soils. The variable soils mean that the soil moisture and temperature data being used may not necessarily be representative. Having soil moisture meter's installed within the farm gates would in my opinion help to reduce the risk.

68. Possible increase to the nitrogen surplus present in the soil is likely to result from an increase in stocking rate, the barn and the associated inputs required. Any increase to the surplus will likely increase leaching.

69. Potential for soil structural damage: Surface damage to the soil from the introduction of heavier animals on the Cochrane block, compaction will likely result in increased occurrence of runoff, or surface ponding which increase the flow of nutrients through saturation of the soil.

70. The applicant's FEMPs detail a number of good management practices which would aid to minimise the risks identified. However, the lack of an on-farm FEMP auditing protocol carried out by a suitably qualified individual means that there is relatively limited accountability in terms of following the FEMP. Or for creating recognition for the good management practices that are unaccounted for in Overseer. Regular FEMP audits would improve the level of

confidence that the mitigations are being implemented and managed effectively.

KEY CONSIDERATION WHEN USING OVERSEER TO MODEL CLAY RICH SOILS

71. Because of the dynamic nature of farms, Overseer is unable to capture with detail of all the intricacies of a farm, it's management and the nutrient cycles occurring. For this reason, it reverts back to the model assumptions listed in clauses 58.1-5.

72. One of the areas that the model lacks in is modelling bypass flow, the model does consider a soil types propensity for run-off and bypass flow, however, it is the full extent that of site-specific variability that presents challenges to the model. This is particularly relevant for the areas of clay-rich soils such as the Braxton soils on the farms.

73. Natural geomorphological processes, temporal effects and land use variability make it exceptionally challenging to accurately model the nutrient-soil interactions occurring.

74. These factors create a high degree of uncertainty as to whether the modelled nutrient changes will be achieved, with a risk that higher losses will result into the groundwater and surface water in these areas.

REFERENCES

Crawford M (2019) Current and Proposed Farm System Nutrient Budgets for Effluent consent (WW4 & 5)

Crops for Southland (2002) Topoclimate Southland Soil Information Sheet No. 31

DairyNZ (July 2018) www.dairynz.co.nz/news/latest-news/solutions-to-reduce-n-leaching-and-maintain-profit Accessed 05/07/2019.

Duncan, C (2019) Nutrient Budget Analysis – WW1 & WW2 pg 25 & 26

Environment Southland (n.d) Central Plains Zone Technical Information https://waterandland.es.govt.nz/repository/libraries/id:1tkqd22dp17q9stkk8gh/hiera rchy/Physiographic%20zone%20technical%20sheets/Central%20Plains%20Zone%20web.pdf Accessed 29/07/2019

Environment Southland (n.d) Oxidising Zone Technical Information https://waterandland.es.govt.nz/repository/libraries/id:1tkqd22dp17q9stkk8gh/hierarchy/Physiographic%20zone%20factsheets/oxidising.pdf

Environment Southland (n.d) Riverine Zone Technical Information https://waterandland.es.govt.nz/repository/libraries/id:1tkqd22dp17q9stkk8gh/hierarchy/Physiographic%20zone%20factsheets/riverine.pdf

Fertiliser Association (2018) Code of Practice Appendix 3: Fertiliser Activities and Environmental Concerns

Houlbrooke. D, Monaghan. R (October 2009) The influence of soil drainage characteristics on contaminant leakage risk associated with the land application of farm dairy effluent. Prepared for Environment Southland

Houlbrooke. D, Paton. R, Littlejohn. R, Morton. J (June 2011) Land-use intensification in New Zealand: Effects on soil properties and pasture production. The Journal of Agricultural Science; vol 149

Killick. Michael (2018) Investigation of cracking soils: Heddon Bush, January 2018 WW 4 & 5 application

Landcare Research (2015) Partitioning land according to vulnerability to runoff and leaching losses of phosphorus in Canterbury. Environment Canterbury Report No. R15/121

McLaren R, Cameron K, (1996) Soil Science Sustainable production and environmental protection ISBN: 9780195583458

McLeod M, Schipper LA, Taylor MD (1998) Preferential flow in a well-drained and a poorly drained soil under different overhead irrigation regimes. Soil Use and Management, 14, 96-100

Overseer (2018) https://www.overseer.org.nz/how-overseer-engine-works#design-assumption. Accessed 26/07/2019

Overseer (2018) Best Practice Data Input Standards v6.3.0

Environment Southland 2018 Proposed Southland Water and Land Plan Part A

Scandrett. J (2017) Soil type assessments of soils at Woldwide 1 & 2 dairy farms. Appendix B WW1 & 2 Application

APPENDIX 1

Figure 1 Images of soil cracks Killick, M (2018)

APPENDIX 2

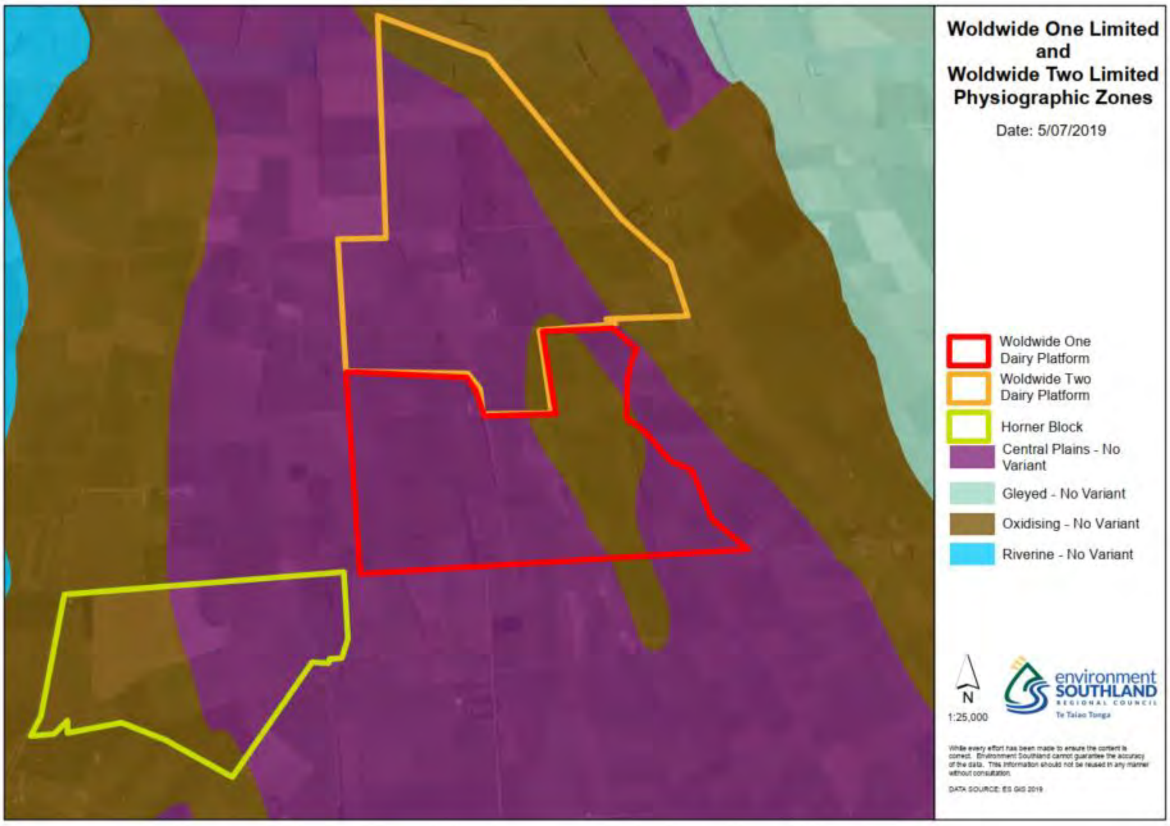


Figure 2 Physiographic zones of WW1 & 2

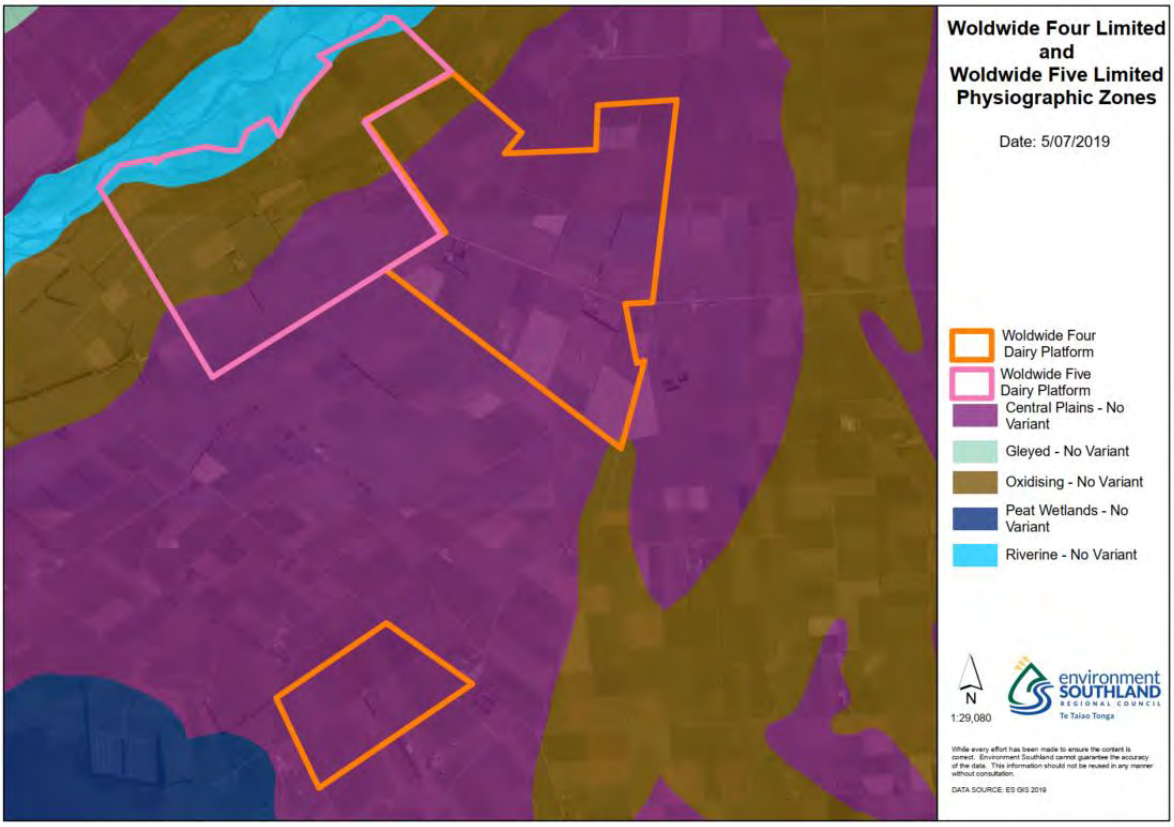


Figure 4 Physiographic zones WW4 & 5

Figure 5 Physiographic zones Woldwide Runoff

Introduction

1. My name is Nicole Irene Phillips.

2. I am an Environmental Consultant.

3. I hold a Bachelor of Science degree from Lincoln University and Intermediate and Advanced certificates in Sustainable Nutrient Management from Massey University. I am a Certified Nutrient Management Advisor.

4. I was a member of the now discontinued OVERSEER Working Group (OWG); a group of professionals discussing issues arising when using OVERSEER in regional council planning frameworks. The OWG had members from regional councils throughout the country along with representatives from fertiliser companies, OVERSEER Management Services Ltd and industry groups.

5. I have worked throughout Canterbury and Otago for the past eight years as an Environmental Consultant, with an emphasis on OVERSEER modelling and Farm Environment Plans. In this time, I have gained considerable experience with the auditing and modelling of approximately 750 farms through numerous versions of OVERSEER. These 750 farms represent a range of farming types from piggeries, cropping farms and dairy farms through to complex high-country sheep and beef farms.

6. I have provided expert OVERSEER advice to applicants for resource consents as well as consent authorities. I have provided evidence on the application of OVERSEER as a result.

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

Scope of Evidence

8. My evidence will address and form conclusions on the particular aspects that were identified by Aurora Grant of Environment Southland in an email dated 10 June 2019.

9. I have reviewed and read the following documents:

Woldwide 1 & 2

I. Resource Consent Application – WW1 & WW2
II. Application (Part A) – WW1 & WW2
III. Application Appendices – Key – WW1 & WW2
IV. Farm Environment Management Plan – Appendix WW 1 & 2
V. Farm Environment Management Plan -Appendix N – WW1
VI. Farm Environment Management Plan – Appendix N – WW2
VII. Nutrient Budget Analysis – WW1 & WW2 – updated report provided in August 2019
VIII. Resource Consent Application (Wintering Barn) – WW1
IX. Resource Consent Application (wintering barn) – WW2
X. WW1+2 – summary of amendments to application for resource consent
XI. Appendix A – WW1 & WW2
XII. Appendix B – WW1 & WW2
XIII. Appendix C – WW1 & WW2
XIV. Appendix D – WW1 & WW2
XV. Appendix E – WW1 & WW2
XVI. Phosphorus mitigation plan WW1_WW2_31_07_2019 – provided in August 2019

Woldwide 4 & 5

I. Resource Consent Application – WW4 and WW5
II. Application (Part A) & Companies Register – WW4 & WW5
III. Farm Environment Management Plan – WW4
IV. Farm Environment Management Plan – WW5
V. Farm Scenario Plan – WW4 – updated report provided in August 2019
VI. Farm Scenario Plan – WW5 – updated report provided in August 2019
VII. Nutrient Budget Analysis – Woldwide Runoff – WW4 & WW5
VIII. Investigation of Cracking soils – WW4 & WW5
IX. Woldwide 4 5 Ltd P Mitigation and Barn changes nutrient budget final – provided in August 2019

Woldwide Runoff

I. Nutrient budget Analysis – Woldwide Runoff – WW4 & WW5 – updated report provided August 2019

II. Proposal & AEE – Woldwide Runoff – WW4 & WW5

10. OverseerFM files were published and provided after the updated nutrient budget analysis was provided by the applicant in August 2019. This has allowed me to review my evidence using the OverseerFM publications. I had published access to the following FM modelling:

Woldwide One & Two Ltd

- Year ending 2014
- Year ending 2015
- Year ending 2016
- Year ending 2017
- Horner Block current
- Horner block proposed
- Woldwide One and Two Ltd – Proposed final

Woldwide Four Ltd

- Current Year Sheep farm
- Proposed Consent adj area 2019
- Current season 2012-13 to 16-17
- Woldwide4 Consent Barn Final Proposed 2019

Woldwide Five Ltd

- Proposed consent xtra effluent
- Current years 16-18 Effluent adj

- Woldwide Five winter barn inclR2HfrApril 2019#adj

Background and OVERSEER review

11. In August 2018 the Regional Council instructed Irricon Resource Solutions Limited to carry out a technical review of the OVERSEER Nutrient budgets and supporting information provided to the Council by the appellants and to report on:

    I. The appropriateness of the inputs into the modelling.
    II. The robustness of the nutrient loss to water estimates made by the OVERSEER modelling.
    III. The consistency of the OVERSEER budgets with the application as a whole and with best practice guidelines.
    IV. The extent to which the modelled farms represent realistic, viable long-term farming systems.

12. For the purposes of the assessment I was provided with:

    V. OVERSEER XML Files for: Woldwide 1,2 & 96 for 2013/2014, 2014/2015, 2015/2016 and 2016/2017
    VI. Application Woldwide One Ltd, Woldwide Two Ltd Nutrient budgets analysis
    VII. Woldwide 4 – current and proposed OVERSEER XML Files
    VIII. Application Woldwide Four Ltd -Nutrient Budget analysis
    IX. Woldwide 5 – current and proposed OVERSEER XML files
    X. Application Woldwide Five Ltd – Nutrient budget analysis

13. I subsequently produced a written report for the Council on the modelling that had been carried out.

14. In June 2019 the Council requested that I review the OVERSEER analysis for the most recent application from the applicant and comment on any changes.

15. The following four reports were provided by the Council:

    I. Farm Scenario Plan WW5
    II. Farm Scenario Plan WW4

III. Nutrient Budget/Analysis WW Runoff

IV. Nutrient Budget/Analysis WW1,2, SH96 and Marcel block.

16. No OVERSEER XML files were provided in June 2019.

17. The Nutrient Budget/Analysis report provided for WW1 and WW2 (including SH96 and Marcel Blocks) in June 2019 is the same report provided in August 2018, with updated Nitrogen and Phosphorus losses in OVERSEER v6.3.1. The report was completed by TIAKI – Farm Source Sustainable Dairying. As the nutrient losses were updated into the current version of OVERSEER v6.3.1 I was able to check the N and P loss against the original XML file provided. The N and P loss in the report provided in June 2018 was the same as the XML file provided in August 2018.

18. The Farm Scenario Plan for WW5 provided in June 2019 is dated 22/02/2019 and was completed by Ravensdown Environmental. This report has a different date from that provided in August 2018, but the nutrient loss figures are the same and reported using OVERSEER v6.3.0.

19. The Farm Scenario Plan for WW4 provided in June 2019 is dated 07/08/2018 and was completed by Ravensdown Environmental. This is the same date and report provided in August 2018 and uses nutrient loss figures from OVERSEER version 6.3.0.

20. I have reviewed the Farm Scenario Plans or Nutrient Budget/analysis reports provided to me by the Council in June 2019 and can confirm that these are the same reports for the budgets reviewed in August 2018 for WW1, 2, 4 and 5.

21. I have also reviewed the OverseerFM publications and can confirm these are the same files provided by Council in June 2019.

22. A Nutrient Budget analysis for Woldwide Runoff has been provided in June 2019. No analysis was provided in August 2018 for this property, so a review has been completed as part of this evidence. I can confirm that I have identified no issues within this Nutrient budget that would cause concern and that it has a medium - high robustness of inputs and outputs.

23. The original nutrient budgets/analysis report indicates that there are no changes proposed to the Runoff property, that the operation is proposed to continue within the nutrient loss parameters identified in the report.

24. An updated report provided in August 2019 indicates there will be changes on the Runoff block.

25. The main change outlined on page 4 of the report is the wintering of 450 R2's in June and July.

26. The report outlines that this stock have previously been wintered at Heddon Bush. 55% of the R2's will be wintered in barn facilities on WW 1,2 and 4, whilst the remainder (450) will be moved out of the Heddon Bush area where soils are more prone to nitrate leaching.

27. These changes results in a reduction in N loss under the proposed scenario from 26kg N/ha/yr to 25kg N/ha/yr, and a reduction in P loss from 0.6kgP/ha/yr to 0.5kgP/ha/yr.

28. Three additional aspects were requested by the Council to be reviewed and discussion/comments provided. These are outlined below:
    I. Comment on the conversion of sheep pasture to dairy, and what the expected change in losses could be (increase or decrease) and if any proposed mitigations/ GMPS are likely to be enough to offset the change in use on the sheep block.
    II. Discuss the effect on nutrient losses from installing barns as a mitigation, and what losses could be expected to be until that mitigation is installed
    III. Discuss the farm systems in place on the properties and if they are in line with generally accepted GMPS/ BMP (including the runoff block and cut and carry blocks).

Conversion of sheep pasture to dairy, what the expected change in losses could be and if any proposed mitigations/GMP's are likely to be enough to offset the change in use on the sheep block

29. The applications for WW4 and WW5 seek to change land use on 136.3ha from predominantly sheep pasture to dairy and associated support farm.

30. The Farm Scenario reports provided detail the nutrient loss on the current sheep farm and the proposed nutrient loss when the 136.3ha is incorporated into the existing dairy and support farms.

31. WW4 is proposing to include 63.3ha of the sheep farm in the dairy platform and WW5 will include 70ha.

32. The current sheep farm operation is identified as occurring on Brax_4a.1 (Braxton), Tuap_6b.2 (Tuatapere) and Upuk_8a.1 (Upukerora) soils. There is a swede block that is modelled as a fodder crop block that I have excluded, as it is modelled as a fodder crop block rotating around all of the different soil types.

33. The sheep farm blocks have been added to the following blocks in the proposed dairy platform for WW4 (page 22 of the Farm Scenario Plan):

    I. Brax_4a.1 Non-Eff Tile – 38.5ha

    II. Tuap_6b.2 Non-Eff – 23.5ha

    III. 1.3ha into non-productive or Riparian area

34. Page 30 of the Farm Scenario report – WW4 confirms that the Upukerora soils have not been included in the proposed scenario for WW4 as these soils are all proposed to be included in the WW5 farm area.

35. The difference in nutrient loss between the different land uses has been summarised in the Tables 1 and 2 below. All figures are from Farm Scenario Plan WW4 and Farm Scenario Plan WW5.

Table 1: N and P loss from the current sheep operation and the proposed dairy on WW4 -summary across all soil types and block types

WW4 – N loss v6.3.1	Current Sheep		Proposed Dairy	
Kg/ha/yr	N	P	N	P
Brax_4a.1	10	0.4	27	0.5
Tuap_6b.2	15	0.1	49	0.2
Upuk_8a.1	38	0.3	-	-

36. As the above tables outlines for WW4 the Nitrogen and Phosphorus loss on the Braxton and Tuatapere soils increases

37. The sheep farm area has been included in the following blocks on the proposed dairy platform for WW5 (Farm Scenario Plan Page 25)

    I. Brax_4a.1 Non-Eff – 30.6ha

    II. Tuap_6b.2 Non eff – 2.0ha

    III. Upuk_8a.1 Non eff – 3.6ha

    IV. Tuap_6b.2 FBt>Fbt – 10ha

    V. Tuap_6b.2 Past>Fbt – 10ha

VI. Tuap_6b.2 FBt>YG – 10ha

VII. Brax_4a.1 Past>Fbt – 1.23ha

VIII. Brax_4a.1 Fbt>Fbt – 1.23ha

IX. Brax_4a.1 FBt>YG – 1.23ha

38. The N and P loss is more complicated for WW5 due to the nine blocks that the sheep farm area has been spread across. Where there is no crop rotation noted above the block is a pasture block.

Table 2: N and P loss from the current sheep operation and the proposed dairy on WW5 -summary across all soil types and block types

WW5 – N loss v6.3.1	Crop rotation	Current Sheep		Proposed Dairy	
Kg/ha/yr		N	P	N	P
Brax_4a.1		10	0.4	26	0.2
Brax_4a.1	Fbt>Fbt			53	1
Brax_4a.1	Past>Fbt			43	1
Brax_4a.1	Fbt>YG			31	0.5
Tuap_6b.2		15	0.1	46	0.1
Tuap_6b.2	Fbt>Fbt			84	0.4
Tuap_6b.2	Past>Fbt			72	0.3
Tuap_6b.2	Fbt>YG			51	0.2
Upuk_8a.1		38	0.3	83	0.4

39. The N loss for WW5 increases across all soil types and block types, with the greatest increase on the Tuap_6b.2 Fbt>Fbt crop block. The P sees an increase on the Upukerora pasture block, a reduction on the Braxton pasture and no change on the Tuatapere pasture block. All of the crop blocks see an increase in P loss across the Braxton and Tuatapere soils.

40. Page 31 of the Farm Scenario Plan for WW4 outlines the Whole Farm Nutrient loss based on the total farm area of 349.3ha. The below table is a summary of the nutrient loss across the under the combined current (dairy platform and sheep) and the proposed scenario (dairy platform), along with the barn example.

Table 3: WW4 – summary of N and P losses

WW4 – v6.3.1	Combined Current loss	Proposed	Barn Example
N loss kg/ha/yr	29	28	23
Total N loss kg/farm	11,792	11,619	9,550

P loss risk kg/ha/yr	0.9	0.8	0.9
Total P loss kg/farm	340	345	366

41. The N loss on a kg/ha/yr and total kg/farm basis decreases across both proposed scenarios , on WW4.

42. The P loss increases on a total kg/farm basis under both proposed scenarios Page 34 of the Farm Scenario Plan for WW5 outlines the Whole Farm Nutrient loss. The below table is a summary of the nutrient loss across the total 349.3ha area under the combined current and the proposed, along with the barn example.

Table 4: WW5 – summary of N and P losses

WW5 – v6.3.1	Current loss	Proposed	Barn Example
N loss from the root zone kg/ha/yr	48	48	43
Total N loss kg/farm	15,978	16,029	14,378
P loss risk kg/ha/yr	0.7	0.7	0.7
Total P loss kg/farm	239	232	244

43. The N on a kg/ha/yr basis remains unchanged under the proposed whilst the barn example shows a decrease.

44. The P loss on a kg/ha/yr basis remains unchanged under both proposed scenarios.

45. However, The total kg/farm N loss increases under the proposed scenario and shows a decrease under the barn example.

46. The P shows decrease on a total kg/farm basis for the proposed scenario and an increase in the barn example.

47. These mitigations are described below and an outline of whether this will see a decrease in N or P loss across the farms.

<u>WW4</u>

48. A reduction in stocking rate and Nitrogen use in the proposed scenario is shown as able to be achieved due to the increase in land area and reduction in pasture production across the total

farm area from 15.2T currently and 14.2T under the proposed system. Due to the increase in area and the lower pasture production, Nitrogen use consequently is also reduced.

a. Effluent storage – no changes under the proposed farm system

b. Cropping on Braxton soils – no crops will be grown on the Tuatapere soils that are introduced from the sheep block. This is due to the lighter nature of these soils.

c. Winter barn – the introduction of a winter barn allows the farm to remove all cropping area from the cut and carry block. This shows a reduction in N loss.

49. WW5 mitigations are confined to the use of the wintering barn which will be discussed in the next section of this evidence.

50. The mitigations for WW4 are included in the OVERSEER modelling and are therefore included in the N and P loss figures in the tables above.

51. The proposed scenarios for both WW4 and WW5 show an increase in N loss on a block level, across all three soil types when comparing the sheep pasture to the dairy platform and associated crops.

52. The current and proposed mitigations for WW4 suggest that there is no increase in N and P across the total farm area when reviewing the properties on a kg/ha/yr basis.,

53. The proposed mitigations included in the modelling for WW5 also suggest that there is no increase in N or P loss across the total farm area on a kg/ha/yr basis.

54. None of the proposed mitigations or practices identified on WW4 or WW5 offset the increase in N and P loss on the sheep pasture when converted to dairy, although they suggest that there is no increase in N and P losses on a kg/ha/yr basis across the total farm area.

Effect on nutrient losses from installing barns as a mitigation and what the losses could be expected to be until the barns are installed

55. A proposed scenario has been modelled for all four dairy platforms that includes either the construction of a wintering barn (WW4 and WW5) or the expansion of the existing barns (WW1 and WW2).

56. There are many environmental benefits from the construction of a wintering barn as outlined in the Farm Scenario Plans for WW4 and WW5 and Nutrient budget/analysis – WW1,2, SH92 and Horner block, such as:

    I. Reduction (or removal) of summer and winter crop area as stock are wintered inside; and

    II. Expanded use of dairy effluent and a corresponding decrease in N fertiliser use.

57. There is either no change or a reduction in N loss under the proposed barn examples on a kg/ha/yr basis. Across all four dairy platforms the P loss on a kg/ha/yr basis does not change under the barn scenario.

Table 5: Summary of N and P loss kg/ha/yr across all four dairy platforms under the current farm system and the proposed barn example

V6.3.1	WW1 and WW2		WW4		WW5	
kg/ha/yr	Current	Barn	Current	Barn	Current	Barn
N loss	41	38	29	23	48	43
P loss	0.7	0.7	0.9	0.9	0.7	0.7

58. There are mitigations detailed in the Farm Scenario or Nutrient Budget/analysis reports but the key drivers of the decrease in N loss with the increase in cow numbers under a barn scenario is the removal of winter and summer crops.

<u>WW1 and WW2</u>

59. WW1 and WW2 currently has a barn on farm as outlined in the Nutrient Budget/Analysis with the proposed barn scenario incorporating:

    I. Increasing the barn facilities to house 1250 cows from 900;

    II. removal of in paddock winter grazing of mixed age cows and young stock;

    III. Increasing peak cow numbers to 1500 from a currently consented 1340.

60. The proposed nutrient loss with the expanded barn facilities is 38kg N/ha/yr and 0.7kg P/ha/yr, as a combined average across both properties.

61. WW1 and WW2 have been modelled together in the one Nutrient budget for the proposed scenario. Therefore, the proposed expanded barn facilities and increase in cow numbers is modelled as occurring across both properties.

62. As WW1 and WW2 have been modelled as one nutrient budget the proposed losses cannot be easily split between the two properties from the information provided.

63. A report provided in August 2019 titled *Phosphorus Mitigation plan* details additional mitigation calculations completed in relation to P loss on farm.

64. It is noted in the report that the calculations relate to aspects that are not taken into account as Overseer is not spatially explicit and is unable to account for landscape features.

65. Therefore, additional calculations were provided by the applicant to show reductions that were likely to occur on farm in relation to improved vegetative buffer strips and lane management as outlined in the report.

66. The reduction in P loss is detailed in Table 1 as 13.1kg/farm reduction in losses from lanes, resulting in a recalculated P loss of 338kg/year or 0.7kg P/ha/yr under the barn scenario for WW1 and 2.

WW4

67. From reviewing the Farm Scenario plan for WW4 it appears as though there is no barn on the farm at present, therefore the N and P loss for the proposed scenario (28kg N and 0.8kg P/ha/yr) are the modelled losses on farm until such time as a barn is installed. This includes the increase in calving numbers from 810 currently to 850 and peak milking numbers from 775 to 830. The barn example sees a further increase in cows to 1030.

68. The proposed nutrient loss with the barn is 23kg N and 0.9kg P/ha/yr.

69. A report provided in August 2019 titled *Consent Nutrient Budget Adjustments* details P mitigation losses from Other sources.

70. Page 9 of the report looks at the same aspects as the *Phosphorus Mitigation Plan* for WW1 and 2 P mitigations e.g. lanes and critical sources.

71. Page 10 of the *Consent Nutrient Budget Adjustments* for WW4 details issues with Overseer not being able to account for P loss from Other sources when a winter barn is used as a scenario.

72. Additional Overseer modelling outlined in Table 4, page 10 shows the difference in N and P loss when modelling in Overseer with and without a Barn.

73. There is very little difference in P loss when modelling with and without a barn, indicating that the model maybe assuming that the additional cows being milked, and cattle wintered are still on the lanes and yards, whereas in this scenario they are proposed to be in the barn.

74. In my opinion Table 4 clearly shows that the model is likely to be overestimating P loss in a barn scenario.

75. The recalculated P loss is 337kg/year or 0.8kg P/ha/yr under the barn scenario for WW4, a reduction of 28.8kg. This reduction includes calculations based on lane and critical source areas and also the barn and no barn calculations.

<u>WW5</u>

76. From reviewing the Farm Scenario Plan for WW5, it does not have a wintering barn on farm at present.

77. The proposed barn farm system with nutrient loss of 43kg N/ha/yr and 0.7kg P/ha/yr includes an increase to calving 960 and peak milking 930 cows.

78. WW5 has modelled additional mitigation measures when the barn is installed of reducing peak cow numbers by 70 (page 3 of Farm Scenario Plan).

79. As above the recalculated P loss for WW5 with a barn based on the information described in pages 12 of the supplementary report is 233kg/year or 0.7kg P/ha/yr, A reduction of 12.7kg/farm.

80. All four dairy platforms have applied for an increase in milking cow numbers under the proposed scenarios with further increases in cow numbers under the new or expanded barn scenarios.

81. As outlined above the modelled for WW1 and WW2 is combined and therefore the increase in cow numbers is modelled as across the two properties.

Table 6: Proposed N and P losses for all four– not including a barn

	WW1 and WW2	WW4	WW5
N loss kg/ha/yr	38	28	43
P loss kg/ha/yr	0.7	0.8	0.7

82. The modelled proposed losses in Table 6 above are the likely nutrient losses across all four farms until the barns are expanded or installed.

83. This is provided that any changes/mitigations included in the Farm Scenario plans and Nutrient Budget/Analysis for the platforms are adhered too and the cow numbers milked are those that align with the proposed scenarios and not the barn scenarios.

84. Another consideration of expanding the barns on WW1 and WW2 is the additional effluent that will be generated and assumed to be deposited on the Horner block as is the current practice.

85. The Nutrient Budget/analysis on page 5 details that a legal opinion was provided in October 2018 that indicated that the Horner block was not considered to form part of the land holding connected to WW1 and WW2. As details have been provided it has still been considered in regard to the overall context of the application.

86. There is limited information on the current and proposed scenarios in the WW1 and WW2 Nutrient Budget/Analysis for the Horner block (pages 24-26).

87. It is unclear from reviewing the limited details whether stock have been included in the proposed modelling for the Horner block. Page 24 of the Nutrient Budget/analysis report indicates that the current modelling has been based on the 2017-2018 cut and carry operation. It is stated that wintered cows and young stock have been grazed on the property in the past but have not been included in the current modelling.

88. This is no detail on any stock to be grazed under the proposed scenario, detail is provided on the grass silage being cut per hectare. This is modelled as 17T/ha Dry matter grass silage being cut across the two cut and carry block inputs. At this rate of pasture being harvested for silage production, I would assume that no stock have been modelled as being grazed.

Table 7: Current and Proposed losses on the Horner block

	Current	Proposed
N loss kg/ha/yr	20	19
Total N loss kg/farm	3155	3107
P loss kg/ha/yr	0.1	0.1
Total P loss kg/farm	24	22

89. The volume of effluent applied in the current scenario and the proposed is high. The effluent is predominantly from the barn slurry.

90. The proposed scenario sees the Horner block split into two separate blocks for slurry application:

    a. 97ha grass silage with slurry from WW1 and WW2

    b. 56.5ha grass silage with slurry from WW3.

91. The 97ha grass silage block that is proposed to receive slurry from WW1 and WW2, sees an increase in nutrients applied through barn slurry from 166kg N and 42kg P in the current to 243kg N and 61kg P applied from wintering barn effluent in the proposed scenario.

92. The fertiliser applications are proposed to reduce under the proposed scenario from 293kg N and 21kg P to 207kg N and 10kg P.

93. Due to the limited information provided it is assumed that the proposed scenario considers the additional effluent from the expanded barn at WW1 and WW2.

94. Page 14 of the Nutrient Budget/Analysis shows that the proposed scenario for WW1 and WW2 dairy platforms includes one application of barn slurry onto 185ha. It is unclear if this is the additional slurry that is generated from the expanded wintering barn, or if it includes effluent from WW3

95. If the proposed scenario does not include the additional effluent from the expanded wintering barn, or the effluent is not spread across the dairy platforms, then it can be assumed that the N and P applied in winter barn slurry would increase on the 97ha area of the Horner block when the expanded barn is built and therefore potentially the N and P losses would increase beyond what is modelled in the proposed scenario.

Table 8: Total N applied to the WW1 and WW2 barn slurry area of the Horner block in the current and proposed scenarios

	Current	Proposed
N from effluent	166	243
N from fertiliser	293	207
Total N applied across WW1 and WW2 area	459kg N/ha/yr	450kg N/ha/yr

96. As can be seen in Table 8 the total N applied across the area of the Horner block receiving WW1 and WW2 barn slurry is very similar in the current (459kg N/ha/yr) and the proposed scenario (450kg N/ha/yr).The Proposed Southland Water and Land Plan Part A, decision version, Rule 38 indicates that the maximum loading rate of Nitrogen for a permitted activity is 150kg N/ha/yr.

97. Fertiliser use on NZ Dairy Farms booklet indicates that annual loading rates from effluent can vary from 150kg N/ha to 200kg N/ha across New Zealand. The proposed scenario N applied in effluent (243kg N/ha/yr) exceeds the higher of the booklet application rates and the permitted activity rate in the Land and Water plan decisions version.

98. The total N loading rate applied across the WW1 and WW2 area of the Horner block is very high at 459kg N and 450kg N/ha/yr in the current and proposed scenarios respectively.

99. The N loss from the Overseer modelling appears to be quite low considering the high total N inputs, but the N loss is consistent across the two scenarios so is therefore comparable.

100. The property contains Braxton soils. These soils are rich in clay and are known for their swell when wet and crack when dry properties. This potentially creates preferential pathways (via artificial drainage when wet or soil cracks when dry) for contaminants to drain rapidly through the soil and enter groundwater.

101. As the same soil types have been used for both the current and proposed scenarios we are comparing ‘like with like’ in regard to modelled effects below the root zone and beyond the property boundary.

102. Provided the applications of effluent and fertiliser adhere to good management practices then the modelling suggests that the effect of the proposed scenario will be no greater than the current.

103. There is a 1% reduction in total N loss (kg/farm) across the total farm area under the proposed scenario, although the reduction on a kg/ha/yr basis is 5%.

104. It is therefore assumed that the modelled impact below the root zone and beyond the farm boundary of the proposed scenario is similar to the current scenario.

105. In my opinion the total N applied on the Horner block is very high, with the N applied in effluent exceeding the generally accepted application rates of between 150-200 kg N/ha/yr.

106. I would expect due to the very high total N applied that a certified consultant is providing fertiliser recommendations including the need for additional N from fertiliser, on an annual basis for this property. It is not clear from the Nutrient Budget/analysis report if fertiliser recommendations are provided.

Discuss the farm systems in place on the properties and if they are in line with generally accepted Good Management Practice (GMP) (including the runoff block and cut and carry blocks).

107. OVERSEER is the only tool available in New Zealand that produces annual nutrient loss information at a farm scale across a large range of farming types, including pastoral, arable, horticultural and cut and carry systems.

108. OVERSEER is based on three assumptions:

a. Annual average – the model uses annual average inputs and produces annual average outputs.

b. Near equilibrium conditions – model assumes that the farm is in a 'steady state' where there are minimal changes each year

c. Actual and reasonable inputs - need to understand the impacts of changing inputs on the outputs. Also assumes farms are operating at GMP.

109. There are a number of physical good management practices that are assumed within OVERSEER that cannot be modelled e.g. direction of grazing winter feed crops in relation to waterways, even spread of effluent and fertiliser.

110. For these properties a reasonable amount of detail on the GMP's that cannot be specifically modelled in OVERSEER is included in the Farm Environment Management Plans (FEMP). The use of a FEMP is generally accepted as the best tool to contain information on GMP's that are unable to be modelled in OVERSEER.

111. The adherence to the GMP's outlined in the FEMP forms a large part of ensuring that the property is operating in accordance with GMP and giving parties the confidence of what is actually occurring on farm. Two different parties have completed the FEMP's for these properties: WW1 and WW2 – Dairy Green Ltd and WW4 and WW5 – Landpro.

112. The FEMP for WW1 and WW2 has been reviewed in 2018 and 2019 by Dairy Green Ltd. There is no comment included in the FEMP on whether the property was adhering to the GMP's included in the FEMP at the time of review.

113. The FEMP's for WW4 and WW5 are proposed to be reviewed annually and a report provided to the Council. There is no definition of the person who would review and complete the report. It does not appear as though the FEMP's for WW4 and WW have been reviewed at this time.

114. To ensure that the GMP's in all of the FEMP are being adhered too and the Council has confidence of this, in my opinion it is important that the FEMP is reviewed and audited by a person independent of the farming operation.

115. There are also generally accepted GMP's where OVERSEER modelling allows inputs to veer from what would be considered GMP such as winter fertiliser applications or large P applications.

116. The Farm Scenario plans, and Nutrient Budget/analyses have been reviewed to identify any inputs into OVERSEER that would be seen to not necessarily be in line with GMP's.

117. It is assumed that all other inputs are in line with generally accepted GMP with the exception of the inputs identified in the table below.

118. The following documents were used as reference documents for determining GMP:

I. Fertiliser use on New Zealand Dairy Farms – Fertiliser Association of New Zealand

II. Industry agreed Good Management Practices relating to water quality – MGM Governance Group, September 2015

Table 9: Summary of OVERSEER inputs that are not likely to be in line with generally accepted GMP's

WW1 and 2	**Not in line with GMP or no comment to allow a conclusion to be made**
Effluent	N/A
Soil/Cropping/ Sediment	Sowing of crops – no ability to determine how soon after grazing, crops are resown into pasture or crop
Fertiliser	WOL and WTL non effluent block in 2014/2015 has a N application in May Current year NB and Proposed NB shows a difference in total N applied (includes effluent and fertiliser) to effluent and non-effluent blocks. Example: Proposed - 209kg N on non-effluent compared to 271kg on the effluent block – when comparing the same soil type (Drum_2a.1)

	the difference in N loss on the blocks is 38kg N/ha/yr non effluent compared to 45kg N/ha/yr effluent (Nutrient Budget/analysis Appendix 2)
Cut and carry and runoffs	More than 400kg N applied to cut and carry blocks - If more than 200kg N is applied, then the Code of Practice should be consulted
WW4	**Not in line with GMP or no comment to allow a conclusion to be made**
Effluent	N/A
Soil/Cropping/ Sediment	Sowing of crops – no ability to determine how soon after grazing, crops are resown into pasture or crop
Fertiliser	Current and Proposed NB shows a difference in total N applied to effluent and non-effluent blocks. Example: This sees an increase in N loss on a block level between the Braxton soils on the current system from 28kg on the effluent block to 25kg on the non-effluent block (reviewed in published file)(
WW5	**Not in line with GMP or no comment to allow a conclusion to be made**
Effluent	N/A
Soil/Cropping/ Sediment	Sowing of crops – no ability to determine how soon after grazing, crops are resown into pasture or crop
Fertiliser	Current and Proposed NB shows a difference in total N applied to effluent and non-effluent blocks. Example: This sees an increase in N loss on a block level between the Braxton soils on the current system from 32kg on the effluent block to 30kg on the non-effluent block (page 43)
WW Runoff	**Not in line with GMP or no comment to allow a conclusion to be made**
	No issues identified in the Nutrient budget/analysis report

119. The Farm Scenario Plans for WW4 and WW5 indicate that the N fertiliser applied is reduced on the effluent blocks (Farm Scenario plan page 21 – WW4 and page 29 – WW5).

120. Although the N fertiliser has been reduced you still see an increase in the total N applied to the effluent blocks on all four dairy platforms. As can be seen from the examples above the increased total N applied leads to an increase in N loss on a kg/ha/yr block basis.

121. After reviewing the FEMP's, Farm Scenario Plans or Nutrient Budget/analysis for the five properties I can confirm that it appears as though it is the intent of the applicant to farm in line with generally accepted GMP. Although without good FEMP audit documents or a review of the farm records I cannot confirm if the appellants are currently farming in line with generally accepted GMP's. Some inputs in the OVERSEER modelling suggests that some aspects of the current farming operation are not in line with generally accepted GMP's.

122. In my experience any GMP's that will be adopted on farm can be outlined in a Farm Environment Management Plan (FEMP). Regulation of a FEMP can be achieved by way of consent conditions that detail what a FEMP must contain, and requirements for it to be independently audited by a suitably qualified person firstly within 12 months of the first exercise of the consent and then at regular intervals thereafter. In Canterbury for example, the audit timeframe is dependent on the Audit Grade received at the first audit and then subsequent audits thereafter. The Environment Canterbury audit grade timeframes are included as Appendix One.

Conclusions

123. WW4 and WW5 are proposing to convert 139.6ha of sheep farm to a dairy farm and associated crops.

124. The N and P losses on the sheep blocks increase under the proposed scenarios when land use is changed to dairy pasture and associated crops.

125. The N and P loss across the total farm areas on a kg/ha/yr basis show either no change or a decrease under the proposed scenarios when compared with the combined current scenario.

126. Mitigations and GMP's in place or proposed on WW4 and WW5 do not offset the increase in N loss on the sheep blocks, when reviewing the files on a block basis.

127. New barns (WW4 and WW5) and an expanded barn (WW1 and WW2) are provided as proposed scenarios.

128. Cow numbers are proposed to increase under the proposed scenarios across all farms and then further increases in cow numbers are proposed under the barn scenarios.

129. The cow number increases are offset by a reduction or removal of cropping areas.

130. The total N and P loss on a kg/ha/yr basis either doesn't change or shows a decrease under the barn examples when compared to the current combined scenarios.

131. The proposed OVERSEER scenarios are representative of the likely N and P losses until such time as the barns are installed.

132. Additional reports detailing Phosphorus Mitigation measures for other sources of P in barn scenarios for WW4 and WW5 were provided by the applicant.

133. In my opinion based on the modelling results in Table 4 of the report, it is likely that Overseer is overestimating the P loss in the barn scenario.

134. Further P mitigations were provided in relation to lanes and critical source areas for all four farms and the likely reduction in P loss based on implementing actions contained in the relevant reports e.g. culvert placement, buffer riparian areas.

135. These further P reductions for lanes and critical source areas are based on implementing farm actions contained in the relevant plans for each property. It is imperative that these on farm actions are implemented and monitored in order to achieve the reductions specified.

136. From reviewing the FEMP's, Farm Scenario Plans or Nutrient budget/analysis reports it is clear that it is the intention of the appellants to operate the farm systems in line with generally accepted GMP's. Those practices that are unable to be modelled in OVERSEER are included in the FEMP's.

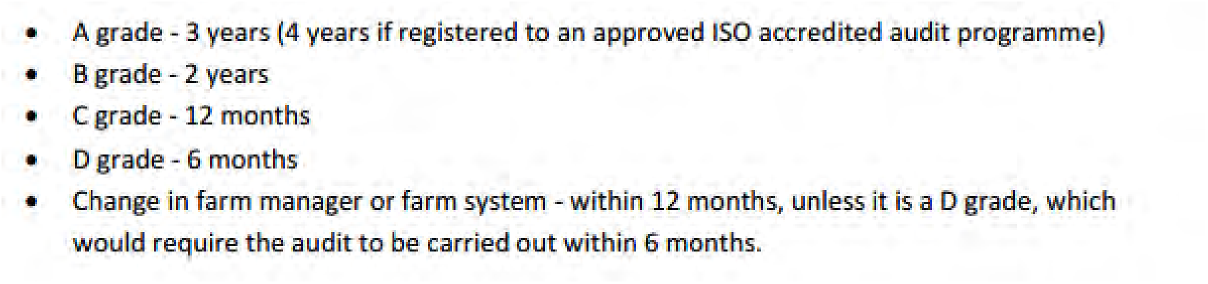
137. There is one key input in the OVERSEER modelling that indicated that the current farm systems are not necessarily operating in line with generally accepted GMP's; total N application on the effluent blocks are higher than the non-effluent blocks.

138. It is clear from WW4 and WW5 scenario plans that the fertiliser inputs have been reduced on the effluent blocks, even with the reductions there is an increase in total N applied. Examples of the difference in N loss on effluent and non-effluent blocks on the same soil types are included in Table 7.

139. It is my view that the OVERSEER model should be used in conjunction with Farm Environment Management Plans (FEMP or FEP), which will ideally detail the mitigation strategies that will be employed on farm that OVERSEER currently does not account for along with all relevant GMP's. The FEP/FEMP should be audited by an independent suitably qualified person at regular intervals to ensure that the mitigation strategies are being carried out and that the GMP's detailed in the FEMP are being adhered to, but also to review their effectiveness.

Appendices

Appendix One: FEP Audit Timeframe after the first Audit has been completed.



- A grade - 3 years (4 years if registered to an approved ISO accredited audit programme)
- B grade - 2 years
- C grade - 12 months
- D grade - 6 months
- Change in farm manager or farm system - within 12 months, unless it is a D grade, which would require the audit to be carried out within 6 months.

References.

Watkins. N & Selbie. D. *Technical Description of OVERSEER for Regional Councils. Report prepared for Bay of Plenty Regional Council.* September 2015

Environment Canterbury. Canterbury Certified Farm Environment Plan (FEP) Auditor Manual. February 2016.

Fertiliser use on NZ Dairy Farms booklet. Fertiliser Association of NZ.

NUTRIENT BUDGETS/ANALYSIS

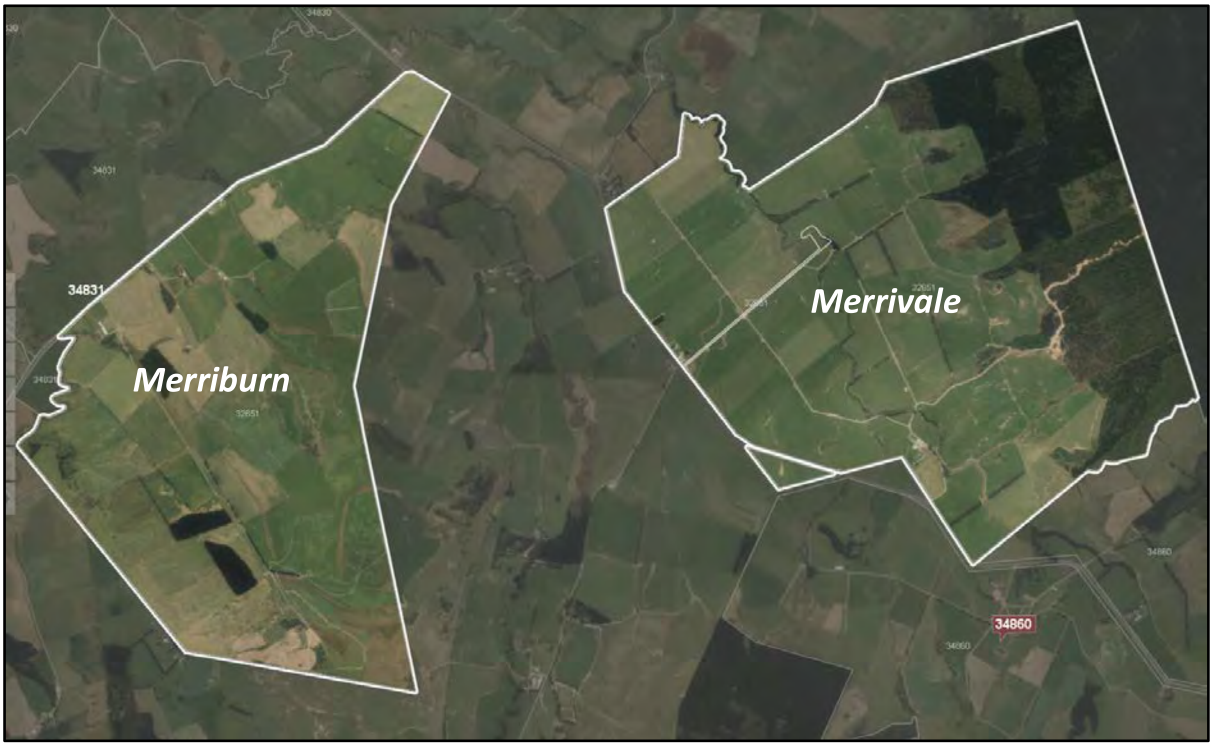
Woldwide Runoff (Supplementary Report)

1.0 Overview

This report provides details and commentary on the nutrient budgeting that has been undertaken for Woldwide Runoff (WR) and forms part of two wider resource consent applications for expanded dairying at Woldwide 1, 2, 4 & 5. Background information and details of the nutrient budgeting for Woldwide 1, 2, 4, 5 and Horner Block can be found in the detailed reports produced for those farms by Ravensdown and Farm Source.

WR is comprised of two separate blocks being the 385ha (~338ha effective) Merriburn Block and the 507ha (~321ha effective) Merrivale Block. The Merrivale Block is owned by WR with the Merriburn Block being leased; however they are both run as a single farm. The two properties are located in Western Southland to the north east of Tuatapere.

WR is used to graze young stock from five dairy farms with baleage being made during periods of surplus grass production. Baleage is used to supplement the winter grazing of young stock at WR and is also sold to Woldwide Farms and the Woldwide dairy farms. In addition to the raising of young stock and baleage production, WR also has approximately 100ha of commercial pine plantation and 60ha of Beech forest under a sustainable management plan.



The Merriburn Block was incorporated into WR in the 2017-18 dairy season, however there was only limited information made available on its production potential and previous stocking rates. This was largely due to the passing away of one of the previous owners who had overseen the property.

This has resulted in difficulties being able to source information to model the use of the Merriburn Block prior to 2017. In general terms it is known that the property was used for the rearing and wintering of young stock (R1's and R2's) for the former Milkpride dairy management company.

It is important that the use of the land prior to the property being leased to WR is reflected as the available evidence indicates it was a significantly more intensive use than what is proposed and currently occurring on the Merrivale Block. This is significant as in 2017-18 WR was understocked, resulting in considerable difficulty controlling pasture growth, which in turn impacted on pasture quality and animal growth rates.

Only using the 2017-18 land use to determine baseline nitrogen and phosphorus losses would result in further reductions in nutrient losses being required from a baseline that already reflects significant reductions in nitrogen and phosphorus loss compared to past years. On this basis a 2016-17 nutrient budget has also been produced, which reflects the actual inputs for the Merrivale Block (which was under the ownership of WR) and a conservative estimate of the land use occurring on the Merriburn block.

	16/17	**17/18**	**Average**	**Proposed**	**% Change**
Total N Loss (kg)	26134	19931	23033	22603	-1.9
N Loss/ha (kg)	29	22	26	25	
Total P Loss (kg)	500	532	516	489 (433)*	-5.2 (-16)*
P Loss/ha (kg)	0.6	0.6	0.6	0.5	
Pasture Grown (kg/DM/ha/yr)	12639	11024	11832	13282	

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

2.0 Pre-Expansion Land Use

Two pre-expansion nutrient budgets have been produced covering the period from August 2016 to July 2018. An overview of the pre-expansion files is provided below with details of the inputs used contained in Section 9.

2.1 *August 2016 – July 2017*

In 2016/17 there were 850 rising 1 year olds (R1's) and 850 rising 2 year olds (R2's) on the Merrivale Block. R2 numbers were trimmed by 115 cows in March due to a cull of empty cows (not in calve). In addition to the R1's and R2's there were 25 empty carry over cows. On the Merriburn Block stock data estimates have been provided by the former farm manager who estimated there were 600 R1's and 600 R2's on the property. All stock were wintered on. In addition to this there would have also been some carry over cows (conservative number of 25 used) and mating bulls. 70 mating bulls (1st November to 10th January) have been used across both properties, as per what currently occurs.

Kale was grown on both blocks to facilitate the winter grazing of 1450 R1's and 600 R2's. The Dairy NZ crop calculator has been used to determine the area of winter crop required for the 600 R2's (480kg/lwt) on the Merriburn Block with 650 (220kg/DM) bales of baleage also fed. The calculator determined approximately 38ha of kale is required to provide sufficient feed for 2 months (June & July).

In addition to this, 850 R1's were wintered on the Merrivale Block on 30ha of kale with approximately 600 bales of baleage. On Merriburn the Dairy NZ crop calculator was again used to determine the required area of kale crop for 600 R1's (210kg/lwt) with 400 bales (220kg/DM) of baleage also fed. The calculator determined approximately 20ha was required.

In order to support the winter grazing assumptions made for the Merriburn Block aerial imagery (Google Earth) has been used to look at areas of the farm that were under cultivation. The most recent image of the farm prior to it being leased to WR is December 2015. The areas cultivated at this time have been placed onto a farm map (Appendix 3) showing paddocks and their subsequent size. The area under cultivation was approximately 120ha. Assuming half of this area was returning to grass (which is unlikely as some paddocks would be double cropped) then 60ha would have been utilised for winter grazing. This can be compared to the 58ha under winter crop in the Merriburn Block in the 2016/17 Nutrient Budget.

Fertiliser inputs into the nutrient budget are based on purchase records from Ravensdown for the 2016-17 season for the Merrivale Block, with soil test results entered as an Olsen P level of 25, which is the long term objective for WR. On certain areas of the Merrivale Block capital applications of phosphorus were applied in 16/17 to lift Olsen P levels. Fertiliser inputs for the Merriburn Block have been based on conservative fertiliser inputs of both nitrogen and phosphorus (below maintenance requirements) on pasture blocks and standard fertiliser recommendations for the kale crops.

Supplements in the form of baleage was made on Merrivale in the form of 1200 bales (220-240kg/DM) which were utilised on crop paddocks, on normal pasture blocks to cover feed shortages and exported off farm to other Woldwide operations. It is assumed baleage would also have been made on the slightly larger Merriburn Block and a conservative estimate of 1100 bales (220-240kg/DM) were produced and utilised on crop paddocks.

	Total 16/17	**Per/ha 16/17**
Nitrogen Loss (kg/N)	26134	29
Phosphorus Loss (Kg/P)	500	0.6
Pasture Production (kg/DM)		12,639

2.2 August 2017 – July 2018

In 2017/18 there were 1265 R1's and 1265 R2's at WR. R2 numbers were trimmed to approximately 1150 in March due to a cull of empty cows. In addition to the R1's and R2's there were 37 empty carry over cows 70 mating bulls (1st November to 10th January) grazing on WR.

In 2017/18 there was 52ha of Kale was grown on WR (36.5ha on Merriburn and 15.5ha on Merrivale) to facilitate the wintering of 1265 R1's between the 20th May and the 10th August. In addition to Kale the R1's were also feed approximately 1188 bales of baleage (240kg/DM).

Fertiliser inputs into the nutrient budget are based on the purchase records from Ravensdown for the 2017-18 season, with soil test results entered as an Olsen P level of 25, which is the long term objective for WR. On certain areas of the Merrivale Block capital applications of phosphorus were applied in 17/18 to lift Olsen P levels. In addition to this paddocks on steeper topography didn't receive fertiliser.

4048 bales (240kg/DM) of baleage were made on WR which were utilised on crop paddocks and exported off farm to other Woldwide operations.

As mentioned previously, during 2017/18 it became clear to the owners of WR that the farms were understocked as pasture growth couldn't be adequately controlled resulting in poor quality pasture and stock growth issues. This is reflected in the lower pasture production figures for the 2016/17 season as Overseer back calculates pasture growth from animal feed demands not actual pasture grown. A more realistic Overseer pasture production figure would be 13T/DM/ha, which shows the under utilisation of pasture during the 16/17 season.

	Total 17/18	**Per/ha 17/18**
Nitrogen Loss (kg/N)	19931	22
Phosphorus Loss (Kg/P)	532	0.6
Pasture Production (kg/DM)		11,024

3.0 Proposed Land Use

In the proposed scenario there are no changes to the total size of WR although an additional 12ha of pasture on the Merrivale Block is planted in trees. This reduces the effective area of the Merrivale Block to ~309ha and the overall effective area of the farm to ~647ha.

It is proposed to continue to rear 1265 R1's and 1265 R2's on the properties with R2 numbers dropping to 1165 in March. Carry over cow and mating bull numbers are based on the 2017-18 figures of 37 carry overs and 70 bulls. The main change in the proposed budget from the 2017-18 season is the wintering of 450 R2's over June and July. Previously R2's have been wintered on support blocks in the Heddon Bush area close to the Woldwide dairy farms. The proposed scenario results in 55% of the R2's for the Woldwide dairy farms being wintered in barn facilities that are to be constructed/expanded as part of the expanded dairying consent applications for Woldwide 1, 2, 4. The majority of R2's not wintered indoors will be moved out of the Heddon Bush area where soils are more prone to nitrate leaching.

To facilitate the winter grazing of the 1265 R1's and 450 R2's it is proposed to grow 78ha of Kale supplemented by 1332 bales of baleage.

Fertiliser inputs into the nutrient budget are based on maintaining Olsen P levels at 25, although a small allowance has been made for paddocks that may require capital applications of fertiliser to raise Olsen p levels to 25. Total nitrogen fertiliser inputs are based on usage in the 17-18 season.

Supplements in the form of baleage (3500 – 240kg/DM bales) and silage (3 cuts off the Merrivale Block – 1050T/DM) are proposed to be produced off WR. Approximately 1300 bale will be utilised on WR with the rest exported to the five Woldwide dairy farms.

	Total Proposed	Per/ha Proposed
Nitrogen Loss (kg/N)	22603	25
Phosphorus Loss (Kg/P)	489	0.5
Pasture Production (kg/DM)		13,282

4.0 Modelling Inputs

To construct the nutrient budgets the following input data has been used;

4.1 Blocks

WR has been split into the following blocks:

Block Name	Soil Type	16/17	17/18	Proposed
Merriburn	Ihak_23a.1	290.5 (86%)	140	290.5 (86%)
Merriburn	Apar_6a.1	47.3 (14%)	27.5	47.3 (14%)
Merriburn Lower Fert	Ihak_23a.1		139.7	
Merriburn Lower Fert	Apar_6a.1		21.1	
Merriburn No Fert	Ihak_23a.1		9.5	
Merrivale	Waiki_36a.1		176.5	220.3 (79%)
Merrivale	Makar_3b.1		31.9	30.7 (11%)
Merrivale	Malok_3a.1			27.8 (10%)
Merrivale Lower Fert	Waiki_36a.1		42.7	
Merrivale Lower Fert	Malok_3a.1		27.7	
Merrivale No Fert	Malok_3a.1		28.1	14.3 (47%)
Merrivale No Fert	Waiki_36a.1		14.3	16.1 (53%)
Merrivale (High N/High P)	Waiki_36a.1	56.8 (83%)		
Merrivale (High N/High P)	Makar_3b.1	11.6 (17%)		
Merrivale (High N/Med P)	Waiki_36a.1	72.1 (91%)		
Merrivale (High N/Med P)	Makar_3b.1	7.1 (9%)		
Merrivale (Low N/Med P)	Malok_3a.1	36.7 (67%)		
Merrivale (Low N/Med P)	Waiki_36a.1	18.1 (33%)		
Merrivale (Med N/High P)	Waiki_36a.1	30.8 (72%)		
Merrivale (Med N/High P)	Malok_3a.1	4.7 (11%)		
Merrivale (Med N/High P)	Makar_3b.1	7.3 (17%)		
Merrivale (Med N/Med P)	Waiki_36a.1	44.0(84%)		
Merrivale (Med N/Med P)	Malok_3a.1	3.1 (6%)		
Merrivale (Med N/Med P)	Makar_3b.1	5.2 (10%)		
Merrivale (No Fert)	Waiki_36a.1	10.4 (44%)		
Merrivale (No Fert)	Malok_3a.1	11.4 (48%)		
Merrivale (No Fert)	Makar_3b.1	1.9 (8%)		

Kale	Rotating	Rotating (88)	Rotating (52)	Rotating (78)
Effective Farm Area		**659**	**659**	**647**
Plantation Forest		100	100	112
Beech Forest		60	60	60
Non-Productive		73	73	73
Total Farm Area		**892**	**892**	**892**

- Soil areas were obtained from Smap/Environment Southland.
- Soil settings were obtained from SMap for all soil types.

4.2 Climate Data

- Location setting = Southland
- Climate station tool used for block climate data
  - 1147 - 1185mm of rainfall
  - 9.9 - 10°C mean annual temperature
  - 731-1450mm daily rainfall pattern. Low variation.
  - 737 - 743mm mean annual PET

4.3 Farm System Inputs

Description	**16/17**	**17/18**	**Proposed**
Stock On Farm	R1's – Friesian	R1's – Friesian	R1's – Friesian
	July – 0	July – 0	July – 0
	Aug – 0	Aug – 0	Aug – 0
	Sep – 0	Sep – 0	Sep – 0
	Oct – 0	Oct – 0	Oct – 0
	Nov – 1450	Nov – 1265	Nov – 1265
	Dec – 1450	Dec – 1265	Dec – 1265
	Jan – 1450	Jan – 1265	Jan – 1265
	Feb – 1450	Feb – 1265	Feb – 1265
	Mar – 1450	Mar – 1265	Mar – 1265
	Apr – 1450	Apr – 1265	Apr – 1265
	May – 1450	May – 1265	May – 1265
	June – 1450	June – 1265	June – 1265
	R2's – Friesian	R2's – Friesian	R2's – Friesian
	July – 1450	July – 1265	July – 1265
	Aug – 1450	Aug – 1265	Aug – 1265
	Sep – 1450	Sep – 1265	Sep – 1265
	Oct – 1450	Oct – 1265	Oct – 1265
	Nov – 1450	Nov – 1265	Nov – 1265
	Dec – 1450	Dec – 1265	Dec – 1265
	Jan – 1450	Jan – 1265	Jan – 1265
	Feb – 1450	Feb – 1265	Feb – 1265
	Mar – 1335	Mar – 1150	Mar – 1165
	Apr – 1335	Apr – 1150	Apr – 1165
	May – 1335	May – 1150	May – 1165

	June – 600 July - 600 Carry Overs July – 50 Aug – 50 Sep – 50 Oct – 50 Nov – 50 Dec – 50 Jan – 50 Feb – 50 Mar – 50 Apr – 50 May – 50 June – 50 Mating Bulls July – 0 Aug – 0 Sep – 0 Oct – 0 Nov – 70 Dec – 70 Jan – 23 Feb – 0 Mar – 0 Apr – 0 May – 0 June – 0	June – 0 Carry Overs July – 37 Aug – 37 Sep – 37 Oct – 37 Nov – 37 Dec – 37 Jan – 37 Feb – 37 Mar – 37 Apr – 37 May – 37 June – 37 Mating Bulls July – 0 Aug – 0 Sep – 0 Oct – 0 Nov – 70 Dec – 70 Jan – 23 Feb – 0 Mar – 0 Apr – 0 May – 0 June – 0	June – 450 July – 450 Carry Overs July – 37 Aug – 37 Sep – 37 Oct – 37 Nov – 37 Dec – 37 Jan – 37 Feb – 37 Mar – 37 Apr – 37 May – 37 June – 37 Mating Bulls July – 0 Aug – 0 Sep – 0 Oct – 0 Nov – 70 Dec – 70 Jan – 23 Feb – 0 Mar – 0 Apr – 0 May – 0 June – 0
Description	**16/17**	**18/19**	**Proposed**
Crop Area and Inputs	50ha Kale 12T/DM/ha Direct Drilled November 128kg/ha/N 49kg/ha/P 48kg/ha/K Grazed 24hrs day 20th May – 10th August by R1's 38ha Kale 12T/DM/ha Conventional Cultivation November	52ha Kale 12T/DM/ha Direct Drilled November 82kg/ha/N 49kg/ha/P 48kg/ha/K Grazed 24hrs day late May to early August by R1's	78ha Kale 12T/DM/ha Direct Drilled November 94kg/ha/N 40kg/ha/P 48kg/ha/K Grazed 24hrs day late May to early August by R1's & R2's

	136kg/ha/N 50kg/ha/P 50kg/ha/K Grazed 24hrs day June & July by R2's.		
Description	**16/17**	**17/18**	**Proposed**
Supplements made on Farm	Baleage (240kg) 2299 Bales 1750 – Kale 150 – Pasture Blocks 399 – Exported	Baleage (240kg) 4048 Bales 1191 – Kale 2857 - Exported	Baleage (240kg) 3500 Bales 1332 – Kale 2168 – Exported Silage (DM) 1050T - Exported
Description	**16/17**	**17/18**	**Proposed**
Fertiliser	Merriburn 98kg/N/ha (Sept, Dec, Feb) 20kg/P/ha (Dec) 12kg/K/ha (Dec) Merrivale (High N/High P) 119kg/N/ha (Oct, Dec-Feb) 79kg/P/ha (Dec-Jan) 121kg/K/ha (Dec-Jan) Merrivale (High N/ Med P) 106kg/N/ha (Oct, Jan-Feb) 31kg/P/ha (Jan) 40kg/K/ha (Jan) Merrivale (Low N/Med P) 21kg/N/ha (Feb) 30kg/P/ha (Feb) Merrivale (Med N/High P) 68kg/N/ha (Oct, Dec-Jan) 80kg/P/ha (Dec-Jan) 108kg/K/ha (Dec-Jan) Merrivale (Med N/Med P) 62kg/N/ha (Oct, Feb) 32kg/P/ha (Feb) 31kg/K/ha (Feb)	Merriburn 136kg/N/ha (Sep, Dec, Feb) 20kg/P/ha (Dec) 26kg/K/ha (Dec) Merriburn Lower Fert 36kg/N/ha (Sep, Dec, Feb) 25kg/P/ha (Dec) 16kg/K/ha (Dec) Merrivale 165kg/N/ha (Aug, Nov, Sep, Feb) 59kg/P/ha (Nov & Jan) 99kg/K/ha (Nov & Jan) Merrivale Lower Fert 57kg/N/ha (Sep & Nov) 22kg/P/ha (Nov) 25kg/K/ha (Nov)	Merriburn 121kg/N/ha (Sep, Dec, Feb) 32kg/P/ha (Dec) 26kg/K/ha (Dec) Merrivale 121kg/N/ha (Aug, Nov, Feb) 40kg/P/ha (Nov, Jan) 110kg/K/ha (Nov, Jan)

5.0 Modelling Results

	16/17	17/18	Average	Proposed	% Change
Total N Loss (kg)	26134	19931	23033	22603	-1.9
N Loss/ha (kg)	29	22	26	25	
Total P Loss (kg)	500	532	516	489 (433)*	-5.2 (-16)*
P Loss/ha (kg)	0.6	0.6	0.6	0.5	
Pasture Grown (kg/DM/ha/yr)	12639	11024	11832	13282	

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

6.0 Modelling Conclusions

Using Overseer, nutrient budgets have been developed for WR, comparing the nutrient losses of the 2016/17 and 2017/18 farm systems against the proposed farm system post expansion of the Woldwide dairy farms. Overseer has predicted that the nitrogen and phosphorus losses will decrease.

Key drivers for the reduction in nitrogen losses are:

- Reduction in cows wintered compared to 16/17 season
- Additional land planted in trees
- More efficient use of nitrogen fertiliser

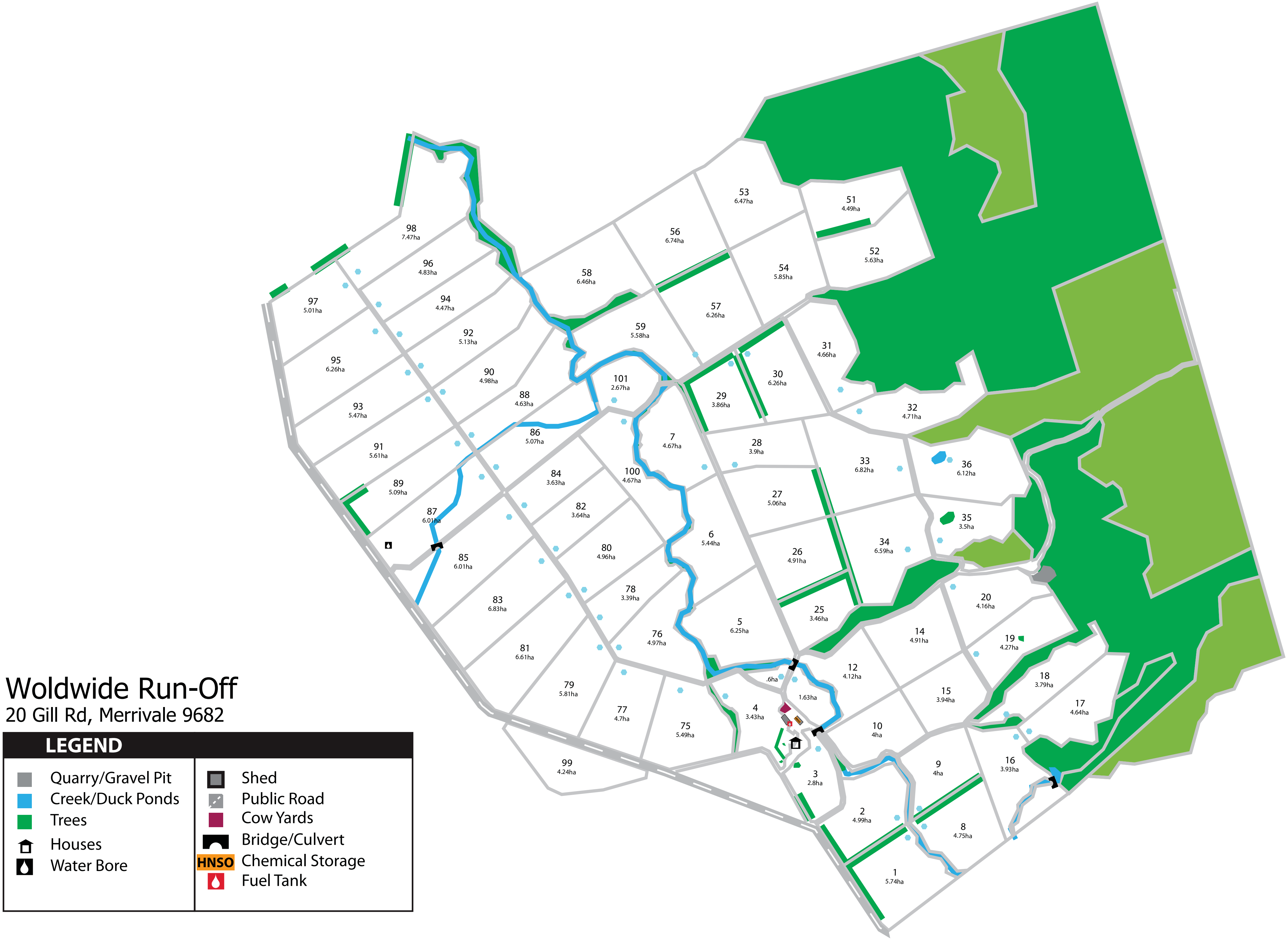
Key drivers for the reduction in phosphorus are:

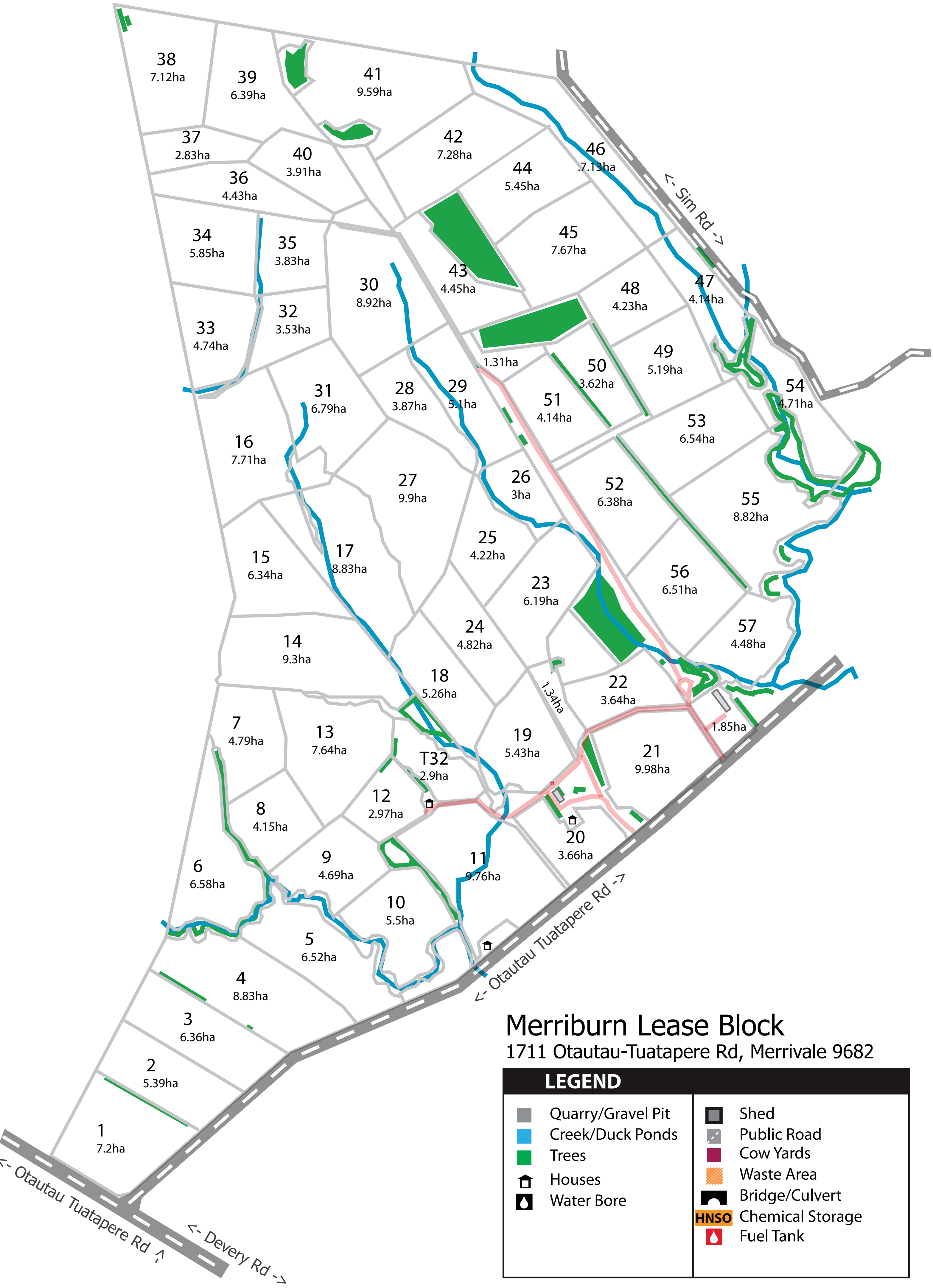
- Additional land planted in trees
- Reducing large applications of phosphorus fertiliser
- Reduction in cows wintered compared to 16/17 season

Appendix 1 – Block & Farm Maps

Woldwide Run-Off

20 Gill Rd, Merrivale 9682

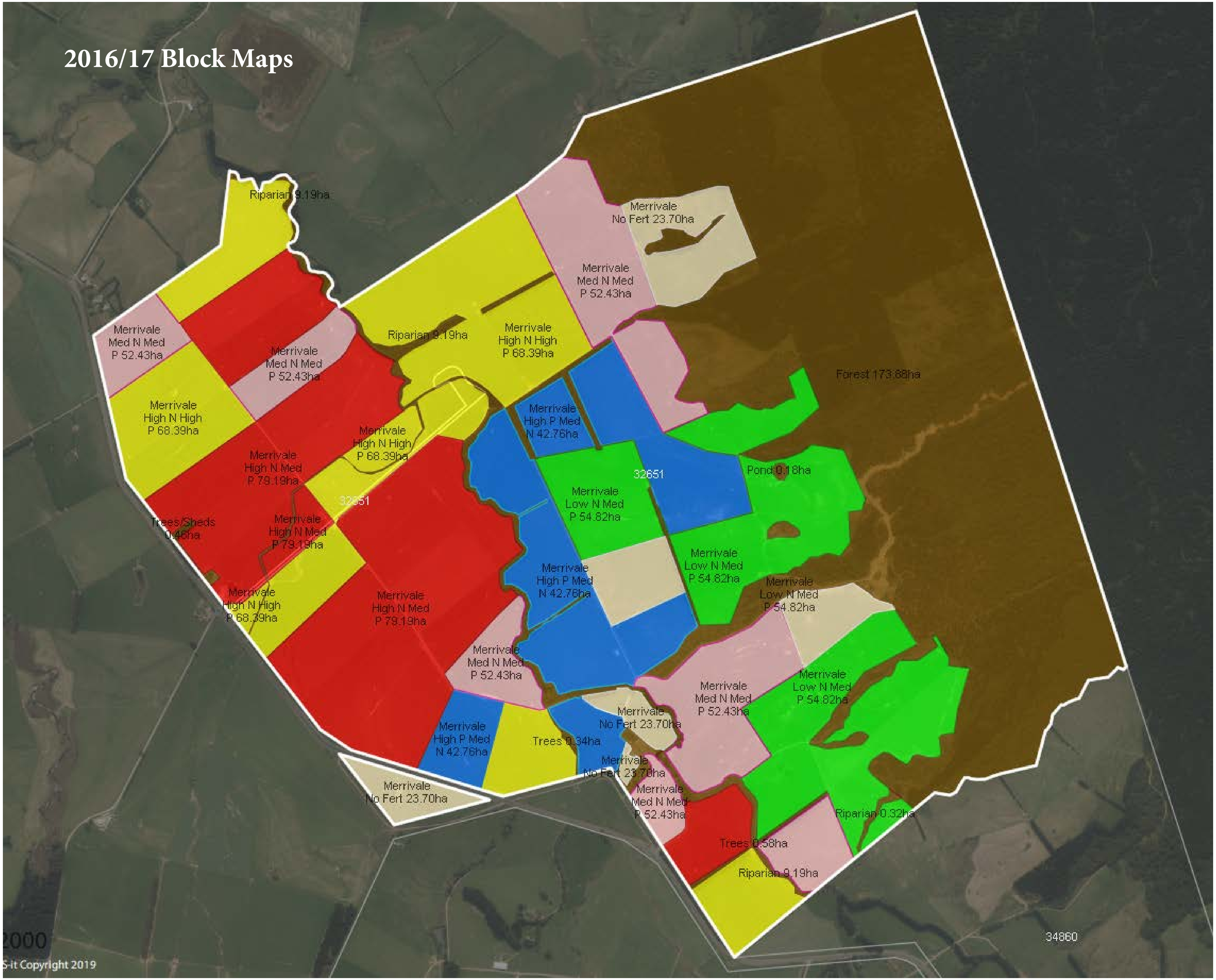


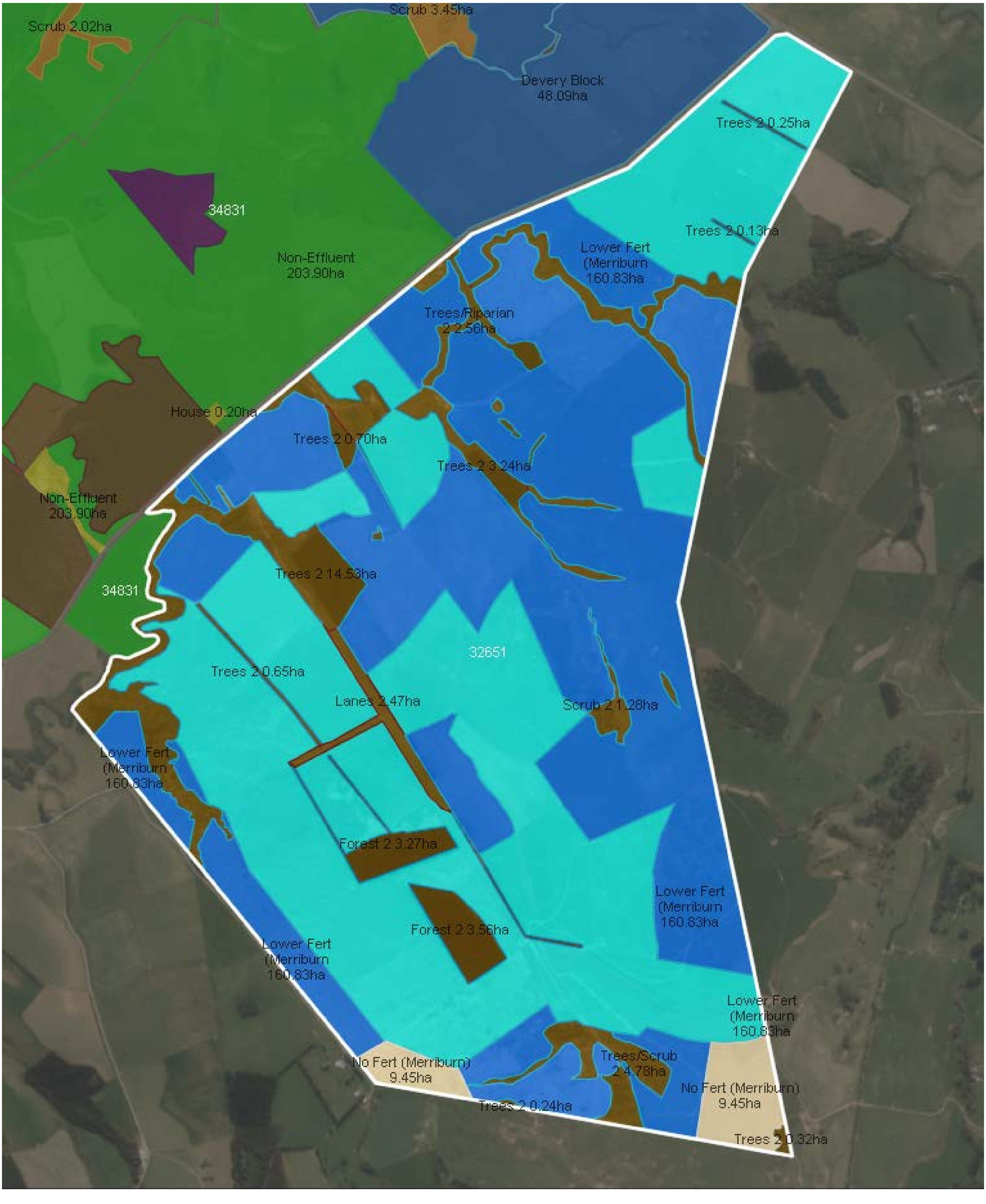


Merriburn Lease Block

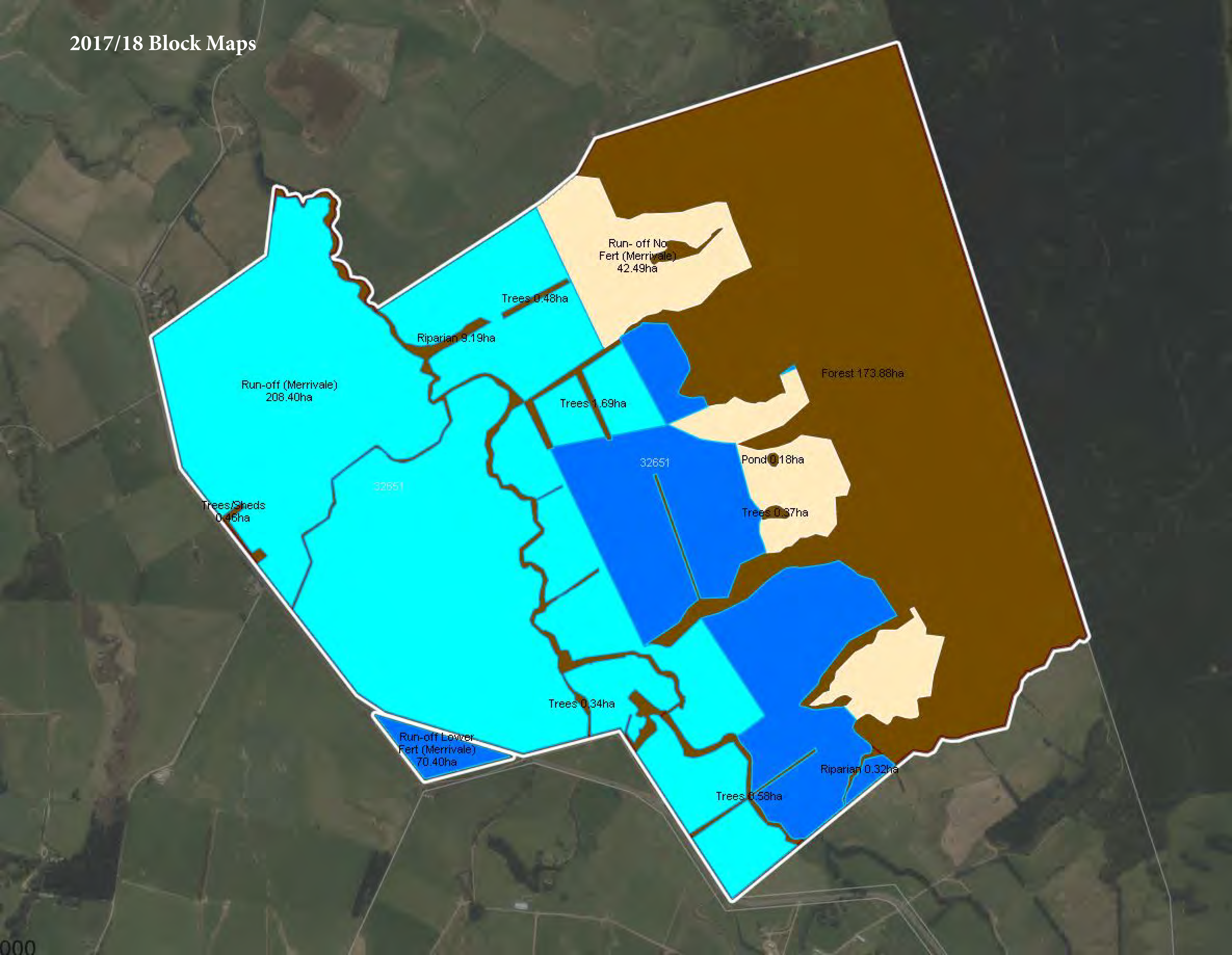
1711 Otautau-Tuatapere Rd, Merrivale 9682

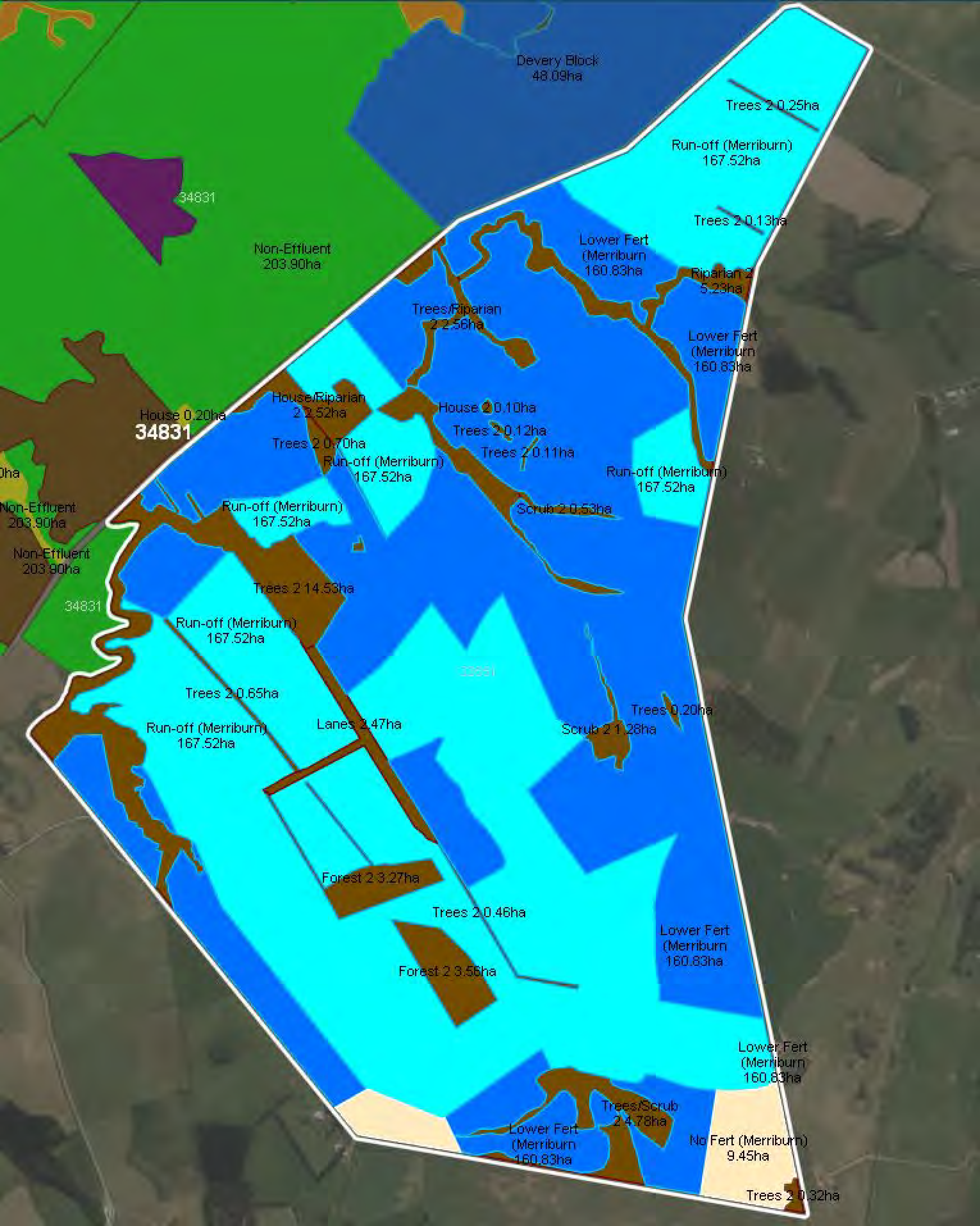
2016/17 Block Maps




Scrub 2.02ha
Scrub 3.45ha
Devery Block
48.09ha
Trees 2 0.25ha
34831
Non-Effluent
203.90ha
Trees 2 0.13ha
Lower Fert
(Merriburn
160.83ha
Trees/Riparian
2 2.56ha
House 0.20ha
Trees 2 0.70ha
Trees 2 3.24ha
Non-Effluent
203.90ha
Trees 2 14.53ha
34831
32651
Trees 2 0.65ha
Lanes 2.47ha
Scrub 2 1.28ha
Lower Fert
(Merriburn
160.83ha
Forest 2 3.27ha
Lower Fert
(Merriburn
160.83ha
Forest 2 3.56ha
Lower Fert
(Merriburn
160.83ha
Lower Fert
(Merriburn
160.83ha
No Fert (Merriburn)
9.45ha
Trees/Scrub
2 4.78ha
No Fert (Merriburn)
9.45ha
Trees 2 0.24ha
Trees 2 0.32ha

2017/18 Block Maps




Devery Block
48.09ha
Trees 2 0.25ha
Run-off (Merriburn)
167.52ha
34831
Non-Effluent
203.90ha
Trees 2 0.13ha
Lower Fert
(Merriburn
160.83ha
Riparian 2
5.23ha
Trees/Riparian
2 2.56ha
Lower Fert
(Merriburn
160.83ha
House/Riparian
2 2.52ha
House 0.20ha
34831
House 2 0.10ha
Trees 2 0.12ha
Trees 2 0.70ha
Run-off (Merriburn)
167.52ha
Trees 2 0.11ha
Run-off (Merriburn)
167.52ha
0ha
Non-Effluent
203.90ha
Run-off (Merriburn)
167.52ha
Scrub 2 0.53ha
Non-Effluent
203.90ha
Trees 2 14.53ha
34831
Run-off (Merriburn)
167.52ha
33551
Trees 2 0.65ha
Trees 0.20ha
Run-off (Merriburn)
167.52ha
Lanes 2.47ha
Scrub 2 1.28ha
Forest 2 3.27ha
Trees 2 0.46ha
Lower Fert
(Merriburn
160.83ha
Forest 2 3.56ha
Lower Fert
(Merriburn
160.83ha
Trees/Scrub
2 4.78ha
Lower Fert
(Merriburn
160.83ha
No Fert (Merriburn)
9.45ha
Trees 2 0.32ha

Appendix 2 – Nutrient Budgets & Block Reports

Woldwide Runoff Limited

1328 Otautau-Tuatapere Rd, Merrivale 9682, Ne...

OverseerFM

Year ending 2017

Analysis type	Year end
Is publication	No
Application version	2.6.0.5
Printed date	28 Jul, 2019, 11:51PM
Model version	6.3.1

Farm details

N: 26134 N/ha: 29 P: 500 P/ha: 0.6 GHG/ha: 5337 NCE: 16%

Total area	892 ha
Productive block area	659.10 ha
Nitrogen conversion efficiency (NCE)	16%
N Surplus	106 kg/ha
Region	Southland

Blocks

NAME	TYPE	AREA (HA)	N LOSS	N LOSS/HA	N SURPLUS/HA	P LOSS	P LOSS/HA
Merriburn	Pasture	337.8	7527	25.6	139	157	0.5
Merrivale (High N / High P)	Pasture	68.4	1582	27.1	140	51	0.9
Merrivale (High N / Med P)	Pasture	79.2	2041	29.8	138	47	0.7
Merrivale (Low N / Med P)	Pasture	54.8	1531	32.4	103	37	0.8
Merrivale (Med N / High P)	Pasture	42.8	958	26.2	121	31	0.8
Merrivale (Med N / Med P)	Pasture	52.4	1287	28.5	121	28	0.6
Merrivale (No Fert)	Pasture	23.7	673	28.3	94	18	0.8
Kale	Fodder crop	50	5735	115	189	20	0.4
Kale (R2's) Merriburn	Fodder crop	38	4005	105	179	16	0.4
Beech Forest	Trees and scrub	60	180	3	0	6	0.1
Plantation Forest	Trees and scrub	100	250	2	0	12	0.1
Other sources	Other	-	363	-	-	77	-

Farm nutrient budget

LOSSES FROM ROOT ZONE

	TOTAL LOSS (KG/YR)	LOSS PER HA (KG/YR)
Nitrogen	26,134	29
Phosphorus	500	0.6

NUTRIENTS ADDED (KG/HA/YR)	N	P	K	S	CA	MG	NA
Fertiliser, lime and other	68	26	25	29	15	0	0
Irrigation	0	0	0	0	0	0	0
Supplements	0	0	0	0	0	0	0
Rain/clover fixation	58	0	2	5	3	7	30

NUTRIENTS REMOVED (KG/HA/YR)	N	P	K	S	CA	MG	NA
Leached from root zone	29	0.6	8	33	30	6	25
As product	18	4	1	2	9	0	0
Transfer	0	0	0	0	0	0	0
Effluent exported	0	0	0	0	0	0	0
To atmosphere	34	0	0	0	0	0	0

CHANGE IN POOLS (KG/HA/YR)	N	P	K	S	CA	MG	NA
Organic pool	37	6	1	-5	0	0	0
Inorganic mineral	0	2	-15	0	-2	-3	-3
Inorganic soil pool	7	12	43	0	-21	3	8

Woldwide Runoff Limited

1328 Otautau-Tuatapere Rd, Merrivale 9682, Ne...

OverseerFM

Year ending 2018

Analysis type	Year end
Is publication	No
Application version	2.6.0.5
Printed date	28 Jul, 2019, 11:51PM
Model version	6.3.1

Farm details

N: 19931 N/ha: 22 P: 532 P/ha: 0.6 GHG/ha: 4572 NCE: 23%

Total area	892 ha
Productive block area	659.00 ha
Nitrogen conversion efficiency (NCE)	23%
N Surplus	92 kg/ha
Region	Southland

Blocks

NAME	TYPE	AREA (HA)	N LOSS	N LOSS/HA	N SURPLUS/HA	P LOSS	P LOSS/HA
Merriburn (Ihak_23a.1)	Pasture	140	2668	21	132	72	0.6
Merriburn (Apar_6a.1)	Pasture	27.5	449	18	133	14	0.6
Merriburn Lower Fert (Ihak_23a.1)	Pasture	139.7	2506	20	101	73	0.6
Merriburn Lower Fert (Apar_6a.1)	Pasture	21.1	335	18	101	11	0.6
Merriburn No Fert (Ihak_23a.1)	Pasture	9.5	193	20	77	7	0.8
Merrivale (Waiki_36a.1)	Pasture	176.5	5048	32	140	97	0.6
Merrivale (Makar_3b.1)	Pasture	31.9	606	21	141	62	2.1
Merrivale Lower Fert (Waiki_36a.1)	Pasture	42.7	889	21	96	32	0.8
Merrivale Lower Fert (Malok_3a.1)	Pasture	27.7	690	25	98	22	0.8
Merrivale No Fert (Malok_3a.1)	Pasture	28.1	711	25	80	21	0.7
Merrivale No Fert (Waiki_36a.1)	Pasture	14.3	304	21	78	10	0.7
Kale	Fodder crop	52	4777	92	150	23	0.4
Plantation Forest	Trees and scrub	100	250	2	0	12	0.1
Beech Forest	Trees and scrub	60	180	3	0	6	0.1
Other sources	Other	-	325	-	-	71	-

Farm nutrient budget

LOSSES FROM ROOT ZONE

	TOTAL LOSS (KG/YR)	LOSS PER HA (KG/YR)
Nitrogen	19,931	22
Phosphorus	532	0.6

NUTRIENTS ADDED (KG/HA/YR)	N	P	K	S	CA	MG	NA
Fertiliser, lime and other	79	25	33	34	48	0	1
Irrigation	0	0	0	0	0	0	0
Supplements	0	0	0	0	0	0	0
Rain/clover fixation	41	0	2	5	3	7	31

NUTRIENTS REMOVED (KG/HA/YR)	N	P	K	S	CA	MG	NA
Leached from root zone	22	0.6	8	39	24	6	25
As product	14	4	1	2	7	0	0
Transfer	0	0	0	0	0	0	0
Effluent exported	0	0	0	0	0	0	0
To atmosphere	28	0	0	0	0	0	0

CHANGE IN POOLS (KG/HA/YR)	N	P	K	S	CA	MG	NA
Organic pool	38	7	1	-5	0	0	0
Inorganic mineral	0	2	-15	0	-2	-3	-3
Inorganic soil pool	3	9	34	0	18	3	8

Woldwide Runoff Limited

1328 Otautau-Tuatapere Rd, Merrivale 9682, Ne...

OverseerFM

Woldwide Run-off Proposed (Final)

Analysis type	Predictive
Is publication	No
Application version	2.6.0.5
Printed date	28 Jul, 2019, 11:26PM
Model version	6.3.1

Farm details

N: 22603 N/ha: 25 P: 489 P/ha: 0.5 GHG/ha: 4823 NCE: 38%

Total area	892 ha
Productive block area	647.00 ha
Nitrogen conversion efficiency (NCE)	38%
N Surplus	90 kg/ha
Region	Southland

Blocks

NAME	TYPE	AREA (HA)	N LOSS	N LOSS/HA	N SURPLUS/HA	P LOSS	P LOSS/HA
Merriburn	Pasture	337.8	7209	24.4	147	166	0.6
Merrivale	Pasture	278.8	5340	21.6	82	185	0.8
Merrivale No Fert	Pasture	30.4	894	29.4	108	21	0.7
Kale	Fodder crop	78	8369	107	138	32	0.4
Plantation Forest	Trees and scrub	112	280	2	0	13	0.1
Beech Forest	Trees and scrub	60	180	3	0	6	0.1
Other sources	Other	-	330	-	-	64	-

Farm nutrient budget

LOSSES FROM ROOT ZONE

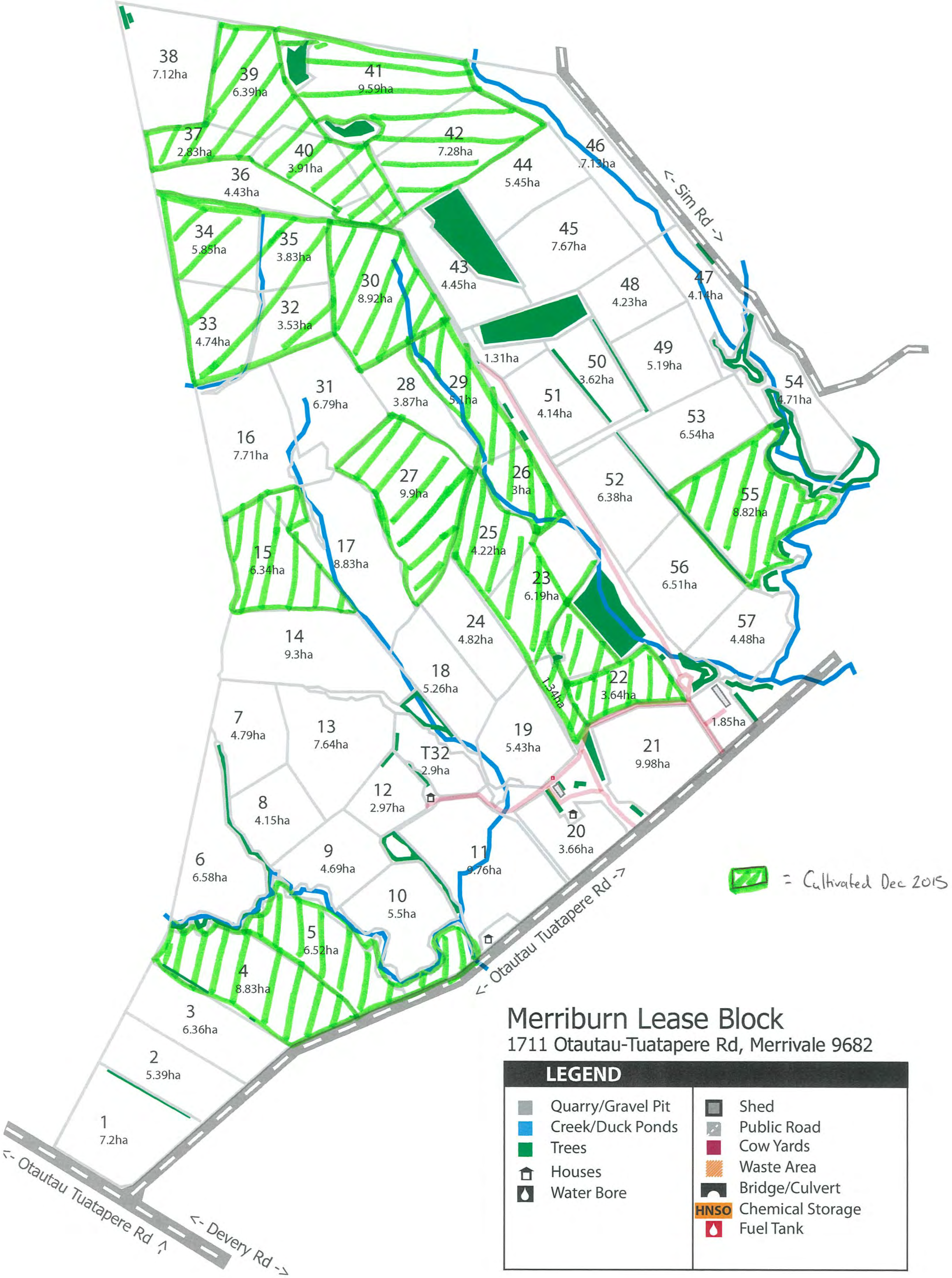
	TOTAL LOSS (KG/YR)	LOSS PER HA (KG/YR)
Nitrogen	22,603	25
Phosphorus	489	0.5

NUTRIENTS ADDED (KG/HA/YR)	N	P	K	S	CA	MG	NA
Fertiliser, lime and other	82	25	43	35	47	0	1
Irrigation	0	0	0	0	0	0	0
Supplements	0	0	0	0	0	0	0
Rain/clover fixation	64	0	2	5	3	7	31

NUTRIENTS REMOVED (KG/HA/YR)	N	P	K	S	CA	MG	NA
Leached from root zone	25	0.5	8	37	27	6	26
As product	15	4	1	2	7	0	0
Transfer	0	0	0	0	0	0	0
Effluent exported	0	0	0	0	0	0	0
To atmosphere	29	0	0	0	0	0	0

CHANGE IN POOLS (KG/HA/YR)	N	P	K	S	CA	MG	NA
Organic pool	29	6	1	-5	0	0	0
Inorganic mineral	0	2	-17	0	-2	-2	-3
Inorganic soil pool	6	8	27	0	9	1	7

Appendix 3 – Evidence/Records



▨ = Cultivated Dec 2015

Merriburn Lease Block

1711 Otautau-Tuatapere Rd, Merrivale 9682

LEGEND

■	Quarry/Gravel Pit	■	Shed
■	Creek/Duck Ponds	▨	Public Road
■	Trees	■	Cow Yards
⌂	Houses	▨	Waste Area
💧	Water Bore	⌒	Bridge/Culvert
		HNSO	Chemical Storage
		💧	Fuel Tank

Nutrient summary report

WOLDWIDE RUNOFF LTD - 60842387

Query range : 01 Jun 2016 to 31 May 2017

Name	Date	Area (ha)	Product	Rate (kg/ha or l/ha)	N kg/ha	P kg/ha	K kg/ha	S kg/ha	Ca kg/ha	Mg kg/ha
1	13/10/2016	5.1	UREA BULK	90	41	-	-	-	-	-
	09/01/2017	5	WW R/off Balage Maintenance	1388	22	54	100	66	312	3
	27/01/2017	4.9	WW R/Off Pot super/Flexi/Lime	994	22	32	31	39	260	3
	24/03/2017	5.4	UREA BULK	87	40	-	-	-	-	-
	Area weighted total				**112**	**74**	**113**	**90**	**491**	**5**
10	07/10/2016	3.7	UREA BULK	89	41	-	-	-	-	-
	17/02/2017	3.9	HILL BLOCK MIX	237	25	35	-	30	15	-
	Area weighted total				**62**	**34**	**-**	**29**	**15**	**-**
100	07/10/2016	4.2	UREA BULK	89	41	-	-	-	-	-
	13/01/2017	4.2	WW R/Off Pot super/Flexi/Lime	1044	23	33	33	41	273	3
	24/03/2017	4.3	UREA BULK	91	42	-	-	-	-	-
	Area weighted total				**96**	**30**	**29**	**37**	**246**	**3**
101	13/10/2016	2.4	UREA BULK	88	40	-	-	-	-	-
	22/12/2016	2.4	WW R/off Balage Maintenance	1472	23	57	106	70	331	3
	13/01/2017	2.5	WW R/Off Pot super/Flexi/Lime	1054	23	34	33	41	276	3
	24/03/2017	2.5	UREA BULK	92	42	-	-	-	-	-
	Area weighted total				**119**	**84**	**128**	**103**	**560**	**5**
12	07/10/2016	3.6	UREA BULK	90	41	-	-	-	-	-
	17/02/2017	3.8	HILL BLOCK MIX	234	25	34	-	29	15	-

	Area weighted total				**59**	**31**	**-**	**27**	**14**	**-**
14	07/10/2016	4.6	UREA BULK	92	42	-	-	-	-	-
	17/02/2017	4.8	HILL BLOCK MIX	261	28	39	-	33	17	-
	Area weighted total				**67**	**37**	**-**	**32**	**16**	**-**
15	22/02/2017	3.7	HILL MIX	237	25	35	-	30	15	-
	Area weighted total				**23**	**32**	**-**	**28**	**14**	**-**
16	22/02/2017	2.6	HILL MIX	240	25	35	-	30	15	-
	Area weighted total				**17**	**24**	**-**	**20**	**10**	**-**
16b	22/02/2017	0.5	HILL MIX	212	22	31	-	27	14	-
	Area weighted total				**11**	**16**	**-**	**13**	**7**	**-**
17	22/02/2017	3.8	HILL MIX	258	27	38	-	32	16	-
	Area weighted total				**22**	**31**	**-**	**27**	**13**	**-**
18	22/02/2017	3.5	HILL MIX	240	25	35	-	30	15	-
	Area weighted total				**23**	**33**	**-**	**28**	**14**	**-**
19	22/02/2017	4.2	HILL MIX	234	25	35	-	30	15	-
	Area weighted total				**24**	**34**	**-**	**29**	**15**	**-**
2	22/09/2016	4.6	Urea	81	37	-	-	-	-	-
	13/10/2016	4.3	UREA BULK	87	40	-	-	-	-	-
	27/01/2017	4.3	WW R/Off Pot super/Flexi/Lime	1017	22	33	32	40	266	3
	24/03/2017	4.5	UREA BULK	90	41	-	-	-	-	-
	Area weighted total				**125**	**28**	**28**	**35**	**231**	**2**
20	**Area weighted total**				**-**	**-**	**-**	**-**	**-**	**-**
25	22/12/2016	1.6	WW R/off Balage Maintenance	1488	24	58	107	71	335	3
	22/12/2016	1.7	WW R/off Balage Maintenance	1318	21	51	95	63	297	3
	17/02/2017	3.3	HILL BLOCK MIX	234	25	34	-	29	15	-
	Area weighted total				**45**	**85**	**97**	**92**	**317**	**3**

26	**Area weighted total**				**-**	**-**	**-**	**-**	**-**	**-**
27	22/09/2016	3.8	Urea	92	42	-	-	-	-	-
	Area weighted total				**32**	**-**	**-**	**-**	**-**	**-**
28	17/02/2017	3.7	HILL BLOCK MIX	229	24	34	-	29	15	-
	Area weighted total				**23**	**32**	**-**	**28**	**14**	**-**
29	21/12/2016	3.4	WW R/off Balage Maintenance	1434	23	56	103	68	323	3
	16/01/2017	3.5	WW R/Off Pot super/Flexi/Lime	1019	22	33	32	40	266	3
	17/02/2017	0.1	HILL BLOCK MIX	199	21	29	-	25	13	-
	Area weighted total				**41**	**80**	**120**	**97**	**525**	**5**
3	27/01/2017	2.4	WW R/Off Pot super/Flexi/Lime	1039	23	33	33	41	272	3
	24/03/2017	2.5	UREA BULK	92	42	-	-	-	-	-
	Area weighted total				**57**	**28**	**28**	**35**	**233**	**2**
30	13/10/2016	4.8	UREA BULK	89	41	-	-	-	-	-
	21/12/2016	4.6	WW R/off Balage Maintenance	1409	22	55	102	67	317	3
	16/01/2017	4.7	WW R/Off Pot super/Flexi/Lime	993	22	32	31	39	260	3
	Area weighted total				**78**	**79**	**120**	**96**	**526**	**5**
31	22/09/2016	4.5	Urea	93	43	-	-	-	-	-
	17/02/2017	4.4	HILL BLOCK MIX	262	28	39	-	33	17	-
	Area weighted total				**68**	**37**	**-**	**32**	**16**	**-**
32	22/02/2017	4.2	HILL MIX	239	25	35	-	30	15	-
	Area weighted total				**22**	**31**	**-**	**27**	**13**	**-**
33	13/10/2016	4.8	UREA BULK	92	42	-	-	-	-	-
	19/12/2016	0.8	WW R OFF BALAGE MIX	1349	21	53	97	64	304	3

	19/12/2016	5.2	WW R/off Balage Maintenance	1707	27	66	123	81	384	3
	17/02/2017	5.7	HILL BLOCK MIX	256	27	38	-	32	16	-
	Area weighted total				**75**	**88**	**105**	**96**	**341**	**3**
34	17/02/2017	6.1	HILL BLOCK MIX	241	25	36	-	30	15	-
	Area weighted total				**23**	**33**	**-**	**28**	**14**	**-**
35	22/02/2017	2.7	HILL MIX	247	26	36	-	31	16	-
	Area weighted total				**20**	**28**	**-**	**24**	**12**	**-**
36	22/02/2017	5.4	HILL MIX	245	26	36	-	31	16	-
	Area weighted total				**23**	**32**	**-**	**27**	**14**	**-**
4a	**Area weighted total**				**-**	**-**	**-**	**-**	**-**	**-**
4b	29/09/2016	3	Urea	81	37	-	-	-	-	-
	22/12/2016	2.7	WW R/off Balage Maintenance	1420	23	55	102	68	320	3
	17/02/2017	3.1	HILL BLOCK MIX	248	26	37	-	31	16	-
	Area weighted total				**75**	**78**	**82**	**83**	**270**	**2**
5	07/10/2016	5.8	UREA BULK	86	40	-	-	-	-	-
	22/12/2016	5.6	WW R/off Balage Maintenance	1387	22	54	100	66	312	3
	27/01/2017	5.6	WW R/Off Pot super/Flexi/Lime	1003	22	32	31	39	262	3
	Area weighted total				**76**	**77**	**118**	**94**	**515**	**5**
51	**Area weighted total**				**-**	**-**	**-**	**-**	**-**	**-**
52	**Area weighted total**				**-**	**-**	**-**	**-**	**-**	**-**
53	07/10/2016	6.2	UREA BULK	91	42	-	-	-	-	-
	27/01/2017	6.1	WW R/Off Pot super/Flexi/Lime	1076	24	34	34	42	281	3
	Area weighted total				**62**	**32**	**32**	**40**	**265**	**3**
54	07/10/2016	5.5	UREA BULK	110	51	-	-	-	-	-

	27/01/2017	5.2	WW R/Off Pot super/Flexi/Lime	1113	24	36	35	44	291	3
	Area weighted total				**69**	**31**	**31**	**38**	**257**	**3**
56	22/09/2016	6.5	Urea	80	37	-	-	-	-	-
	13/10/2016	6.4	UREA BULK	86	39	-	-	-	-	-
	21/12/2016	6.4	WW R/off Balage Maintenance	1438	23	56	104	68	324	3
	16/01/2017	6.6	WW R/Off Pot super/Flexi/Lime	971	21	31	30	38	254	3
	24/03/2017	6.6	UREA BULK	86	39	-	-	-	-	-
	Area weighted total				**154**	**84**	**128**	**102**	**556**	**5**
57	13/10/2016	6	UREA BULK	84	39	-	-	-	-	-
	19/12/2016	6.1	WW R OFF BALAGE MIX	1367	22	53	99	65	308	3
	16/01/2017	6	WW R/Off Pot super/Flexi/Lime	1009	22	32	32	39	264	3
	24/03/2017	6	UREA BULK	87	40	-	-	-	-	-
	Area weighted total				**118**	**83**	**127**	**101**	**554**	**5**
58	07/10/2016	6.1	UREA BULK	85	39	-	-	-	-	-
	19/12/2016	6.1	WW R OFF BALAGE MIX	1367	22	53	99	65	308	3
	16/01/2017	6.2	WW R/Off Pot super/Flexi/Lime	999	22	32	31	39	261	3
	24/03/2017	6.2	UREA BULK	87	40	-	-	-	-	-
	Area weighted total				**117**	**81**	**124**	**99**	**542**	**5**
59	07/10/2016	5.3	UREA BULK	90	41	-	-	-	-	-
	22/12/2016	5.2	WW R/off Balage Maintenance	1609	26	63	116	77	362	3
	27/01/2017	5.1	WW R/Off Pot super/Flexi/Lime	1068	23	34	33	42	279	3
	24/03/2017	5.4	UREA BULK	94	43	-	-	-	-	-

	Area weighted total				**126**	**90**	**139**	**110**	**593**	**6**
6	22/09/2016	5.1	Urea	82	38	-	-	-	-	-
	22/12/2016	4.7	WW R/off Balage Maintenance	1385	22	54	100	66	312	3
	27/01/2017	3.4	WW R/Off Pot super/Flexi/Lime	989	22	32	31	39	259	3
	Area weighted total				**68**	**66**	**106**	**81**	**430**	**4**
7	22/09/2016	4.4	Urea	87	40	-	-	-	-	-
	22/12/2016	4.2	WW R/off Balage Maintenance	1549	25	60	112	74	349	3
	17/02/2017	4.3	HILL BLOCK MIX	226	24	33	-	29	14	-
	Area weighted total				**82**	**85**	**101**	**93**	**329**	**3**
75	29/09/2016	5.2	Urea	77	36	-	-	-	-	-
	20/12/2016	5	WW R/off Balage Maintenance	1388	22	54	100	66	312	3
	09/01/2017	4.9	WW R/Off Pot super/Flexi/Lime	1000	22	32	31	39	262	3
	24/03/2017	5.3	UREA BULK	87	40	-	-	-	-	-
	Area weighted total				**112**	**78**	**119**	**95**	**517**	**5**
76	07/10/2016	4.5	UREA BULK	89	41	-	-	-	-	-
	09/01/2017	2.2	WW R/Off Pot super/Flexi/Lime	1036	23	33	32	40	271	3
	13/01/2017	2.3	WW R/Off Pot super/Flexi/Lime	1031	23	33	32	40	270	3
	Area weighted total				**58**	**30**	**29**	**37**	**246**	**3**
77	29/09/2016	4.5	Urea	81	37	-	-	-	-	-
	20/12/2016	4.1	WW R/off Balage Maintenance	1419	23	55	102	68	319	3
	09/01/2017	2.2	WW R/Off Pot super/Flexi/Lime	1083	24	35	34	42	283	3

	09/01/2017	2.3	WW R/Off Pot super/Flexi/Lime	983	22	31	31	38	257	3
	Area weighted total				**78**	**80**	**121**	**98**	**539**	**5**
78	22/09/2016	3.3	Urea	83	38	-	-	-	-	-
	13/10/2016	3.2	UREA BULK	88	40	-	-	-	-	-
	13/01/2017	3.2	WW R/Off Pot super/Flexi/Lime	1044	23	33	33	41	273	3
	24/03/2017	3.3	UREA BULK	93	43	-	-	-	-	-
	Area weighted total				**138**	**31**	**31**	**38**	**257**	**3**
79	29/09/2016	5.6	Urea	83	38	-	-	-	-	-
	16/01/2017	5.7	WW R/Off Pot super/Flexi/Lime	1014	22	32	32	40	265	3
	24/03/2017	5.5	UREA BULK	86	40	-	-	-	-	-
	Area weighted total				**97**	**32**	**31**	**39**	**260**	**3**
8	22/09/2016	4.5	Urea	81	37	-	-	-	-	-
	17/02/2017	4.6	HILL BLOCK MIX	224	24	33	-	28	14	-
	Area weighted total				**58**	**32**	**-**	**27**	**14**	**-**
80	13/10/2016	4.8	UREA BULK	81	37	-	-	-	-	-
	13/01/2017	4.8	WW R/Off Pot super/Flexi/Lime	1008	22	32	32	39	264	3
	24/03/2017	4.9	UREA BULK	85	39	-	-	-	-	-
	Area weighted total				**96**	**31**	**31**	**38**	**257**	**3**
81	22/09/2016	6.5	Urea	82	38	-	-	-	-	-
	16/01/2017	6.4	WW R/Off Pot super/Flexi/Lime	979	21	31	31	38	256	3
	24/03/2017	6.4	UREA BULK	83	38	-	-	-	-	-
	Area weighted total				**94**	**31**	**30**	**37**	**250**	**3**
82	22/09/2016	3.5	Urea	81	37	-	-	-	-	-
	13/01/2017	3.6	WW R/Off Pot super/Flexi/Lime	985	22	31	31	38	258	3

	24/03/2017	3.6	UREA BULK	82	38	-	-	-	-	-
	Area weighted total				**95**	**31**	**30**	**38**	**252**	**3**
83	07/10/2016	6.7	UREA BULK	82	38	-	-	-	-	-
	14/01/2017	5	WW R/Off Pot super/Flexi/Lime	1050	23	34	33	41	275	3
	16/01/2017	1.4	WW R/Off Pot super/Flexi/Lime	908	20	29	28	35	238	2
	24/03/2017	6.7	UREA BULK	85	39	-	-	-	-	-
	Area weighted total				**96**	**30**	**30**	**37**	**249**	**3**
84	22/09/2016	3.5	Urea	80	37	-	-	-	-	-
	13/10/2016	3.5	UREA BULK	88	40	-	-	-	-	-
	13/01/2017	3.5	WW R/Off Pot super/Flexi/Lime	966	21	31	30	38	253	3
	14/01/2017	0	WW R/Off Pot super/Flexi/Lime	484	11	15	15	19	127	1
	24/03/2017	3.6	UREA BULK	93	43	-	-	-	-	-
	Area weighted total				**137**	**30**	**29**	**37**	**246**	**3**
85	22/09/2016	6.4	Urea	83	38	-	-	-	-	-
	20/12/2016	5.8	WW R/off Balage Maintenance	1407	22	55	101	67	317	3
	09/01/2017	6.4	WW R/Off Pot super/Flexi/Lime	1046	23	33	33	41	274	3
	24/03/2017	6.7	UREA BULK	87	40	-	-	-	-	-
	Area weighted total				**111**	**75**	**112**	**91**	**504**	**5**
86	07/10/2016	4.6	UREA BULK	86	40	-	-	-	-	-
	20/12/2016	3.9	WW R/off Balage Maintenance	1404	22	55	101	67	316	3
	13/01/2017	4.4	WW R/Off Pot super/Flexi/Lime	1033	23	33	32	40	270	3
	24/03/2017	4.6	UREA BULK	93	43	-	-	-	-	-

	Area weighted total				**112**	**70**	**106**	**86**	**475**	**5**
87	29/09/2016	5.5	Urea	87	40	-	-	-	-	-
	27/01/2017	5.1	WW R/Off Pot super/Flexi/Lime	1080	24	35	34	42	283	3
	24/03/2017	5.5	UREA BULK	92	42	-	-	-	-	-
	Area weighted total				**95**	**30**	**29**	**36**	**242**	**3**
88	22/09/2016	4.3	Urea	85	39	-	-	-	-	-
	13/01/2017	4.3	WW R/Off Pot super/Flexi/Lime	1040	23	33	33	41	272	3
	24/03/2017	4.5	UREA BULK	95	44	-	-	-	-	-
	Area weighted total				**100**	**31**	**30**	**38**	**254**	**3**
89	29/09/2016	4.8	Urea	81	37	-	-	-	-	-
	14/01/2017	4.7	WW R/Off Pot super/Flexi/Lime	1036	23	33	32	40	271	3
	24/03/2017	4.9	UREA BULK	94	43	-	-	-	-	-
	Area weighted total				**98**	**30**	**30**	**37**	**248**	**3**
9	22/09/2016	1.5	Urea	76	35	-	-	-	-	-
	Area weighted total				**14**	**-**	**-**	**-**	**-**	**-**
90	07/10/2016	4.7	UREA BULK	85	39	-	-	-	-	-
	13/01/2017	4.8	WW R/Off Pot super/Flexi/Lime	1027	23	33	32	40	269	3
	24/03/2017	4.9	UREA BULK	89	41	-	-	-	-	-
	Area weighted total				**99**	**32**	**31**	**39**	**260**	**3**
91	22/09/2016	5.4	Urea	76	35	-	-	-	-	-
	13/10/2016	5.4	UREA BULK	86	40	-	-	-	-	-
	14/01/2017	5.2	WW R/Off Pot super/Flexi/Lime	950	21	30	30	37	248	3
	24/03/2017	5.3	UREA BULK	78	36	-	-	-	-	-
	Area weighted total				**125**	**28**	**28**	**35**	**231**	**2**

92	09/01/2017	4.8	WW R/Off Pot super/Flexi/Lime	1024	22	33	32	40	268	3
	24/03/2017	5	UREA BULK	79	37	-	-	-	-	-
	Area weighted total				**56**	**31**	**30**	**37**	**250**	**3**
93	29/09/2016	5.2	Urea	78	36	-	-	-	-	-
	20/12/2016	4.9	WW R/off Balage Maintenance	1410	22	55	102	67	317	3
	09/01/2017	5.1	WW R/Off Pot super/Flexi/Lime	973	21	31	30	38	254	3
	Area weighted total				**74**	**78**	**119**	**95**	**521**	**5**
94	29/09/2016	4.3	Urea	89	41	-	-	-	-	-
	06/01/2017	4.3	WW R/Off Pot super/Flexi/Lime	1026	22	33	32	40	268	3
	24/03/2017	4.4	UREA BULK	87	40	-	-	-	-	-
	Area weighted total				**100**	**31**	**31**	**38**	**257**	**3**
95	22/09/2016	6	Urea	79	36	-	-	-	-	-
	13/10/2016	6.1	UREA BULK	88	40	-	-	-	-	-
	22/12/2016	5.8	WW R/off Balage Maintenance	1352	22	53	97	64	304	3
	13/01/2017	2.3	WW R/Off Pot super/Flexi/Lime	1099	24	35	34	43	287	3
	14/01/2017	4	WW R/Off Pot super/Flexi/Lime	954	21	31	30	37	250	3
	24/03/2017	6.2	UREA BULK	91	42	-	-	-	-	-
	Area weighted total				**157**	**82**	**123**	**100**	**549**	**5**
96	07/10/2016	4.5	UREA BULK	89	41	-	-	-	-	-
	06/01/2017	4.6	WW R/Off Pot super/Flexi/Lime	1061	23	34	33	41	278	3
	24/03/2017	4.6	UREA BULK	80	37	-	-	-	-	-
	Area weighted total				**95**	**32**	**31**	**39**	**262**	**3**

97	29/09/2016	4.7	Urea	78	36	-	-	-	-	-
	06/01/2017	4.8	WW R/Off Pot super/Flexi/Lime	1121	25	36	35	44	293	3
	Area weighted total				**57**	**34**	**34**	**42**	**280**	**3**
98	13/10/2016	6.9	UREA BULK	84	39	-	-	-	-	-
	19/12/2016	4.7	WW R/off Balage Maintenance	1361	22	53	98	65	306	3
	20/12/2016	1.9	WW R/off Balage Maintenance	1393	22	54	100	66	313	3
	06/01/2017	6.8	WW R/Off Pot super/Flexi/Lime	1034	23	33	32	40	270	3
	24/03/2017	7	UREA BULK	92	42	-	-	-	-	-
	Area weighted total				**115**	**78**	**117**	**95**	**521**	**5**
99	**Area weighted total**				**-**	**-**	**-**	**-**	**-**	**-**
Drain 2	**Area weighted total**				**-**	**-**	**-**	**-**	**-**	**-**
Pump Shed	**Area weighted total**				**-**	**-**	**-**	**-**	**-**	**-**
Weighted average rate based on applied areas and rates for selected areas					**74**	**44**	**50**	**51**	**257**	**2**

Note: Total and average rates assume product applications cover effective area of paddock(s) selected.
This is dependent on positional accuracy of paddock boundaries

Nutrient summary report

WOLDWIDE RUNOFF LTD - 60842387

Query range : 01 Jun 2017 to 31 May 2018

Name	Date	Area (ha)	Product	Rate (kg/ha or l/ha)	N kg/ha	P kg/ha	K kg/ha	S kg/ha	Ca kg/ha	Mg kg/ha
1	16/08/2017	5.3	RZR - AMM SE	134	48	-	-	13	-	-
	08/12/2017	5.2	WW R/off Post Cut Maintenance	1410	22	55	102	67	317	3
	13/02/2018	5.3	UREA BULK	109	50	-	-	-	-	-
	Area weighted total				**110**	**50**	**93**	**73**	**289**	**3**
10	16/08/2017	1.7	RZR - AMM SE	130	46	-	-	12	-	-
	13/02/2018	3.8	UREA BULK	110	51	-	-	-	-	-
	Area weighted total				**67**	**-**	**-**	**5**	**-**	**-**
100	16/08/2017	3.9	RZR - AMM SE	139	50	-	-	13	-	-
	05/09/2017	3.8	UREA BULK	151	69	-	-	-	-	-
	21/11/2017	4	WW R/off Post Cut Maintenance	1403	22	55	101	67	316	3
	12/02/2018	4.1	Urea	111	51	-	-	-	-	-
	Area weighted total				**161**	**47**	**87**	**68**	**271**	**2**
101	16/08/2017	2.1	RZR - AMM SE	135	48	-	-	13	-	-
	05/09/2017	2.3	UREA BULK	135	62	-	-	-	-	-
	21/11/2017	2.5	WW R/off Post Cut Maintenance	1426	23	56	103	68	321	3
	12/02/2018	2.5	Urea	113	52	-	-	-	-	-
	Area weighted total				**161**	**52**	**97**	**74**	**302**	**3**
12	16/08/2017	3.4	RZR - AMM SE	137	49	-	-	13	-	-
	08/01/2018	3.7	WW R/Off Pot super/Flexi/Lime	1052	23	34	33	41	275	3

	13/02/2018	3.7	UREA BULK	110	51	-	-	-	-	-
	Area weighted total				**107**	**30**	**30**	**48**	**246**	**3**
14	08/01/2018	4.6	WW R/Off Pot super/Flexi/Lime	1035	23	33	32	40	271	3
	13/02/2018	4.7	UREA BULK	106	49	-	-	-	-	-
	Area weighted total				**67**	**31**	**30**	**38**	**252**	**3**
15	22/11/2017	2	SELENIUM SELPRILL DOUBLE 2%SE DG CL *	219	-	-	-	-	-	-
	08/01/2018	1.3	WW R/Off Pot super/Flexi/Lime	1152	25	37	36	45	301	3
	14/03/2018	3.1	UREA	107	49	-	-	-	-	-
	Area weighted total				**47**	**12**	**12**	**15**	**101**	**1**
16	22/11/2017	3.1	SELENIUM SELPRILL DOUBLE 2%SE DG CL *	224	-	-	-	-	-	-
	13/02/2018	3.7	UREA BULK	108	50	-	-	-	-	-
	Area weighted total				**46**	**-**	**-**	**-**	**-**	**-**
16b	22/11/2017	0.4	SELENIUM SELPRILL DOUBLE 2%SE DG CL *	230	-	-	-	-	-	-
	13/02/2018	0.8	UREA BULK	121	55	-	-	-	-	-
	Area weighted total				**45**	**-**	**-**	**-**	**-**	**-**
17	22/11/2017	3.8	SELENIUM SELPRILL DOUBLE 2%SE DG CL *	233	-	-	-	-	-	-
	Area weighted total				**-**	**-**	**-**	**-**	**-**	**-**
18	22/11/2017	3.3	SELENIUM SELPRILL DOUBLE 2%SE DG CL *	227	-	-	-	-	-	-
	Area weighted total				**-**	**-**	**-**	**-**	**-**	**-**

19	13/02/2018	4.1	UREA BULK	110	50	-	-	-	-	-
	Area weighted total				**48**	**-**	**-**	**-**	**-**	**-**
2	16/08/2017	4.4	RZR - AMM SE	131	47	-	-	13	-	-
	08/12/2017	4.6	WW R/off Post Cut Maintenance	1413	23	55	102	67	318	3
	13/02/2018	4.7	UREA BULK	109	50	-	-	-	-	-
	Area weighted total				**110**	**51**	**94**	**73**	**293**	**3**
20	08/01/2018	3.3	WW R/Off Pot super/Flexi/Lime	1051	23	34	33	41	275	3
	Area weighted total				**19**	**27**	**27**	**33**	**221**	**2**
25	22/11/2017	3.2	WW R/Off Pot super/Flexi/Lime	1003	22	32	31	39	262	3
	13/02/2018	3.3	UREA BULK	110	51	-	-	-	-	-
	Area weighted total				**69**	**29**	**29**	**36**	**240**	**3**
26	22/11/2017	4.3	WW R/Off Pot super/Flexi/Lime	1015	22	32	32	40	265	3
	13/02/2018	4.5	UREA BULK	109	50	-	-	-	-	-
	Area weighted total				**65**	**28**	**28**	**35**	**233**	**2**
27	22/11/2017	3.8	WW R/Off Pot super/Flexi/Lime	1049	23	34	33	41	274	3
	13/02/2018	4.3	UREA BULK	108	50	-	-	-	-	-
	Area weighted total				**60**	**25**	**25**	**31**	**208**	**2**
28	22/11/2017	3.5	WW R/Off Pot super/Flexi/Lime	1030	23	33	32	40	269	3
	13/02/2018	3.8	UREA BULK	108	49	-	-	-	-	-
	Area weighted total				**68**	**30**	**29**	**37**	**244**	**3**
29	16/08/2017	3.4	RZR - AMM SE	135	48	-	-	13	-	-
	08/01/2018	3.3	WW R/Off Pot super/Flexi/Lime	1009	22	32	32	39	264	3
	13/02/2018	3.5	UREA BULK	110	51	-	-	-	-	-

	Area weighted total				**108**	**27**	**27**	**45**	**224**	**2**
2A	05/09/2017	1.6	AMMO 36 BULK	138	49	-	-	13	-	-
	12/02/2018	1.9	UREA BULK	123	56	-	-	-	-	-
	Area weighted total				**87**	**-**	**-**	**10**	**-**	**-**
3	16/08/2017	2.4	RZR - AMM SE	138	49	-	-	13	-	-
	22/11/2017	2.3	WW R/Off Pot super/Flexi/Lime	1028	23	33	32	40	269	3
	13/02/2018	2.5	UREA BULK	110	50	-	-	-	-	-
	Area weighted total				**105**	**27**	**26**	**44**	**221**	**2**
30	16/08/2017	4	RZR - AMM SE	128	46	-	-	12	-	-
	13/02/2018	4.4	UREA BULK	111	51	-	-	-	-	-
	Area weighted total				**79**	**-**	**-**	**10**	**-**	**-**
31	08/01/2018	4.1	WW R/Off Pot super/Flexi/Lime	1058	23	34	33	41	277	3
	Area weighted total				**21**	**30**	**29**	**37**	**246**	**3**
32	22/11/2017	4.2	SELENIUM SELPRILL DOUBLE 2%SE DG CL *	237	-	-	-	-	-	-
	Area weighted total				**-**	**-**	**-**	**-**	**-**	**-**
33	21/11/2017	4.5	WW R/off Post Cut Maintenance	1471	23	57	106	70	331	3
	13/02/2018	5.7	UREA BULK	110	51	-	-	-	-	-
	Area weighted total				**58**	**38**	**71**	**47**	**220**	**2**
34	22/11/2017	5.9	SELENIUM SELPRILL DOUBLE 2%SE DG CL *	224	-	-	-	-	-	-
	13/02/2018	6.2	UREA BULK	107	49	-	-	-	-	-
	Area weighted total				**46**	**-**	**-**	**-**	**-**	**-**
35	22/11/2017	2.8	SELENIUM SELPRILL DOUBLE 2%SE DG CL *	234	-	-	-	-	-	-

	Area weighted total				**-**	**-**	**-**	**-**	**-**	**-**
36	22/11/2017	5.3	SELENIUM SELPRILL DOUBLE 2%SE DG CL *	225	-	-	-	-	-	-
	Area weighted total				**-**	**-**	**-**	**-**	**-**	**-**
4a	**Area weighted total**				**-**	**-**	**-**	**-**	**-**	**-**
4b	16/08/2017	3	RZR - AMM SE	142	51	-	-	14	-	-
	22/11/2017	3.2	WW R/Off Pot super/Flexi/Lime	1031	23	33	32	40	270	3
	13/02/2018	3	UREA BULK	112	51	-	-	-	-	-
	Area weighted total				**110**	**30**	**30**	**49**	**249**	**3**
4c	**Area weighted total**				**-**	**-**	**-**	**-**	**-**	**-**
5	16/08/2017	5.6	RZR - AMM SE	132	47	-	-	13	-	-
	30/11/2017	6	MURIVALE KALE	392	58	66	28	3	-	-
	Area weighted total				**98**	**63**	**26**	**14**	**-**	**-**
51	**Area weighted total**				**-**	**-**	**-**	**-**	**-**	**-**
52	**Area weighted total**				**-**	**-**	**-**	**-**	**-**	**-**
53	**Area weighted total**				**-**	**-**	**-**	**-**	**-**	**-**
54	**Area weighted total**				**-**	**-**	**-**	**-**	**-**	**-**
56	16/08/2017	6.3	RZR - AMM SE	133	48	-	-	13	-	-
	08/01/2018	6.3	WW R/Off Pot super/Flexi/Lime	990	22	32	31	39	259	3
	13/02/2018	6.5	UREA BULK	108	49	-	-	-	-	-
	Area weighted total				**112**	**29**	**29**	**48**	**240**	**3**
57	16/08/2017	5.5	RZR - AMM SE	128	46	-	-	12	-	-
	22/11/2017	5.9	WW R/Off Pot super/Flexi/Lime	988	22	32	31	39	258	3
	13/02/2018	5.9	UREA BULK	108	50	-	-	-	-	-
	Area weighted total				**108**	**30**	**29**	**47**	**244**	**3**
58	16/08/2017	6	RZR - AMM SE	137	49	-	-	13	-	-

	05/09/2017	5.9	UREA BULK	128	59	-	-	-	-	-
	08/12/2017	5.8	WW R/off Post Cut Maintenance	1417	23	55	102	67	319	3
	13/02/2018	6.1	UREA BULK	105	48	-	-	-	-	-
	Area weighted total				**166**	**49**	**91**	**72**	**285**	**3**
59	16/08/2017	5.2	RZR - AMM SE	137	49	-	-	13	-	-
	05/09/2017	5.2	UREA BULK	135	62	-	-	-	-	-
	08/01/2018	4.9	WW R/Off Pot super/Flexi/Lime	1007	22	32	32	39	263	3
	13/02/2018	5.3	UREA BULK	106	49	-	-	-	-	-
	Area weighted total				**168**	**28**	**28**	**47**	**230**	**2**
6	16/08/2017	5	RZR - AMM SE	136	48	-	-	13	-	-
	30/11/2017	5.3	MURIVALE KALE	396	59	67	28	3	-	-
	Area weighted total				**102**	**65**	**27**	**15**	**-**	**-**
7	16/08/2017	4	RZR - AMM SE	133	48	-	-	13	-	-
	30/11/2017	4.4	MURIVALE KALE	404	60	68	28	3	-	-
	Area weighted total				**97**	**64**	**27**	**14**	**-**	**-**
75	16/08/2017	5.2	RZR - AMM SE	129	46	-	-	12	-	-
	05/09/2017	5.3	UREA BULK	129	59	-	-	-	-	-
	22/11/2017	5.2	WW R/Off Pot super/Flexi/Lime	997	22	32	31	39	261	3
	08/01/2018	5	WW R/Off Pot super/Flexi/Lime	973	21	31	31	38	254	3
	Area weighted total				**141**	**59**	**58**	**84**	**482**	**5**
76	16/08/2017	4.5	RZR - AMM SE	147	52	-	-	14	-	-
	05/09/2017	4.5	UREA BULK	136	63	-	-	-	-	-
	22/11/2017	4.6	WW R/Off Pot super/Flexi/Lime	999	22	32	31	39	261	3
	12/02/2018	4.5	Urea	117	54	-	-	-	-	-
	14/03/2018	4	UREA	104	48	-	-	-	-	-

	Area weighted total				**212**	**30**	**29**	**49**	**244**	**3**
77	16/08/2017	4.5	RZR - AMM SE	133	47	-	-	13	-	-
	05/09/2017	4.6	UREA BULK	134	61	-	-	-	-	-
	28/10/2017	4.5	Post Cust - Grazed mix	1062	36	27	65	33	256	5
	08/01/2018	4.5	WW R/Off Pot super/Flexi/Lime	1033	23	33	32	40	270	3
	Area weighted total				**161**	**58**	**93**	**83**	**504**	**7**
78	16/08/2017	3.3	RZR - AMM SE	141	50	-	-	13	-	-
	05/09/2017	3.3	UREA BULK	134	62	-	-	-	-	-
	28/10/2017	3.2	Post Cust - Grazed mix	1064	36	27	65	33	256	5
	08/12/2017	3	WW R/off Post Cut Maintenance	1513	24	59	109	72	340	3
	12/02/2018	3.3	Urea	113	52	-	-	-	-	-
	Area weighted total				**214**	**78**	**159**	**109**	**545**	**7**
79	16/08/2017	5.7	RZR - AMM SE	132	47	-	-	13	-	-
	05/09/2017	5.6	UREA BULK	130	60	-	-	-	-	-
	28/10/2017	5.7	Post Cust - Grazed mix	1051	36	27	64	33	253	4
	08/01/2018	5.6	WW R/Off Pot super/Flexi/Lime	1002	22	32	31	39	262	3
	21/02/2018	5.6	UREA BULK	110	50	-	-	-	-	-
	Area weighted total				**209**	**57**	**93**	**82**	**498**	**7**
8	13/02/2018	4.5	UREA BULK	108	50	-	-	-	-	-
	Area weighted total				**47**	**-**	**-**	**-**	**-**	**-**
80	16/08/2017	4.7	RZR - AMM SE	129	46	-	-	12	-	-
	05/09/2017	4.9	UREA BULK	126	58	-	-	-	-	-
	12/02/2018	4.9	Urea	107	49	-	-	-	-	-
	Area weighted total				**149**	**-**	**-**	**12**	**-**	**-**

81	16/08/2017	6.3	RZR - AMM SE	124	44	-	-	12	-	-
	05/09/2017	6.4	UREA BULK	124	57	-	-	-	-	-
	28/10/2017	6.4	Post Cust - Grazed mix	1028	35	26	63	32	248	4
	08/01/2018	6.4	WW R/Off Pot super/Flexi/Lime	1042	23	33	33	41	272	3
	13/02/2018	5.1	UREA BULK	102	47	-	-	-	-	-
	Area weighted total				**189**	**58**	**93**	**82**	**503**	**7**
82	16/08/2017	3.4	RZR - AMM SE	123	44	-	-	12	-	-
	05/09/2017	3.5	UREA BULK	119	55	-	-	-	-	-
	28/10/2017	3.6	Post Cust - Grazed mix	1107	37	28	68	35	267	5
	08/12/2017	3.4	WW R/off Post Cut Maintenance	1525	24	59	110	73	343	3
	12/02/2018	3.6	Urea	100	46	-	-	-	-	-
	Area weighted total				**198**	**83**	**168**	**112**	**578**	**7**
83	16/08/2017	6.7	RZR - AMM SE	128	46	-	-	12	-	-
	05/09/2017	6.7	UREA BULK	129	59	-	-	-	-	-
	28/10/2017	4.7	Post Cust - Grazed mix	1062	36	27	65	33	256	5
	28/10/2017	1.9	Post Cust - Grazed mix	1001	34	26	61	31	241	4
	08/01/2018	6.5	WW R/Off Pot super/Flexi/Lime	1135	25	36	36	44	297	3
	12/02/2018	6.7	Urea	111	51	-	-	-	-	-
	Area weighted total				**210**	**61**	**96**	**86**	**527**	**7**
84	16/08/2017	3.2	RZR - AMM SE	125	45	-	-	12	-	-
	05/09/2017	3.5	UREA BULK	139	64	-	-	-	-	-
	28/10/2017	3.5	Post Cust - Grazed mix	1084	37	28	66	34	261	5

	08/12/2017	3.3	WW R/off Post Cut Maintenance	1466	23	57	106	70	330	3
	12/02/2018	3.6	Urea	113	52	-	-	-	-	-
	Area weighted total				**209**	**79**	**160**	**107**	**552**	**7**
85	16/08/2017	6.4	RZR - AMM SE	135	48	-	-	13	-	-
	05/09/2017	6.6	UREA BULK	133	61	-	-	-	-	-
	28/10/2017	6.3	Post Cust - Grazed mix	1083	37	28	66	34	261	5
	08/12/2017	6.6	WW R/off Post Cut Maintenance	1407	22	55	101	67	317	3
	12/02/2018	6.7	Urea	113	52	-	-	-	-	-
	Area weighted total				**203**	**75**	**153**	**104**	**524**	**7**
86	16/08/2017	4.4	RZR - AMM SE	139	50	-	-	13	-	-
	05/09/2017	4.5	UREA BULK	137	63	-	-	-	-	-
	08/12/2017	4.1	WW R/off Post Cut Maintenance	1537	24	60	111	73	346	3
	Area weighted total				**118**	**49**	**91**	**71**	**283**	**3**
87	16/08/2017	5.5	RZR - AMM SE	147	52	-	-	14	-	-
	05/09/2017	5.4	UREA BULK	142	65	-	-	-	-	-
	08/12/2017	0	WW R/off Post Cut Maintenance	1300	21	51	94	62	293	3
	08/12/2017	5.4	WW R/off Post Cut Maintenance	1490	24	58	107	71	335	3
	21/02/2018	5.4	UREA BULK	113	52	-	-	-	-	-
	Area weighted total				**173**	**52**	**96**	**76**	**299**	**3**
88	16/08/2017	4	RZR - AMM SE	135	48	-	-	13	-	-
	05/09/2017	4.3	UREA BULK	142	65	-	-	-	-	-
	28/10/2017	4.3	Post Cust - Grazed mix	1050	35	27	64	33	253	4

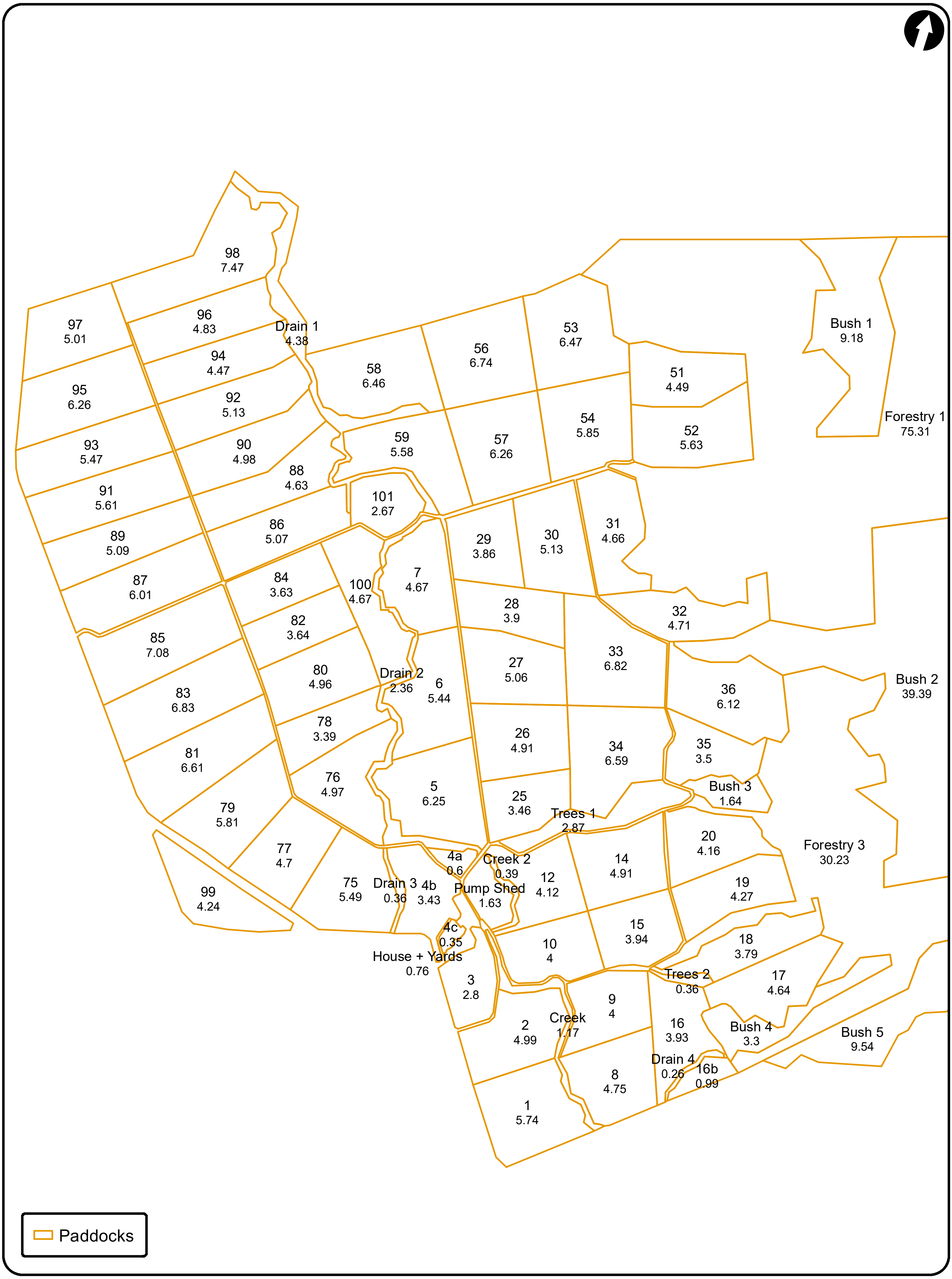
	08/12/2017	4.1	WW R/off Post Cut Maintenance	1444	23	56	104	69	325	3
	Area weighted total				**156**	**75**	**153**	**103**	**525**	**7**
89	16/08/2017	4.8	RZR - AMM SE	127	45	-	-	12	-	-
	05/09/2017	4.8	UREA BULK	136	62	-	-	-	-	-
	28/10/2017	0.6	Post Cust - Grazed mix	982	33	25	60	31	237	4
	28/10/2017	4.1	Post Cust - Grazed mix	1026	35	26	63	32	247	4
	08/12/2017	4.8	WW R/off Post Cut Maintenance	1371	22	53	99	65	309	3
	21/02/2018	4.9	UREA BULK	111	51	-	-	-	-	-
	Area weighted total				**203**	**75**	**151**	**103**	**519**	**7**
9	13/02/2018	3.3	UREA BULK	109	50	-	-	-	-	-
	Area weighted total				**42**	**-**	**-**	**-**	**-**	**-**
90	16/08/2017	4.1	RZR - AMM SE	130	46	-	-	12	-	-
	05/09/2017	4.8	UREA BULK	134	62	-	-	-	-	-
	28/10/2017	4.9	Post Cust - Grazed mix	1096	37	28	67	34	264	5
	29/01/2018	4.7	WW R/off Post Cut Maintenance	1410	22	55	102	67	317	3
	Area weighted total				**155**	**79**	**162**	**107**	**557**	**7**
91	16/08/2017	5.3	RZR - AMM SE	114	41	-	-	11	-	-
	05/09/2017	5.4	UREA BULK	112	52	-	-	-	-	-
	28/10/2017	1.6	Post Cust - Grazed mix	1081	37	28	66	34	260	5
	28/10/2017	3.8	Post Cust - Grazed mix	1063	36	27	65	33	256	5
	08/12/2017	5.4	WW R/off Post Cut Maintenance	1287	20	50	93	61	290	3
	Area weighted total				**142**	**75**	**152**	**102**	**527**	**7**

92	16/08/2017	4.4	RZR - AMM SE	124	44	-	-	12	-	-
	05/09/2017	4.9	UREA BULK	119	55	-	-	-	-	-
	21/11/2017	4.7	WW R/off Post Cut Maintenance	1356	22	53	98	65	305	3
	Area weighted total				**110**	**48**	**89**	**69**	**277**	**2**
93	16/08/2017	5.3	RZR - AMM SE	133	48	-	-	13	-	-
	05/09/2017	5.3	UREA BULK	133	61	-	-	-	-	-
	28/10/2017	5.3	Post Cust - Grazed mix	1062	36	27	65	33	256	5
	08/12/2017	5.3	WW R/off Post Cut Maintenance	1324	21	52	95	63	298	3
	21/02/2018	5.4	UREA BULK	109	50	-	-	-	-	-
	Area weighted total				**211**	**77**	**156**	**106**	**539**	**7**
94	16/08/2017	3.7	RZR - AMM SE	129	46	-	-	12	-	-
	05/09/2017	4.3	UREA BULK	130	60	-	-	-	-	-
	28/10/2017	4.3	Post Cust - Grazed mix	1002	34	26	61	31	241	4
	08/12/2017	4.2	WW R/off Post Cut Maintenance	1458	23	57	105	69	328	3
	Area weighted total				**149**	**78**	**157**	**105**	**538**	**7**
95	16/08/2017	6.1	RZR - AMM SE	121	43	-	-	12	-	-
	05/09/2017	6.1	UREA BULK	119	55	-	-	-	-	-
	28/10/2017	6	Post Cust - Grazed mix	977	33	25	60	31	235	4
	08/12/2017	6.1	WW R/off Post Cut Maintenance	1409	22	55	102	67	317	3
	21/02/2018	6.1	UREA BULK	100	46	-	-	-	-	-
	Area weighted total				**194**	**78**	**158**	**107**	**539**	**7**
96	16/08/2017	4.2	RZR - AMM SE	125	45	-	-	12	-	-
	05/09/2017	4.4	UREA BULK	122	56	-	-	-	-	-

	28/10/2017	4.7	Post Cust - Grazed mix	1019	34	26	62	32	245	4
	08/12/2017	4.6	WW R/off Post Cut Maintenance	1388	22	54	100	66	312	3
	Area weighted total				**145**	**77**	**156**	**105**	**537**	**7**
97	16/08/2017	4.7	RZR - AMM SE	135	48	-	-	13	-	-
	05/09/2017	4.8	UREA BULK	133	61	-	-	-	-	-
	28/10/2017	4.9	Post Cust - Grazed mix	1027	35	26	63	32	247	4
	08/12/2017	4.6	WW R/off Post Cut Maintenance	1407	22	55	101	67	317	3
	21/02/2018	4.9	UREA BULK	113	52	-	-	-	-	-
	Area weighted total				**210**	**76**	**155**	**105**	**533**	**7**
98	16/08/2017	6.6	RZR - AMM SE	144	51	-	-	14	-	-
	05/09/2017	6.8	UREA BULK	130	60	-	-	-	-	-
	28/10/2017	7.1	Post Cust - Grazed mix	1059	36	27	65	33	255	4
	08/12/2017	0.5	WW R/off Post Cut Maintenance	1728	28	67	125	82	389	3
	08/12/2017	7.1	WW R/off Post Cut Maintenance	1420	23	55	102	68	320	3
	21/02/2018	5.3	UREA BULK	111	51	-	-	-	-	-
	Area weighted total				**193**	**83**	**167**	**114**	**573**	**7**
99	**Area weighted total**				**-**	**-**	**-**	**-**	**-**	**-**
Weighted average rate based on applied areas and rates for selected areas					**109**	**38**	**62**	**51**	**254**	**3**

Note: Total and average rates assume product applications cover effective area of paddock(s) selected.
This is dependent on positional accuracy of paddock boundaries

* The product that you have created, is missing nutrient values. This will affect any averages or totals in the Nutrient summary. Please go to the event concerned and add the nutrient values to the appropriate product.



My Ravensdown Smart Maps
www.myravensdown.co.nz
Note: Areas are in hectares
Copyright Ravensdown Ltd

Merrivale

0 80 160 320 480 640 Metres

ravensdown

11 October 2018

Nutrient summary report

WOLDWIDE RUNOFF LTD - 60842387

Query range : 01 Jun 2017 to 31 May 2018

Name	Date	Area (ha)	Product	Rate (kg/ha or l/ha)	N kg/ha	P kg/ha	K kg/ha	S kg/ha	Ca kg/ha	Mg kg/ha
2A	05/09/2017	1.6	AMMO 36 BULK	138	49	-	-	13	-	-
	12/02/2018	1.9	UREA BULK	123	56	-	-	-	-	-
	Area weighted total				**87**	**-**	**-**	**10**	**-**	**-**
A1	05/09/2017	4	AMMO 36 BULK	139	50	-	-	13	-	-
	12/02/2018	4	UREA BULK	108	50	-	-	-	-	-
	Area weighted total				**89**	**-**	**-**	**12**	**-**	**-**
B1	05/09/2017	6.2	AMMO 36 BULK	129	46	-	-	12	-	-
	24/11/2017	5.9	Post Cut mix to be cut again	355	58	10	54	12	22	7
	12/02/2018	6.4	UREA BULK	109	50	-	-	-	-	-
	Area weighted total				**146**	**9**	**49**	**23**	**20**	**7**
B2	05/09/2017	7.7	AMMO 36 BULK	144	52	-	-	14	-	-
	10/01/2018	7.8	Merriburn Grazed MaintenanCE+N	887	43	23	-	29	240	5
	12/02/2018	8.2	UREA BULK	115	53	-	-	-	-	-
	Area weighted total				**132**	**21**	**-**	**37**	**211**	**5**
barn lane?	05/09/2017	1.1	AMMO 36 BULK	122	44	-	-	12	-	-
	12/02/2018	1.2	UREA BULK	105	48	-	-	-	-	-
	Area weighted total				**78**	**-**	**-**	**10**	**-**	**-**
C1	05/09/2017	5.9	AMMO 36 BULK	129	46	-	-	12	-	-
	24/11/2017	6	Post Cut mix to be cut again	352	57	10	53	12	21	7
	12/02/2018	6.2	UREA BULK	110	50	-	-	-	-	-

	Area weighted total				**146**	**9**	**50**	**22**	**20**	**7**
C2	05/09/2017	6.2	AMMO 36 BULK	137	49	-	-	13	-	-
	10/01/2018	6.1	Merriburn Grazed MaintenanCE+N	894	44	24	-	29	242	5
	12/02/2018	6.3	UREA BULK	110	51	-	-	-	-	-
	Area weighted total				**136**	**22**	**-**	**39**	**225**	**5**
C3	05/09/2017	3.7	AMMO 36 BULK	148	53	-	-	14	-	-
	08/12/2017	3.2	Post Cust - Grazed mix	1118	38	29	68	35	269	5
	Area weighted total				**67**	**20**	**47**	**35**	**184**	**3**
D1	05/09/2017	4	AMMO 36 BULK	133	48	-	-	13	-	-
	24/11/2017	4	Post Cut mix to be cut again	358	58	10	54	12	22	7
	12/02/2018	4.2	UREA BULK	114	53	-	-	-	-	-
	Area weighted total				**150**	**9**	**51**	**23**	**20**	**7**
D2	05/09/2017	4.5	AMMO 36 BULK	150	54	-	-	14	-	-
	24/11/2017	4.4	Merriburn Grazed Maintenance+N	932	45	25	-	30	252	6
	12/02/2018	4.7	UREA BULK	112	51	-	-	-	-	-
	Area weighted total				**133**	**21**	**-**	**38**	**216**	**5**
D3	05/09/2017	2.5	AMMO 36 BULK	138	50	-	-	13	-	-
	Area weighted total				**30**	**-**	**-**	**8**	**-**	**-**
E1	05/09/2017	1	AMMO 36 BULK	135	48	-	-	13	-	-
	24/11/2017	0.8	Merriburn Grazed Maintenance+N	972	47	26	-	31	263	6
	12/02/2018	1.2	UREA BULK	120	55	-	-	-	-	-
	Area weighted total				**114**	**15**	**-**	**29**	**157**	**4**
E2	05/09/2017	2.1	AMMO 36 BULK	135	48	-	-	13	-	-
	24/11/2017	2.9	Merriburn Grazed Maintenance+N	992	48	26	-	32	269	6

	12/02/2018	3.3	UREA BULK	112	52	-	-	-	-	-
	Area weighted total				**113**	**21**	**-**	**33**	**212**	**5**
E3	05/09/2017	3.2	AMMO 36 BULK	141	51	-	-	14	-	-
	11/01/2018	1.1	Merriburn Grazed Maintenance+N	872	42	23	-	28	236	5
	12/02/2018	4	UREA BULK	118	54	-	-	-	-	-
	Area weighted total				**100**	**6**	**-**	**18**	**60**	**1**
F1	05/09/2017	3	AMMO 36 BULK	132	47	-	-	13	-	-
	24/11/2017	2.2	Merriburn Grazed Maintenance+N	924	45	24	-	30	250	6
	12/02/2018	3.7	UREA BULK	116	53	-	-	-	-	-
	Area weighted total				**98**	**12**	**-**	**23**	**122**	**3**
F2	05/09/2017	6.7	AMMO 36 BULK	144	52	-	-	14	-	-
	11/01/2018	7.3	Merriburn Grazed Maintenance+N	913	44	24	-	30	247	6
	12/02/2018	7.3	UREA BULK	108	50	-	-	-	-	-
	Area weighted total				**134**	**23**	**-**	**40**	**236**	**5**
F3	05/09/2017	4.8	AMMO 36 BULK	140	50	-	-	13	-	-
	11/01/2018	5.2	Merriburn Grazed Maintenance+N	901	44	24	-	29	244	6
	12/02/2018	5.3	UREA BULK	113	52	-	-	-	-	-
	Area weighted total				**136**	**23**	**-**	**40**	**232**	**5**
F4	05/09/2017	0.7	AMMO 36 BULK	145	52	-	-	14	-	-
	Area weighted total				**9**	**-**	**-**	**2**	**-**	**-**
G1	05/09/2017	1.4	AMMO 36 BULK	120	43	-	-	11	-	-
	24/11/2017	1.4	Merriburn Grazed Maintenance+N	865	42	23	-	28	234	5
	21/02/2018	1.5	UREA BULK	102	47	-	-	-	-	-
	Area weighted total				**120**	**20**	**-**	**35**	**206**	**5**
G2	05/09/2017	5.6	AMMO 36 BULK	145	52	-	-	14	-	-

	24/11/2017	5.6	Merriburn Grazed Maintenance+N	956	47	25	-	31	259	6
	11/01/2018	6.6	Merriburn Grazed Maintenance+N	957	47	25	-	31	259	6
	12/02/2018	7.1	UREA BULK	114	53	-	-	-	-	-
	Area weighted total				**169**	**43**	**-**	**63**	**435**	**10**
G3	05/09/2017	5.8	AMMO 36 BULK	145	52	-	-	14	-	-
	Area weighted total				**31**	**-**	**-**	**8**	**-**	**-**
G4	**Area weighted total**				**-**	**-**	**-**	**-**	**-**	**-**
H1	05/09/2017	0.6	AMMO 36 BULK	136	49	-	-	13	-	-
	24/11/2017	0.6	Merriburn Grazed Maintenance+N	936	46	25	-	30	253	6
	21/02/2018	0.7	UREA BULK	104	48	-	-	-	-	-
	Area weighted total				**113**	**19**	**-**	**34**	**194**	**4**
H2	16/08/2017	4.2	RZR - AMM SE	139	50	-	-	13	-	-
	24/11/2017	4.1	Post Cut mix to be cut again	358	58	10	54	12	22	7
	Area weighted total				**100**	**9**	**50**	**23**	**20**	**7**
H3	05/09/2017	3.2	AMMO 36 BULK	141	51	-	-	14	-	-
	24/11/2017	3.1	Merriburn Grazed Maintenance+N	930	45	25	-	30	252	6
	21/02/2018	3.3	UREA BULK	119	55	-	-	-	-	-
	Area weighted total				**124**	**20**	**-**	**35**	**200**	**5**
H4	16/08/2017	2.3	RZR - AMM SE	140	50	-	-	13	-	-
	24/11/2017	0.3	Post Cut mix to be cut again	374	61	10	57	12	23	8
	08/12/2017	2.1	Post Cust - Grazed mix	1137	38	29	70	36	274	5
	21/02/2018	2.1	UREA BULK	126	58	-	-	-	-	-
	Area weighted total				**119**	**23**	**58**	**39**	**210**	**4**

H5	05/09/2017	3.6	AMMO 36 BULK	140	50	-	-	13	-	-
	Area weighted total				**28**	**-**	**-**	**7**	**-**	**-**
H6	**Area weighted total**				**-**	**-**	**-**	**-**	**-**	**-**
R1	05/09/2017	6.2	AMMO 36 BULK	138	49	-	-	13	-	-
	06/12/2017	6.6	DAP Boron/ Potash and Slugbait	399	46	52	56	3	-	1
	Area weighted total				**87**	**49**	**53**	**14**	**-**	**1**
R10	05/09/2017	4.2	AMMO 36 BULK	134	48	-	-	13	-	-
	29/01/2018	3.9	WW R/off Post Cut Maintenance	1389	22	54	100	66	313	3
	12/02/2018	4.3	UREA BULK	109	50	-	-	-	-	-
	Area weighted total				**99**	**41**	**77**	**61**	**239**	**2**
R11	05/09/2017	3.6	AMMO 36 BULK	137	49	-	-	13	-	-
	24/11/2017	3.6	Post Cut mix to be cut again	361	59	10	55	12	22	7
	12/02/2018	3.7	UREA BULK	122	56	-	-	-	-	-
	Area weighted total				**155**	**9**	**52**	**24**	**21**	**7**
R12	05/09/2017	8.1	AMMO 36 BULK	135	48	-	-	13	-	-
	19/10/2017	0.1	TZT - AGL SUP	155	-	7	-	9	44	-
	17/11/2017	0.1	GERMINATION MIX	612	32	44	27	54	98	-
	24/11/2017	8.3	Post Cut mix to be cut again	382	62	10	58	13	23	8
	12/02/2018	8.8	UREA BULK	111	51	-	-	-	-	-
	14/03/2018	0.2	UREA	95	44	-	-	-	-	-
	Area weighted total				**138**	**10**	**49**	**22**	**22**	**7**
R13	19/10/2017	7.1	TZT - AGL SUP	171	-	8	-	9	48	-
	17/11/2017	7.6	GERMINATION MIX	731	38	52	32	64	117	-
	14/03/2018	7.8	UREA	113	52	-	-	-	-	-
	Area weighted total				**79**	**52**	**28**	**63**	**139**	**-**
R14	16/08/2017	6.4	RZR - AMM SE	134	48	-	-	13	-	-

	12/02/2018	6.5	UREA BULK	111	51	-	-	-	-	-
	Area weighted total				**93**	**-**	**-**	**12**	**-**	**-**
R15	16/08/2017	6	RZR - AMM SE	135	48	-	-	13	-	-
	05/09/2017	2.1	AMMO 36 BULK	122	44	-	-	12	-	-
	24/11/2017	8	Post Cut mix to be cut again	361	59	10	55	12	22	7
	12/02/2018	8.2	UREA BULK	111	51	-	-	-	-	-
	Area weighted total				**142**	**9**	**49**	**22**	**20**	**7**
R16	05/09/2017	3.2	AMMO 36 BULK	133	48	-	-	13	-	-
	08/12/2017	3.4	Post Cust - Grazed mix	1078	36	28	66	34	260	5
	10/01/2018	3.2	Merriburn Grazed MaintenanCE+N	1012	49	27	-	33	274	6
	12/02/2018	3.4	UREA BULK	109	50	-	-	-	-	-
	Area weighted total				**158**	**47**	**58**	**68**	**457**	**9**
R17	16/08/2017	2.8	RZR - AMM SE	132	47	-	-	13	-	-
	08/12/2017	3.2	Post Cust - Grazed mix	1051	36	27	64	33	253	4
	10/01/2018	3.1	Merriburn Grazed MaintenanCE+N	1029	50	27	-	33	278	6
	12/02/2018	3.3	UREA BULK	112	51	-	-	-	-	-
	Area weighted total				**162**	**48**	**58**	**69**	**474**	**10**
R18	16/08/2017	2.1	RZR - AMM SE	141	50	-	-	14	-	-
	05/09/2017	1.2	AMMO 36 BULK	121	43	-	-	12	-	-
	04/12/2017	3.4	DAP Boron/ Potash and Slugbait	418	48	55	59	3	-	1
	Area weighted total				**82**	**48**	**51**	**13**	**-**	**1**
R19	16/08/2017	3.1	RZR - AMM SE	130	46	-	-	12	-	-
	04/12/2017	3.4	DAP Boron/ Potash and Slugbait	432	50	57	61	3	-	2

	Area weighted total				**82**	**50**	**54**	**12**	**-**	**1**
R2	05/09/2017	3.1	AMMO 36 BULK	152	54	-	-	15	-	-
	24/11/2017	2.9	Merriburn Grazed Maintenance+N	956	47	25	-	31	259	6
	12/02/2018	3.2	UREA BULK	120	55	-	-	-	-	-
	Area weighted total				**133**	**20**	**-**	**37**	**209**	**5**
R20	16/08/2017	4.4	RZR - AMM SE	131	47	-	-	12	-	-
	04/12/2017	4.6	DAP Boron/ Potash and Slugbait	396	46	52	56	3	-	1
	Area weighted total				**88**	**51**	**54**	**14**	**-**	**1**
R21	16/08/2017	4.6	RZR - AMM SE	131	47	-	-	13	-	-
	04/12/2017	5.3	DAP Boron/ Potash and Slugbait	396	46	52	56	3	-	1
	Area weighted total				**79**	**47**	**51**	**12**	**-**	**1**
R3	16/08/2017	2.1	RZR - AMM SE	157	56	-	-	15	-	-
	24/11/2017	3.4	Merriburn Grazed Maintenance+N	960	47	25	-	31	260	6
	21/02/2018	3.3	UREA BULK	111	51	-	-	-	-	-
	Area weighted total				**123**	**24**	**-**	**38**	**243**	**5**
R4	05/09/2017	4.8	AMMO 36 BULK	130	46	-	-	12	-	-
	24/11/2017	4.7	Merriburn Grazed Maintenance+N	909	44	24	-	29	246	6
	12/02/2018	5	UREA BULK	110	51	-	-	-	-	-
	Area weighted total				**127**	**21**	**-**	**37**	**215**	**5**
R5	19/10/2017	2.6	TZT - AGL SUP	166	-	7	-	9	47	-
	19/10/2017	4.7	TZT - AGL SUP	338	-	15	-	19	95	-
	17/11/2017	4.7	GERMINATION MIX	719	37	52	32	63	115	-
	12/02/2018	5	UREA BULK	121	56	-	-	-	-	-
	Area weighted total				**86**	**63**	**28**	**77**	**209**	**-**
R6	05/09/2017	4.2	AMMO 36 BULK	138	49	-	-	13	-	-

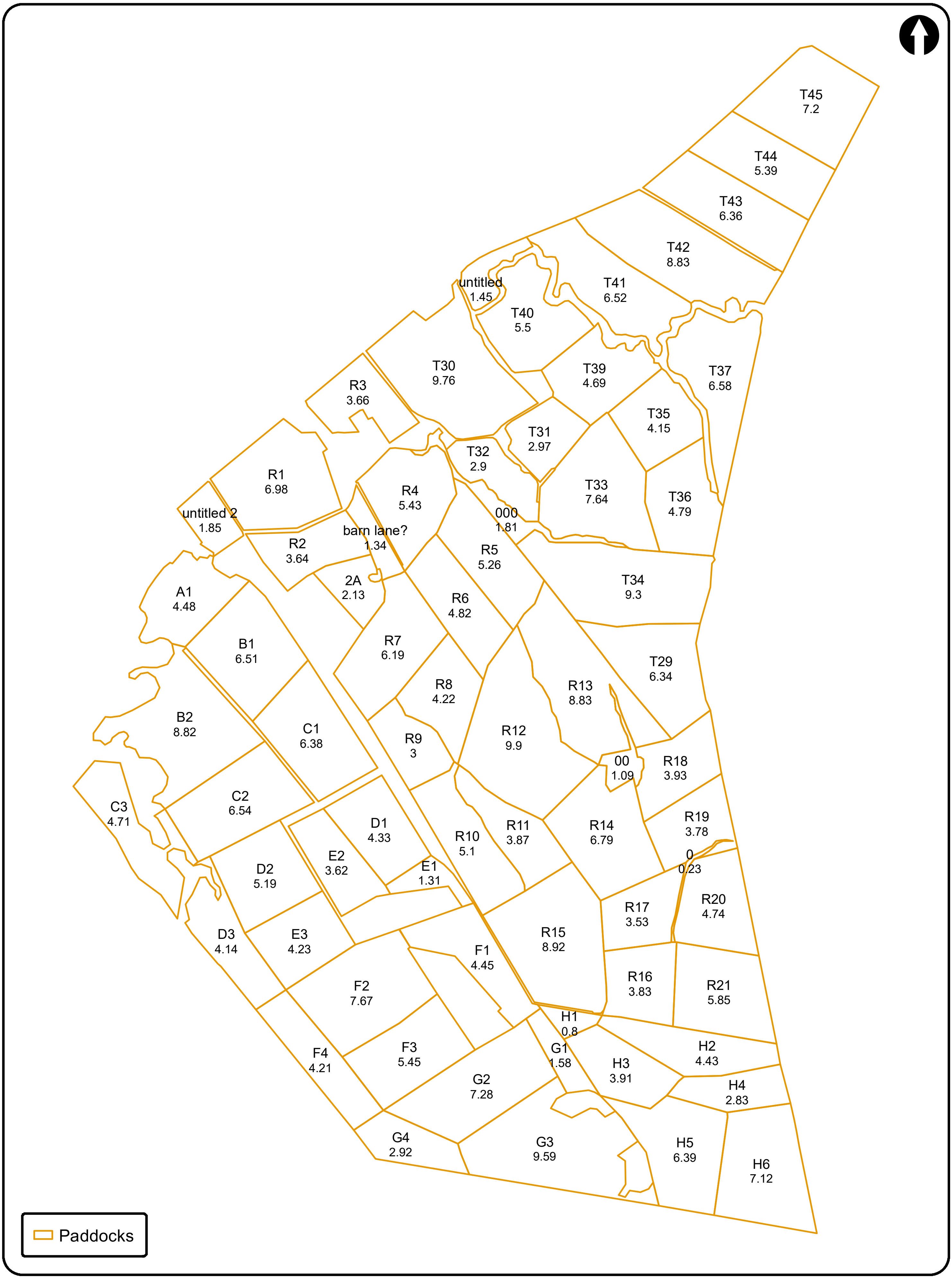
	12/02/2018	4.6	UREA BULK	110	51	-	-	-	-	-
	Area weighted total				**92**	**-**	**-**	**12**	**-**	**-**
R7	05/09/2017	4.2	AMMO 36 BULK	133	48	-	-	13	-	-
	12/02/2018	4.3	UREA BULK	110	51	-	-	-	-	-
	Area weighted total				**68**	**-**	**-**	**9**	**-**	**-**
R8	05/09/2017	3.6	AMMO 36 BULK	135	48	-	-	13	-	-
	24/11/2017	3.6	Merriburn Grazed Maintenance+N	964	47	26	-	31	261	6
	12/02/2018	4	UREA BULK	115	53	-	-	-	-	-
	Area weighted total				**131**	**22**	**-**	**37**	**222**	**5**
R9	05/09/2017	2.3	AMMO 36 BULK	139	50	-	-	13	-	-
	08/12/2017	2.4	Post Cust - Grazed mix	1128	38	29	69	35	272	5
	12/02/2018	2.7	UREA BULK	118	54	-	-	-	-	-
	Area weighted total				**116**	**23**	**56**	**39**	**219**	**4**
T29	05/09/2017	4.7	AMMO 36 BULK	140	50	-	-	13	-	-
	12/02/2018	5.9	UREA BULK	119	55	-	-	-	-	-
	Area weighted total				**88**	**-**	**-**	**10**	**-**	**-**
T30	16/08/2017	4.5	RZR - AMM SE	145	52	-	-	14	-	-
	24/11/2017	4.6	Merriburn Grazed Maintenance+N	919	45	24	-	30	249	6
	06/12/2017	3.9	DAP Boron/ Potash and Slugbait	413	48	54	58	3	-	1
	Area weighted total				**64**	**33**	**23**	**22**	**118**	**3**
T31	19/10/2017	2.8	TZT - AGL SUP	311	-	14	-	17	87	-
	17/11/2017	2.9	GERMINATION MIX	689	36	49	31	60	110	-
	29/01/2018	2.8	UREA BULK	110	50	-	-	-	-	-
	Area weighted total				**83**	**62**	**30**	**76**	**191**	**-**
T32	19/10/2017	2.6	TZT - AGL SUP	322	-	14	-	18	90	-
	17/11/2017	2.6	GERMINATION MIX	730	38	52	32	64	117	-

	29/01/2018	2.4	UREA BULK	112	52	-	-	-	-	-
	Area weighted total				**77**	**59**	**28**	**72**	**183**	**-**
T33	19/10/2017	7.3	TZT - AGL SUP	163	-	7	-	9	46	-
	17/11/2017	7.4	GERMINATION MIX	704	37	51	31	62	112	-
	29/01/2018	7.2	UREA BULK	109	50	-	-	-	-	-
	Area weighted total				**82**	**56**	**30**	**68**	**152**	**-**
T34	19/10/2017	8	TZT - AGL SUP	160	-	7	-	9	45	-
	17/11/2017	7.8	GERMINATION MIX	684	35	49	30	60	109	-
	14/03/2018	8.2	UREA	106	49	-	-	-	-	-
	Area weighted total				**73**	**48**	**26**	**58**	**130**	**-**
T35	19/10/2017	3.9	TZT - AGL SUP	317	-	14	-	17	89	-
	17/11/2017	4	GERMINATION MIX	683	35	49	30	60	109	-
	29/01/2018	3.7	UREA BULK	110	51	-	-	-	-	-
	Area weighted total				**79**	**60**	**29**	**74**	**188**	**-**
T36	05/09/2017	4.7	AMMO 36 BULK	146	52	-	-	14	-	-
	12/02/2018	4.7	UREA BULK	119	55	-	-	-	-	-
	Area weighted total				**105**	**-**	**-**	**14**	**-**	**-**
T37	05/09/2017	6.1	AMMO 36 BULK	145	52	-	-	14	-	-
	24/11/2017	6.2	Merriburn Grazed Maintenance+N	1007	49	27	-	33	272	6
	Area weighted total				**94**	**25**	**-**	**43**	**255**	**6**
T39	19/10/2017	4.1	TZT - AGL SUP	335	-	15	-	18	94	-
	17/11/2017	4	GERMINATION MIX	693	36	50	31	61	111	-
	29/01/2018	3.8	UREA BULK	111	51	-	-	-	-	-
	Area weighted total				**71**	**55**	**26**	**67**	**174**	**-**
T40	19/10/2017	5.3	TZT - AGL SUP	321	-	14	-	18	90	-
	17/11/2017	5	GERMINATION MIX	704	37	51	31	62	112	-
	29/01/2018	5	UREA BULK	110	51	-	-	-	-	-
	Area weighted total				**80**	**60**	**28**	**73**	**190**	**-**

T41	16/08/2017	5.8	RZR - AMM SE	138	49	-	-	13	-	-
	06/12/2017	5.8	DAP Boron/ Potash and Slugbait	400	46	52	56	3	-	1
	Area weighted total				**85**	**46**	**50**	**14**	**-**	**1**
T42	16/08/2017	8.5	RZR - AMM SE	136	49	-	-	13	-	-
	17/11/2017	8.3	UREA BULK	110	50	-	-	-	-	-
	08/12/2017	8.2	Post Cust - Grazed mix	1088	37	28	67	34	262	5
	12/02/2018	8.5	UREA BULK	111	51	-	-	-	-	-
	Area weighted total				**178**	**26**	**62**	**44**	**245**	**4**
T43	16/08/2017	6.1	RZR - AMM SE	134	48	-	-	13	-	-
	17/11/2017	6.3	UREA BULK	111	51	-	-	-	-	-
	08/12/2017	6.2	Post Cust - Grazed mix	1019	34	26	62	32	245	4
	21/02/2018	6.2	UREA BULK	111	51	-	-	-	-	-
	Area weighted total				**179**	**25**	**60**	**43**	**238**	**4**
T44	16/08/2017	4.9	RZR - AMM SE	127	45	-	-	12	-	-
	17/11/2017	5.2	UREA BULK	99	46	-	-	-	-	-
	08/12/2017	5.2	Post Cust - Grazed mix	1039	35	27	64	33	250	4
	21/02/2018	5.1	UREA BULK	97	45	-	-	-	-	-
	Area weighted total				**161**	**26**	**61**	**42**	**240**	**4**
T45	16/08/2017	6.9	RZR - AMM SE	131	47	-	-	12	-	-
	17/11/2017	6.8	UREA BULK	110	50	-	-	-	-	-
	08/12/2017	6.5	Post Cust - Grazed mix	1048	35	27	64	33	252	4
	21/02/2018	6.9	UREA BULK	108	50	-	-	-	-	-
	Area weighted total				**171**	**24**	**58**	**41**	**227**	**4**
untitled	16/08/2017	1	RZR - AMM SE	155	55	-	-	15	-	-

	06/12/2017	0.9	DAP Boron/ Potash and Slugbait	400	46	52	56	3	-	1
	Area weighted total				**67**	**33**	**35**	**12**	**-**	**1**
untitled 2	24/11/2017	1.6	Merriburn Grazed Maintenance+N	999	49	26	-	32	270	6
	Area weighted total				**41**	**22**	**-**	**27**	**227**	**5**
Weighted average rate based on applied areas and rates for selected areas					**103**	**25**	**25**	**33**	**125**	**3**

Note: Total and average rates assume product applications cover effective area of paddock(s) selected.
This is dependent on positional accuracy of paddock boundaries



My Ravensdown Smart Maps
www.myravensdown.co.nz
Note: Areas are in hectares

Merriburn

0 80 160 320 480 640
Metres

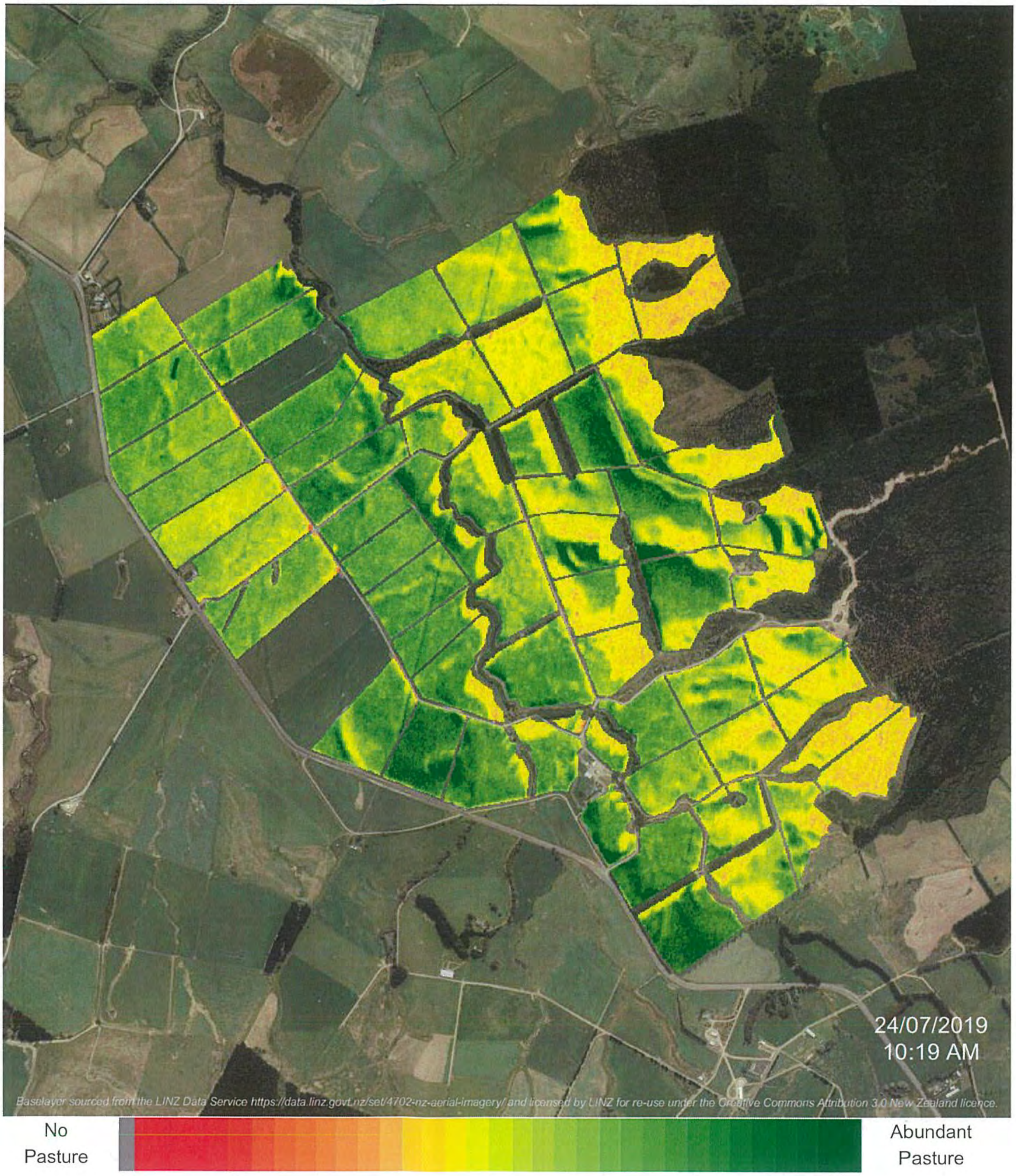
19 October 2016

SPACE™

LIC®

Pasture cover map

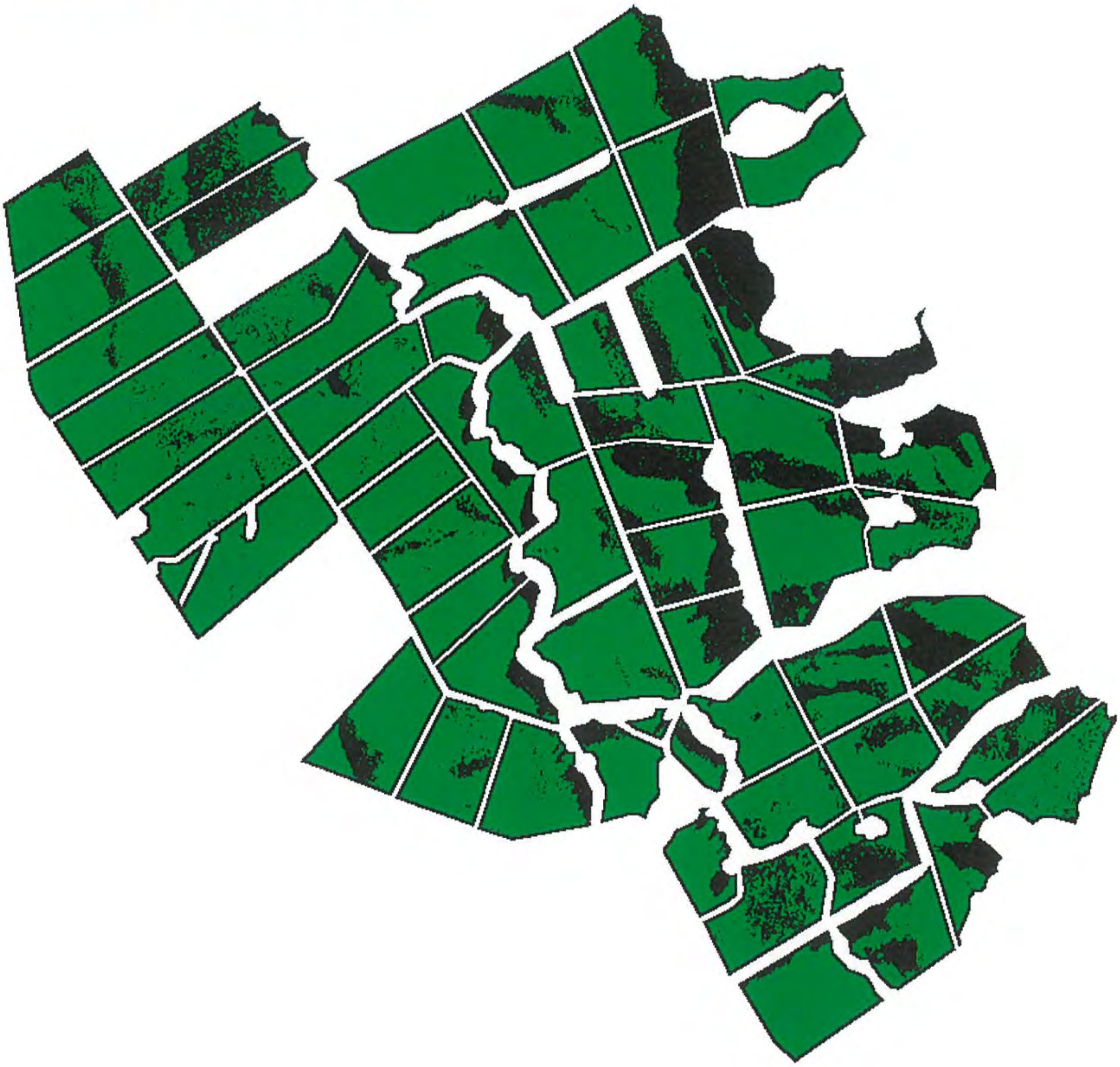
QTKC Runoff 2



Baselayer sourced from the LINZ Data Service https://data.linz.govt.nz/set/4702-nz-aerial-imagery/ and licensed by LINZ for re-use under the Creative Commons Attribution 3.0 New Zealand licence.

SPACE™

Shadow & Cloud map



⬛ - Area excluded from calculation*

🟩 - Area measured

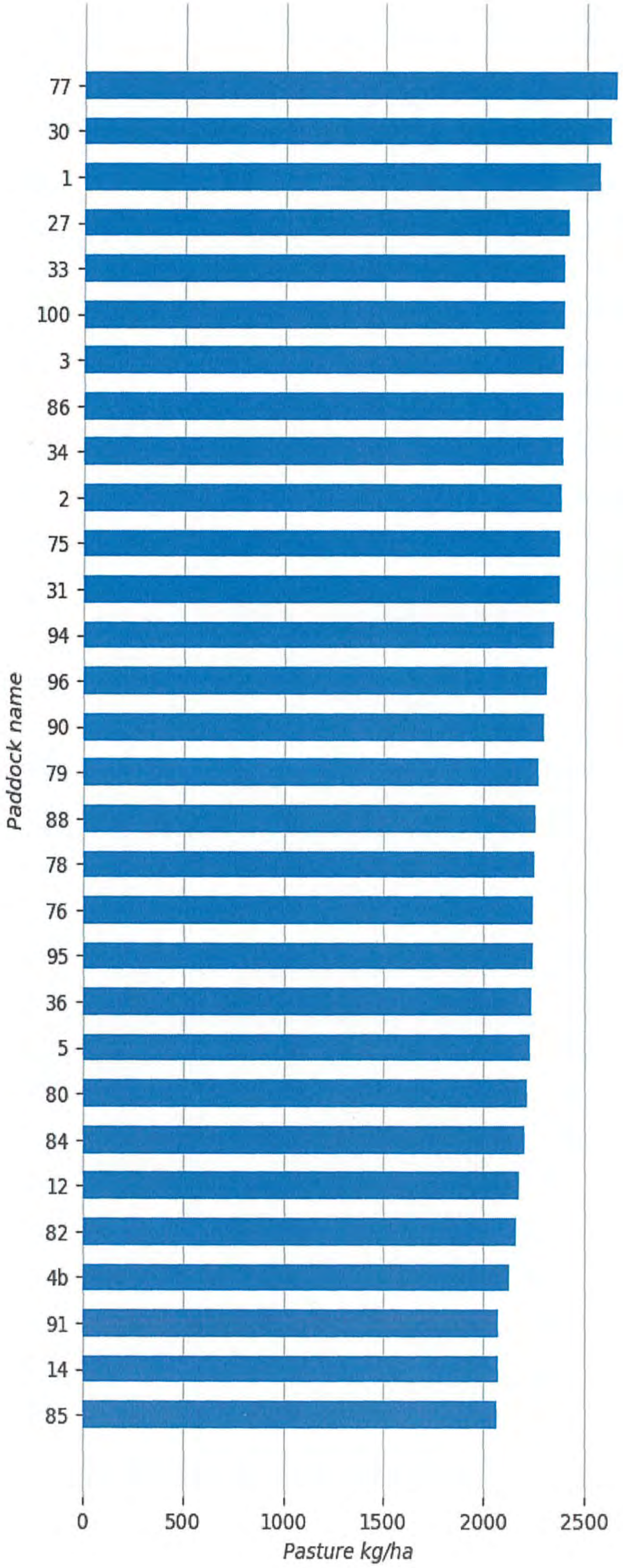
This map shows the areas affected by suspected cloud or shadow. Use this map alongside your pasture cover map to interpret your paddock cover readings.

*Suspected Cloud / Shadow

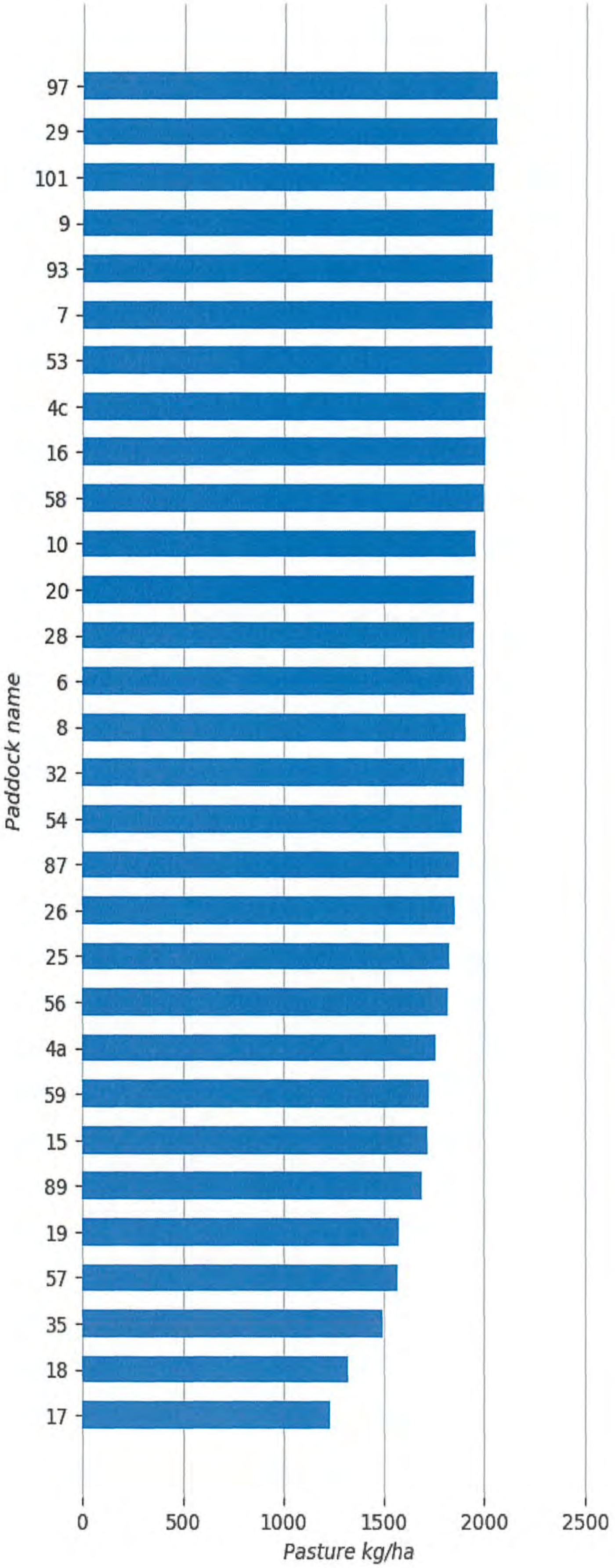
LIC®

77	2650 kg/ha
30	2625 kg/ha
1	2575 kg/ha
27	2425 kg/ha
33	2400 kg/ha
100	2400 kg/ha
3	2400 kg/ha
86	2400 kg/ha
34	2375 kg/ha
2	2375 kg/ha
75	2375 kg/ha
31	2375 kg/ha
94	2350 kg/ha
96	2325 kg/ha
90	2300 kg/ha
79	2275 kg/ha
88	2250 kg/ha
78	2250 kg/ha
76	2250 kg/ha
95	2250 kg/ha
36	2250 kg/ha
5	2225 kg/ha
80	2225 kg/ha
84	2200 kg/ha
12	2175 kg/ha
82	2175 kg/ha
4b	2125 kg/ha
91	2075 kg/ha
14	2075 kg/ha
85	2075 kg/ha

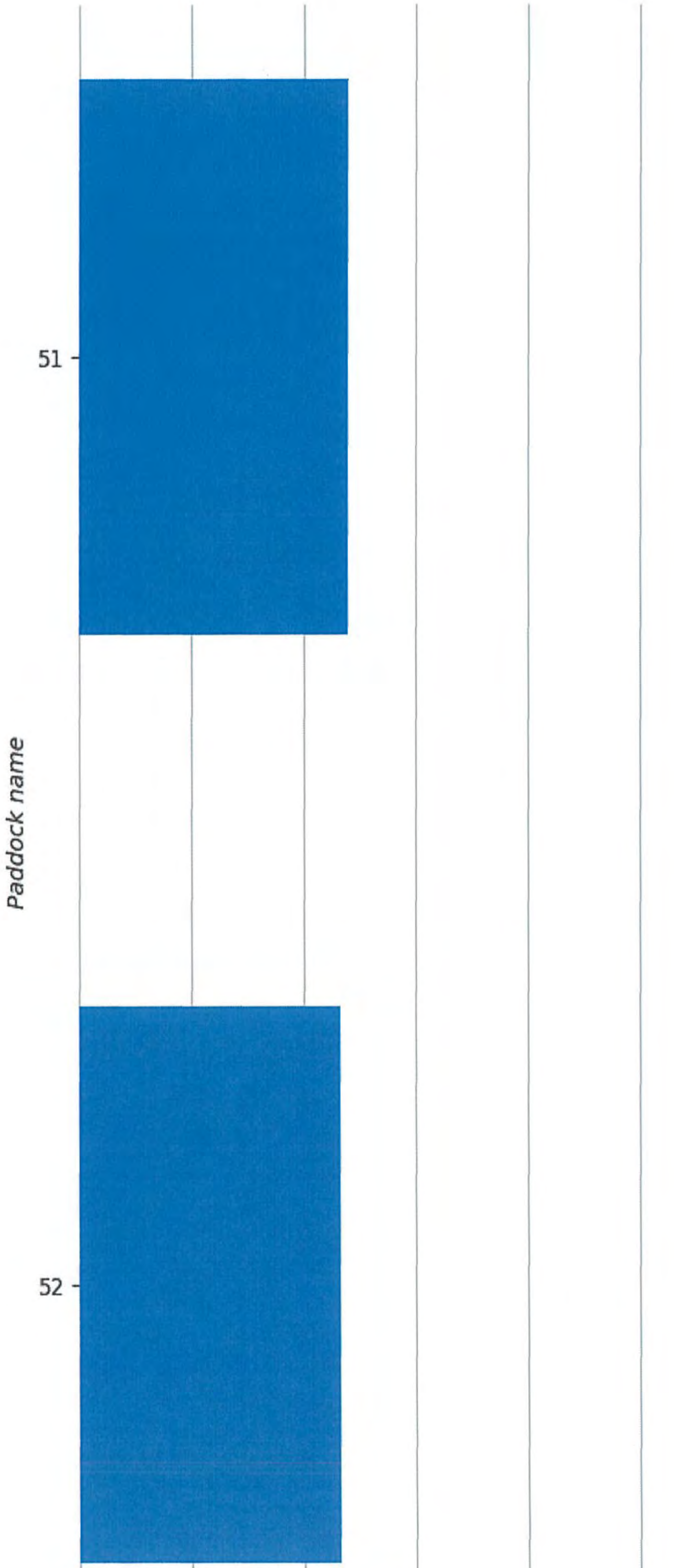
Average: 2078



97	2050 kg/ha
29	2050 kg/ha
101	2050 kg/ha
9	2050 kg/ha
93	2050 kg/ha
7	2050 kg/ha
53	2050 kg/ha
4c	2000 kg/ha
16	2000 kg/ha
58	2000 kg/ha
10	1950 kg/ha
20	1950 kg/ha
28	1950 kg/ha
6	1950 kg/ha
8	1900 kg/ha
32	1900 kg/ha
54	1900 kg/ha
87	1875 kg/ha
26	1850 kg/ha
25	1825 kg/ha
56	1825 kg/ha
4a	1750 kg/ha
59	1725 kg/ha
15	1725 kg/ha
89	1700 kg/ha
19	1575 kg/ha
57	1575 kg/ha
35	1500 kg/ha
18	1325 kg/ha
17	1225 kg/ha



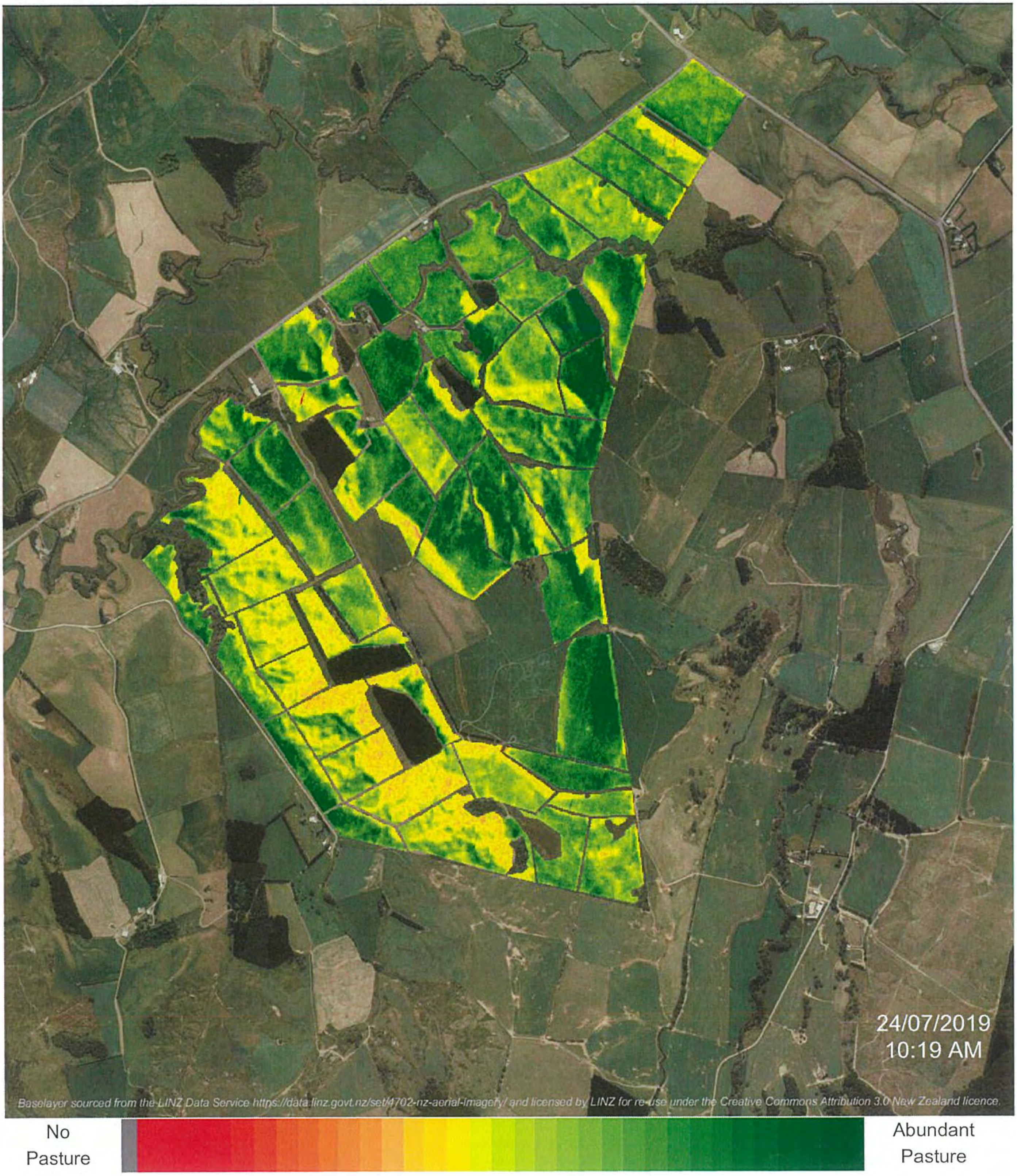
51	1200 kg/ha
52	1175 kg/ha



SPACE™ **LIC®**

Pasture cover map

QTKC Runoff 1

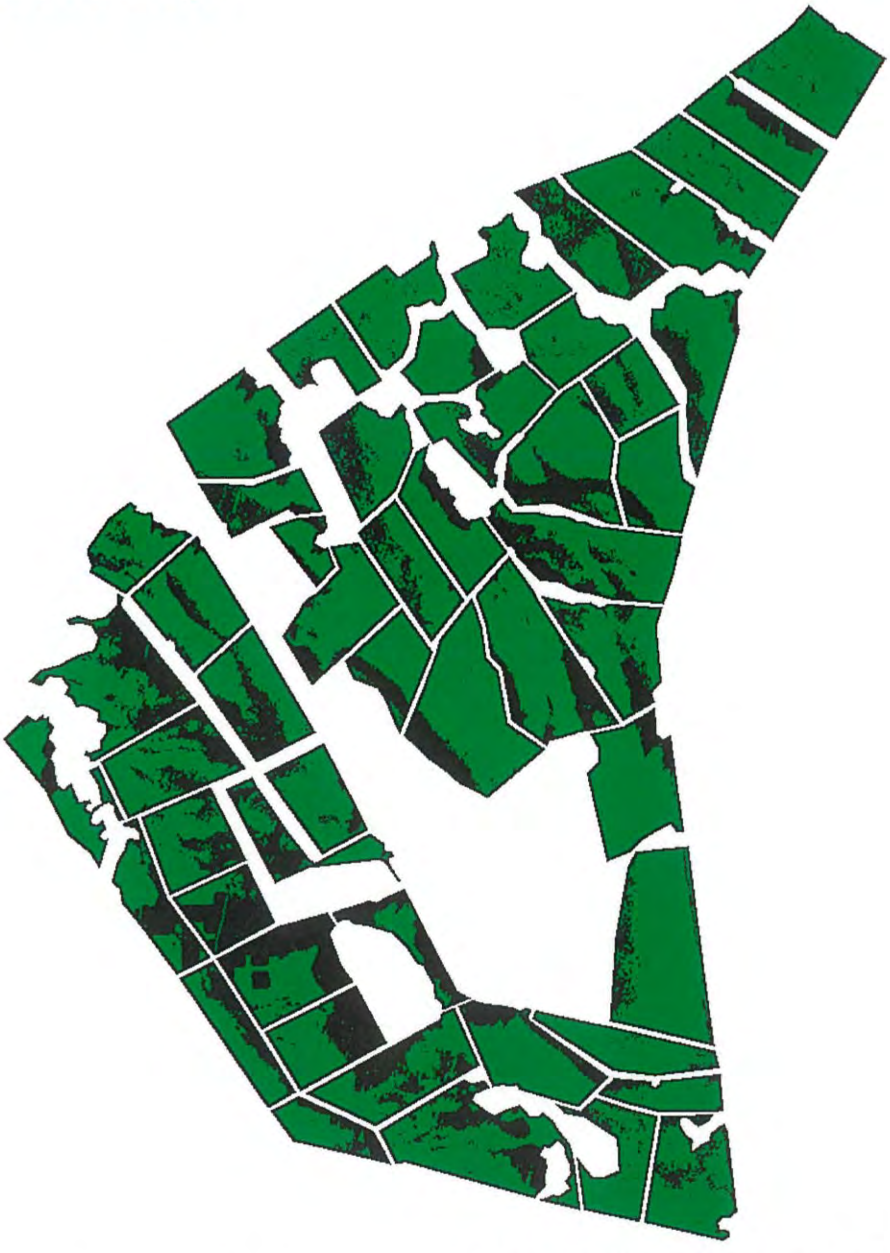


24/07/2019
10:19 AM

Baselayer sourced from the LINZ Data Service https://data.linz.govt.nz/set/4702-nz-aerial-imagery/ and licensed by LINZ for re-use under the Creative Commons Attribution 3.0 New Zealand licence.

SPACE™

Shadow & Cloud map



⬛ - Area excluded from calculation*

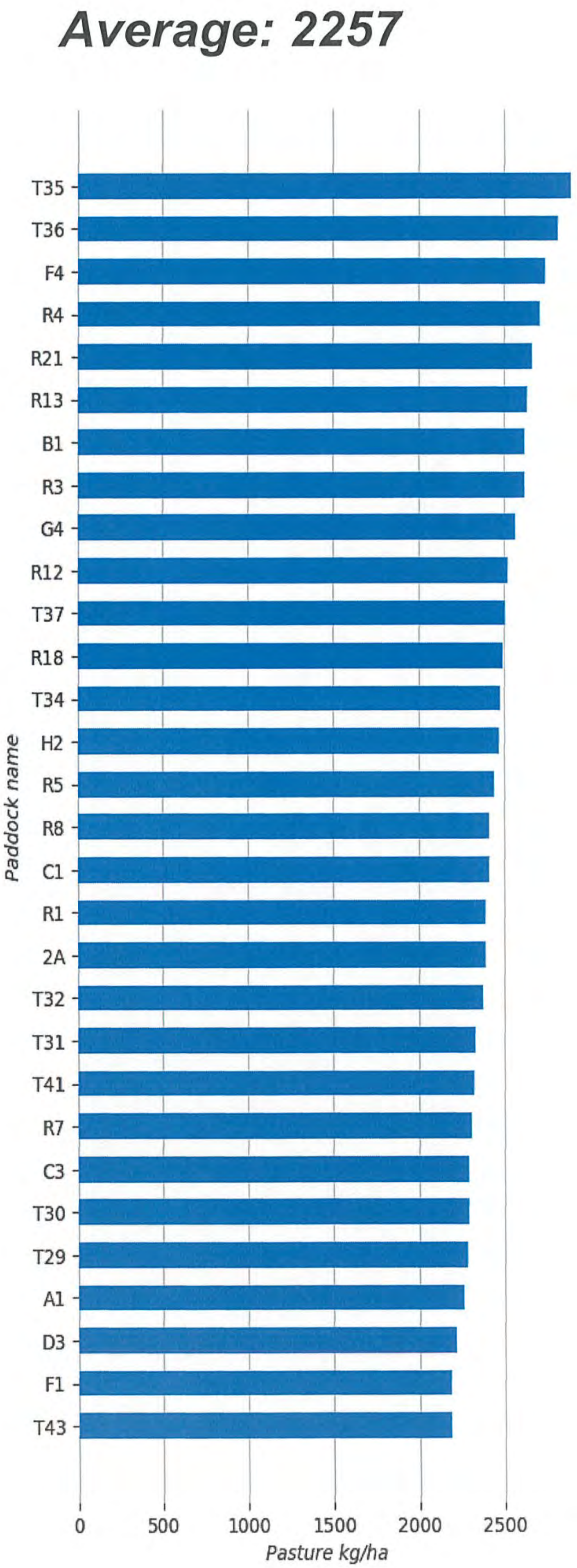
🟩 - Area measured

This map shows the areas affected by suspected cloud or shadow. Use this map alongside your pasture cover map to interpret your paddock cover readings.

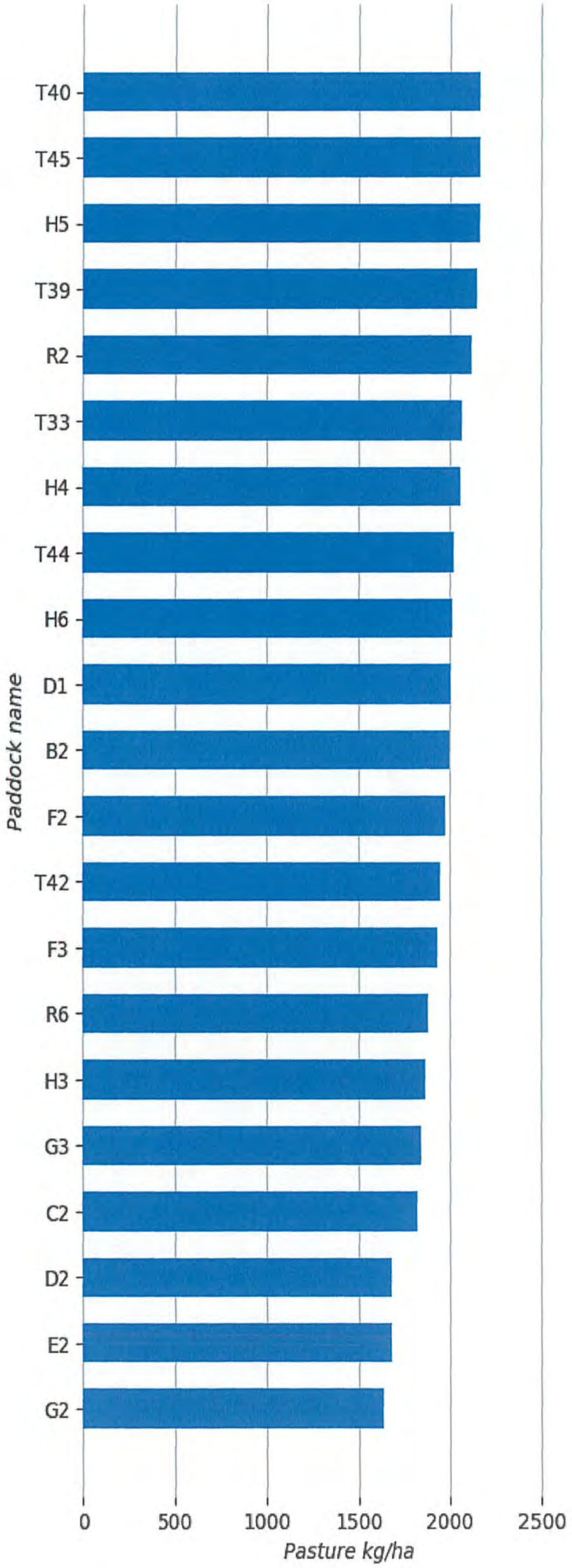
*Suspected Cloud / Shadow

LIC®

T35	2900 kg/ha
T36	2825 kg/ha
F4	2750 kg/ha
R4	2725 kg/ha
R21	2675 kg/ha
R13	2625 kg/ha
B1	2625 kg/ha
R3	2625 kg/ha
G4	2575 kg/ha
R12	2525 kg/ha
T37	2500 kg/ha
R18	2500 kg/ha
T34	2475 kg/ha
H2	2475 kg/ha
R5	2450 kg/ha
R8	2425 kg/ha
C1	2425 kg/ha
R1	2400 kg/ha
2A	2400 kg/ha
T32	2375 kg/ha
T31	2325 kg/ha
T41	2325 kg/ha
R7	2300 kg/ha
C3	2300 kg/ha
T30	2300 kg/ha
T29	2275 kg/ha
A1	2275 kg/ha
D3	2225 kg/ha
F1	2200 kg/ha
T43	2200 kg/ha



T40	2175 kg/ha
T45	2175 kg/ha
H5	2175 kg/ha
T39	2150 kg/ha
R2	2125 kg/ha
T33	2075 kg/ha
H4	2050 kg/ha
T44	2025 kg/ha
H6	2025 kg/ha
D1	2000 kg/ha
B2	2000 kg/ha
F2	1975 kg/ha
T42	1950 kg/ha
F3	1925 kg/ha
R6	1875 kg/ha
H3	1875 kg/ha
G3	1850 kg/ha
C2	1825 kg/ha
D2	1675 kg/ha
E2	1675 kg/ha
G2	1625 kg/ha
E3	EXCLUDED*



WOLDWIDE RUNOFF – PROPOSAL AND AEE

1. Executive summary

Woldwide Runoff (WRO) is a dry stock support block which currently supports all of the five Woldwide dairy farms by providing grazing for dry stock associated with the farms.

This document supports the concurrent resource consent applications for Woldwide 1&2(WW1&2) and Woldwide 4 (WW4) and Woldwide 5 (WW5) which seek various resource consents under the PSWLP for farming activities. This document details the activities currently occurring at WRO and how these activities are proposed to change if the proposals for the abovementioned four dairy farms are approved and enacted. An assessment of effects is provided in this document to enable the Council to be able to fully understand all effects associated with the proposal on WRO.

2. Existing use of WRO

WRO is a dry stock grazing block which also contains a commercial forestry operation, native bush block, commercial gravel extraction operation and land for supplement production. WRO is considered by Environment Southland to form both an individual landholding as well as being part of the landholdings for WW1&2, WW4 and WW5.

In summary, the existing use of the WRO landholding includes:

- The use of land (732ha) for dry stock farming
- The use of land (160ha) for commercial pine plantation and native bush
- The grazing of R1 and R2 heifers plus mating bulls and carry over cows from WW1&2, WW3, WW4 and WW5
- The use of land for intensive winter grazing of dry stock (52 hectares in 2018)

Status of activities at WRO

The land use consent applications for the farming activities for WW1&2, WW4 and WW5 seek consent for all activities located on the landholding which are directly associated with the operation of the respective dairy farms for 365 days of the year.

The proposed farming activity for WW1&2, WW4 and WW5 includes the grazing of dry stock all year round at WRO. Dry stock includes R1 and R2 grazing, mating bull grazing and carry over cow grazing. In this respect, WRO is considered to be part of the landholding for WW1&2, WW4 and WW5 and the grazing of dry stock at WRO has been included in the respective land use consent applications.

When considering WRO as an individual landholding, the use of land at WRO for the current and proposed activities in their entirety would otherwise be a **permitted activity** under Rule 20(a) of the PSWLP:

- There is no dairy platform on the landholding
- There is no associated discharge permit which specifies a maximum number of cows

- A FEMP in accordance with Appendix N of the PSWLP has been prepared for the landholding and implemented (see attached).
- The landholding contains no more than 100ha of intensive winter grazing
- The good management practices for intensive winter grazing specified in Rule 20(a)(iii)(3) have been implemented and detailed in the FEMP.
- A vegetated strip including stock inclusion will be in place adjacent to any water bodies in accordance with the setbacks in Rule 20(a)(iii)(4-6)

The applicant accepts that the activities at WRO which form part of the farming activity on WW1&2, WW4 and WW5 require land use consent as detailed above. However, it is important to note that when viewing WRO as an individual landholding then the current and proposed activities would otherwise be a permitted activity under the PSWLP and would remain so at any point in the future so long as they comply with any requirements, conditions and permissions specified in the RMA, detailed in Rule 20(a) and any applicable regional plans.

The applicant has included WRO in the respective land use consent applications as part of the farming activity and landholding at the request of Environment Southland staff, however the matter of whether it should technically be included in the respective farming activity and the landholdings for WW1&2, WW4 and WW5 lies in the interpretation of the term "landholding" in the PSWLP and in the conclusions from an Environment Southland legal opinion. This is a matter that will be raised and discussed in the upcoming hearing process.

3. Property description

Woldwide Runoff is located 20km to the west of Otautau, on the western side of the Longwood Ranges. WRO is comprised of two separate blocks. The Merrivale Block is owned by Woldwide Runoff Limited and the Merriburn block is leased. The Merriburn lease block is under a 5-year lease agreement, with Woldwide Runoff Limited having first right of renewal.

Property Details – WRO	
Property address	20 Gill Road – Merrivale block 1711 Otautau Tuatapere Road – Merriburn block
Property owner(s)	Woldwide Runoff Ltd
Legal Description	Merrivale Block: Part Section 7 Block XII Waiau SD Part Section 7 Block XII Waiau SD Part Section 7 Block XII Waiau SD Lot 1 DP 3537 Merriburn Lease Block: Lot 1 DP 302409 Sec 26 Merrivale Settlement No. 1 Sec 27 Merrivale Settlement No. 1
Property area (ha)	507 ha total, 321 ha effective – Merrivale 385ha total, 338 ha effective – Merriburn
Location	NZTM 1201022, 4893762 – Merrivale NZTM 1200812, 4890495 – Merriburn
Proposed land use	Both blocks are run as a single operating unit. Grazing of R1 and R2 heifers, grazing of carry over cows and

	grazing of mating bulls all year round (includes intensive winter grazing) Production of baleage 100ha of commercial pine plantation 60ha beech forest under sustainable management
Dry stock in 2017/2018 season	1265 R1 1265 R2 37 carry over cows 70 mating bulls

Figure 1: Current/Proposed farm boundary for WRO. [1]

---

[1] Beacon mapping service, Environment Southland website, accessed 13 February 2019.

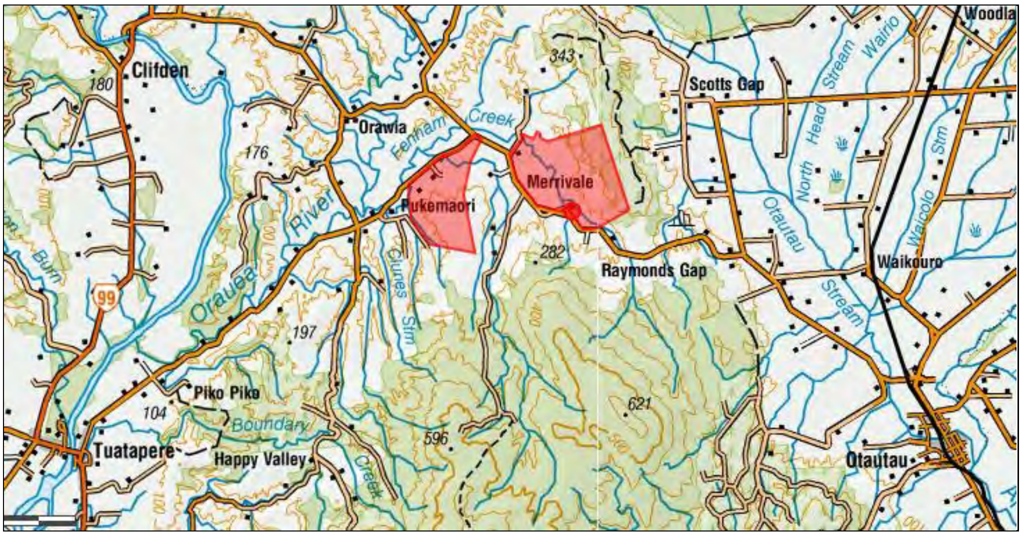


Figure 2: General location of WRO[2]

Figures 3 and 4 show the mapped farm boundaries and features of interest on the original part of the runoff block and the leased part of the runoff block respectively.

---

[2] Beacon mapping service, Environment Southland website, accessed 13 February 2019.

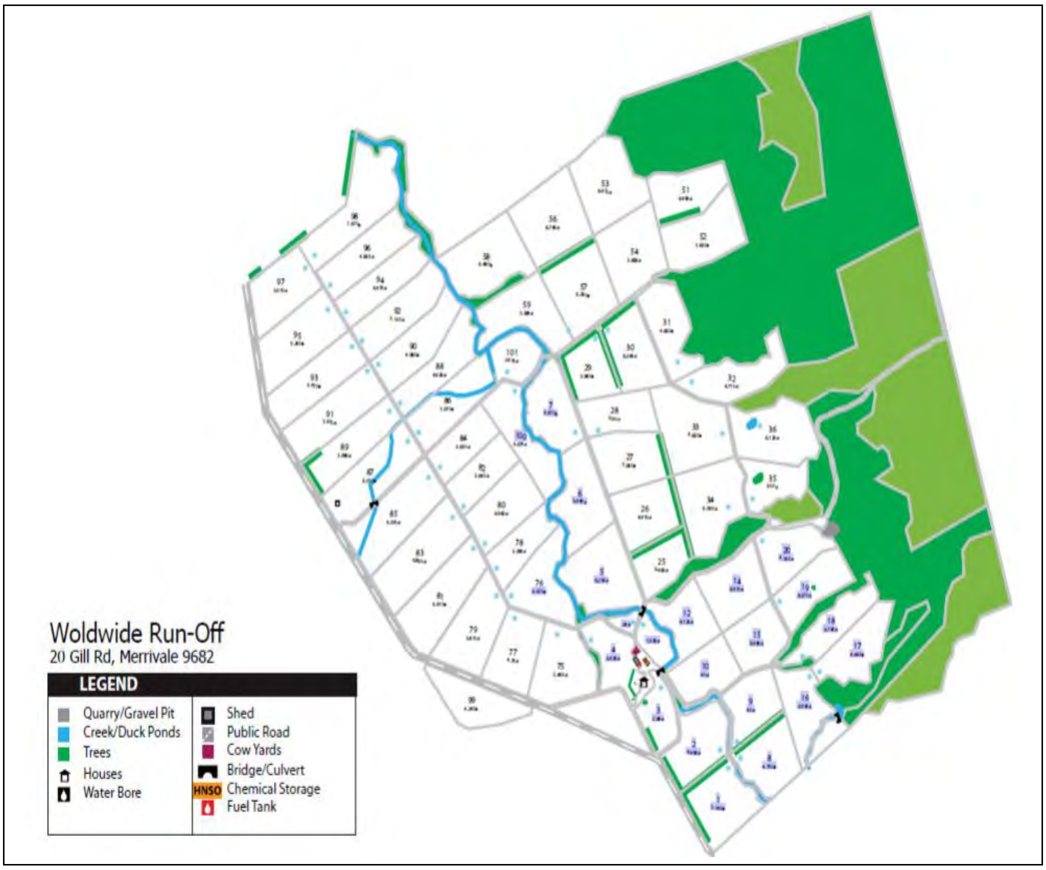


Figure 3: Farm map for Merrivale block

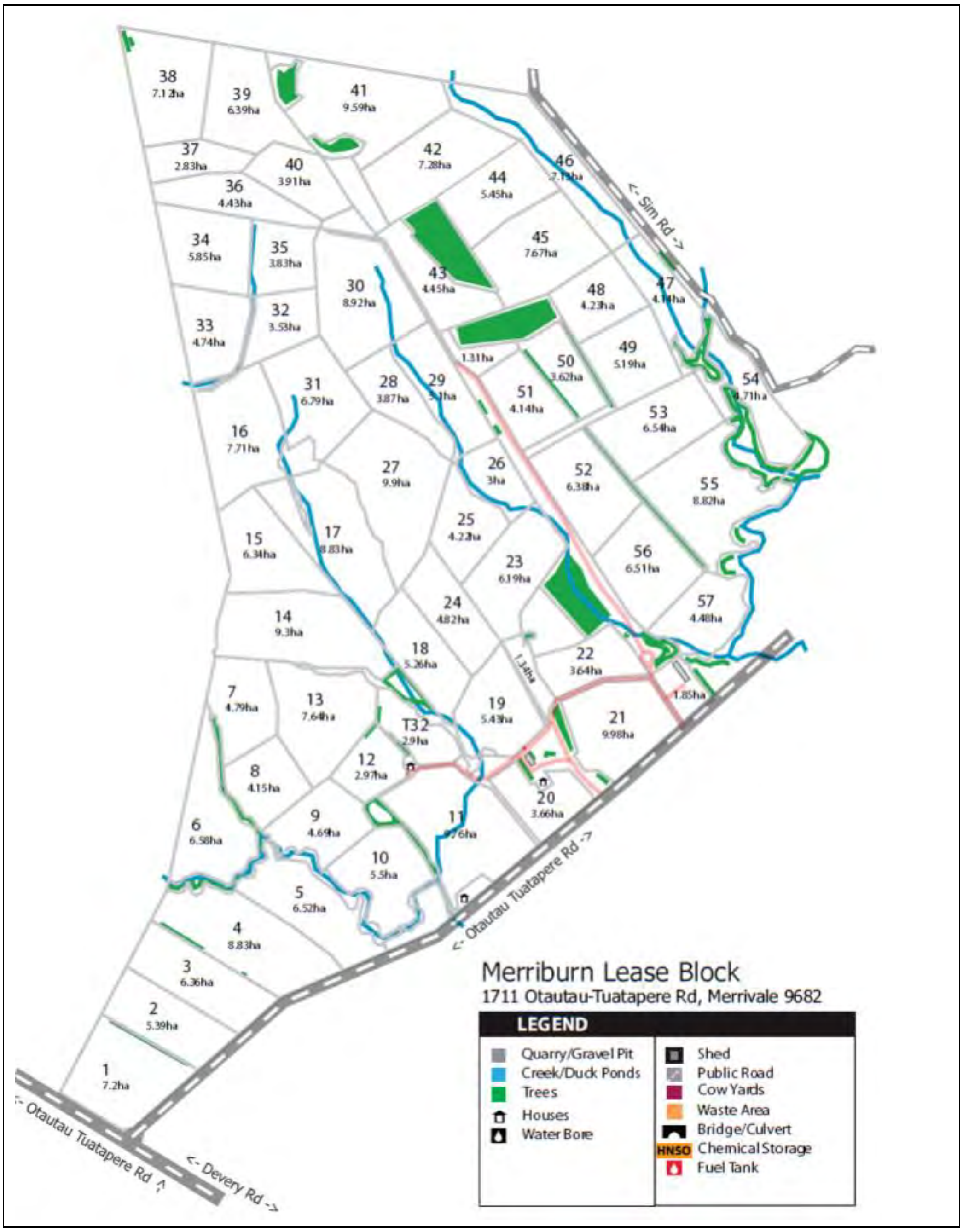


Figure 4: Farm map for Merriburn block (leased)

4. Soils and Physiographic Zones

The Merrivale block contains Malakoff, Waimatuku and Makarewa soils and the Merriburn lease block contains Aparima, Orawia and Makarewa soils. These soils are a mixture of heavier wetter soils and free draining soils.

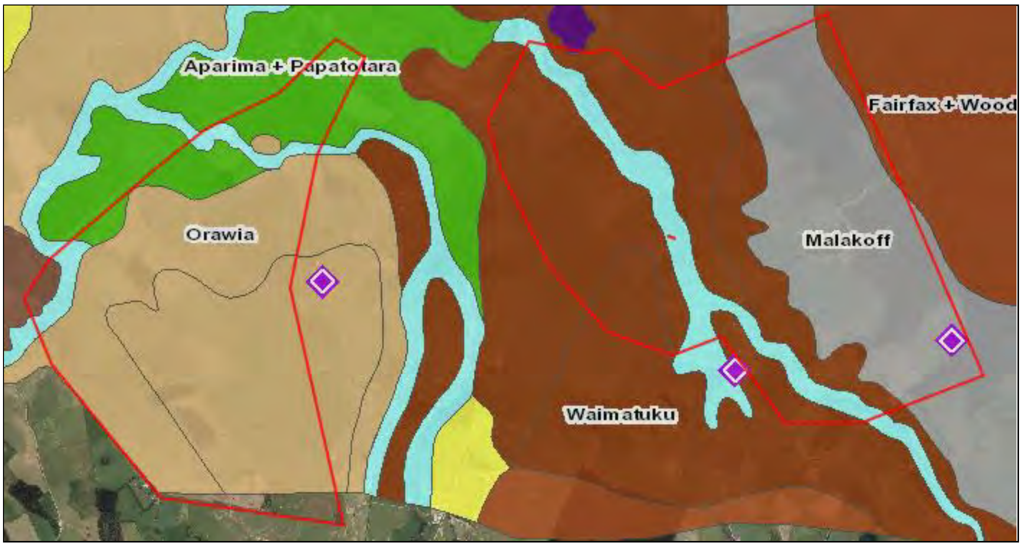


Figure 5: Soil map[3]

The Merrivale block is classified as Hill Country, Oxidizing and Gleyed physiographic zones. The Merriburn lease block is classified as Hill Country, Oxidizing, Gleyed, Marine terraces and Peat physiographic zones.

Figure 6: Physiographic zones[4]

---

[3] Beacon mapping service, Environment Southland website, accessed 13 February 2019.
[4] Beacon mapping service, Environment Southland website, accessed 13 February 2019.

5. Surface water receiving environment

WRO is located within both the Fenham and Merry Creek catchments. Both creeks are tributaries of the Orauea River which flows south-westerly towards Tuatapere township and joins the Waiau River. There is a SOE monitoring site on the Orauea River at Orawia Pukemaori Road which is used to measure water quality information data. The Land and Water website (www.lawa.org.nz) collates this water quality data and provides the most recent water quality data and trends available. **Table 1** below gives a summary of the state and trend measured at this site for key river water quality indicators.

Table 1: Summary of Measurement and State of Orauea River at Orawia[5]

	State	Quality	NOF Band Annual Median	Trend
E. coli	In the worst 25% of all lowland rural sites	315 n/100ml (median 5 year)	E	Likely improving
Clarity	In the worst 25% of all lowland rural sites	1.13 metres (median 5 year)	N/A	Indeterminate
Total Oxidised N	In the worst 25% of all lowland rural sites	0.415 g/m^3 (median)	A - median	Meaningful improvement
Total N	In the worst 50% of all lowland rural sites	0.73 g/m^3 (median)	N/A	Indeterminate
Ammoniacal N	In the best 25% of all lowland rural sites	0.0005 g/m^3 (median)	A – 99% species protection level.	N/A
Dissolved Reactive P	In the worst 50% of all lowland rural sites	0.011 g/m^3 (median)	N/A	Indeterminate

The water quality medians indicate that the Orauea catchment is degraded in regards *E. coli*, however there is a definite trend of improvement. High *E. Coli* levels are a concern for overall water quality within a waterway due to human health risks. Typically, *E. coli* contamination of waterways is caused by stock contact with surface water, point source discharges from septic tanks, wastewater treatment at upstream towns and effluent discharges to land reaching surface water. A high proportion of land within the Orauea catchment is both intensive and extensive sheep farms which is likely to contribute to the high *E. coli* levels because stock on sheep farms are not excluded from waterways in the same manner in which it is compulsory on dairy farms. The other activities listed above may also be contributing factors. *E. coli* is rated as E band in the National Objectives Framework (NOF) of the National Policy Statement for Freshwater Management. An E band rating equates to an average infection risk of greater than 7%.

Conversely, total oxidised nitrogen concentration has improved and is rated as A band under the NOF which means that water quality is considered suitable for the designated use and associated with a high conservation values ecosystem where there is unlikely to be effects even on sensitive species. The national bottom line value is 6.9 mg/L which far exceeds the 0.415 mg/L median at this site.

---

[5] https://www.lawa.org.nz/explore-data/southland-region/river-quality/waiau-river/orauea-river-at-orawia-pukemaori-road/

The median dissolved reactive phosphorus (DRP) is below ANZECC guideline levels and is not showing an evident trend. The raw data shows that DRP is low on the majority of the sampling dates, with spikes most likely occurring during rainfall events where phosphorus can be transported to surface water bodies via runoff and erosion.

The overall impact of the trends in nutrient concentrations is not clear at this stage, however the receiving water is considered low in relation to nitrogen and phosphorus concentrations overall. There is very limited published information on periphyton extent or macroinvetebrate community status in the Orauea River, so it is difficult to assess the current status or trend in biological quality of the stream. However, it is accepted that any increase in nutrient concentrations is likely to create the potential for an increase in periphyton and/or other plant biomass in the stream.

Ecological indicators are measured at the lower catchment *Waiau River at Tuatapere* SOE site with 5-year medians for MCI score, taxonomic richness score and %EPT available. The median MCI score is good at 103 with an indeterminate trend. The median Taxonomic Richness score is 15 and the median %EPT is 47%. One NOF water quality indicator for the *Waiau River at Tuatapere* site shows evidence of land use impacts (periphyton) and three indicators show minimal evidence of land use impacts (*E.coli*, macroinvertebrates and nitrate toxicity). The periphyton parameter indicates moderate nutrient levels and/or natural flow or habitat disruption. In this case the nuisance periphyton levels are likely to be primarily due to natural flow disruption due to the diversion of c.95% of the flow of the Waiau River to Doubtful Sound for hydroelectricity generation.

Over the summer period in 18/19, Environment Southland monitoring of the Waiau River at Tuatapere has confirmed the presence of toxic algae benthic cyanobacteria in the lower Waiau. Given the relatively low level of nutrients N and P in the lower Waiau, it likely that natural flow disruption is a major factor contributing to the growth of algae, including toxic algae in the lower Waiau.

The lower Waiau River also has a significant issue with the invasive stalked diatom *Didymosphenia geminate*, commonly known as didymo or "rock snot." Didymo blooms smother river beds with nuisance mats of algae and typically occur in rivers with low nutrient concentrations, i.e. low levels of N and P. Didymo blooms can lead to changes in communities of invertebrates and other algae on the river bed.

The available physical/chemical data show the Waiau River catchment to be in relatively good health. Nitrate, DRP and *E.coli* levels are relatively low and water clarity is moderately good. Some biological indicators such as the MCI index indicate good water quality with minimal land use effects whereas others such as periphyton levels are elevated at times. The toxic benthic algal bloom seen in the 18/19 summer period is indicative of land use effects, such as natural flow disruption and possibly nutrient losses to an extent although this complex issue is poorly understood.

Surface water is the primary receiving environment for contaminants lost from WRO due to the nature of the soils, topography and drainage channels.

Figure 7: Topomap showing both WRO blocks (marked with X) and SOE site *Orauea River at Orawia Pukemaori.*[6]

6. Groundwater receiving environment

WRO is located in an area of unclassified groundwater management zone. Groundwater nitrate levels in the vicinity of WRO are in the range 0.01 – 1.0 g/m^3, regarded as pristine to modern day background levels. Due to a combination of the topography, depth of groundwater and drainage channels there is a low risk of nitrate accumulation in groundwater in this area. This is supported by the very low mapped nitrate levels.

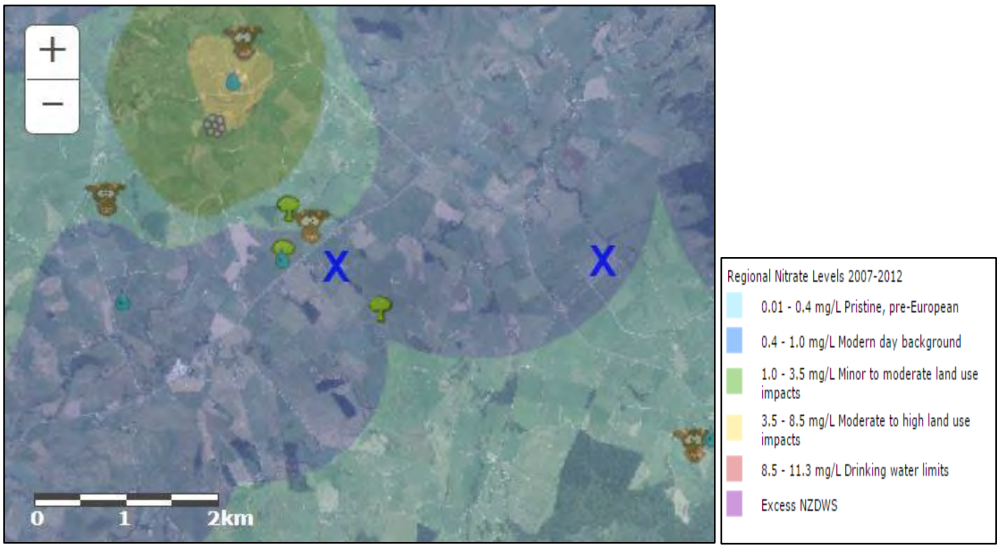


Figure 8: Groundwater nitrate in the vicinity of WRO (approximate location of WRO blocks marked with X)[7]

7. Contaminant Pathways

The production of grass for stock grazing and supplements requires the input of nutrients into the farming system. On a stock grazing block, excess nutrients are primarily lost to the environment from

---

[6] Beacon mapping service, Environment Southland website, accessed 13 February 2019.

[7] Beacon mapping service, Environment Southland website, accessed 13 February 2019.

the deposition of dung and urine spots on pasture. For this property the main contaminant pathways are identified as overland flow, deep drainage and artificial drainage due to the variety of different soil types and physiographic zones on the farm. Woldwide Runoff predominantly grazes young dry stock (R1 and R2 heifers), which cause less soil damage and related effects due to their smaller size and lighter weight than mature cows, in addition the lease arrangement for Merriburn Block prohibits the wintering of adult cows.

Contaminant Pathways – Overland Flow and Artificial drainage

Loss of nutrients via overland flow and artificial drainage presents the highest risk to the environment on the wetter, poorly drained soils on this property primarily in the Gleyed physiographic zone. These areas have high vulnerability to waterlogging, and in some areas require subsurface artificial drainage, which can become a mechanism for the rapid transfer of contaminants to the water bodies they drain to. The applicant will avoid and mitigate the risk of contaminant loss via overland flow and artificial drainage by:

- Ensuring critical source areas are left as buffer zones for cropping and fenced off to exclude stock;
- Re-sowing bare soils as soon as possible;
- Avoid grazing very wet soils by opening the breaks up to reduce tramping damage;
- Using good management practice for intensive winter grazing on either grass or forage crop – back fencing, CSA management, last bite grazing, portable troughs etc.; (See FEMP)
- Ensure water ways are fenced off to exclude stock and existing riparian vegetation is maintained;
- Time fertilizer application to meet pasture demand and apply in a little and often manner;
- Protecting steeper, erosion prone land with trees.

Contaminant Pathways – Deep drainage

Loss of nutrients via deep drainage presents the highest risk to the environment on the free draining soils mainly within the Oxidizing physiographic zone. These areas have high vulnerability for nutrients, particularly N, leaching through the soil profile which has the potential to reach groundwater and surface water receiving environments. The applicant will avoid and mitigate the risk of contaminant loss via deep drainage using the same measures as above, with the primary goal to avoid the accumulation of excess N in the soil profile prior to high drainage periods.

- Maintaining stocking rates at sustainable levels;
- Avoiding the over-application of fertilizer by matching application to pasture demand and undertaking in a little and often manner;
- Utilizing pasture species which result in less N loss;
- Utilizing soil testing to guide fertilizer usage;
- Time fertilizer application to meet pasture demand and apply in a little and often manner.

8. Good Management Practices (GMPs)

GMP adopted on WRO are detailed in the attached FEMP.

9. Description of activities

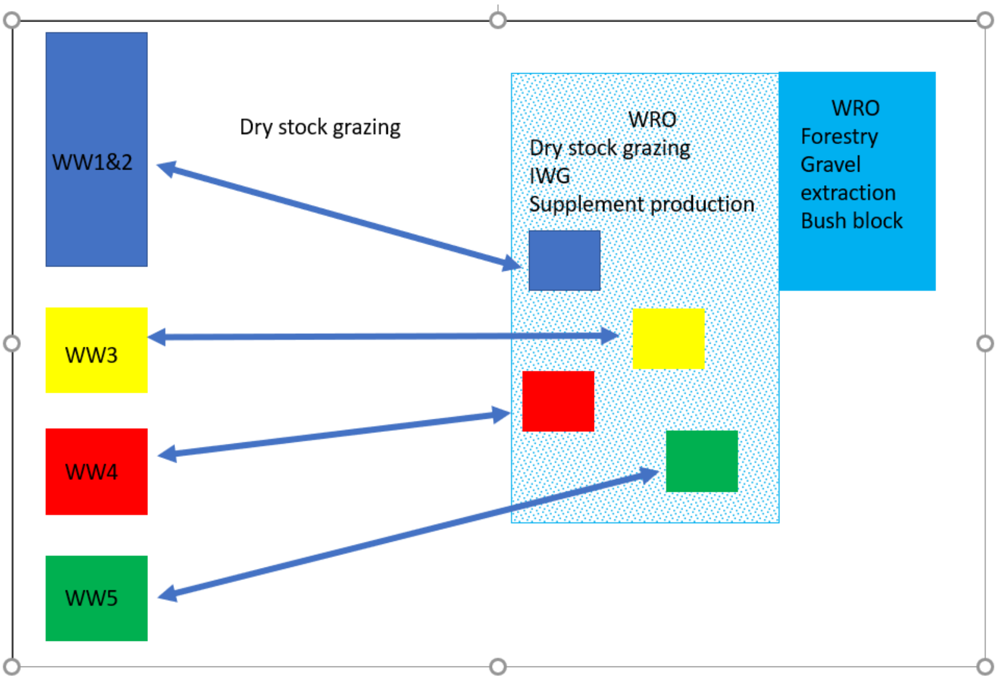
A year end nutrient budget has been completed by Cain Duncan CNMA for the 2017/2018 season to give an indication of the nature and scale of the activities which occurred at WRO during this one reporting year. The nutrient budget and accompanying report are appended to this application and should be referred to for a full description of the farm system at WRO during the 2017/18 year.

The applicant has now had WRO in its entirety (with the combination of the two separate blocks) for two and a half seasons. When the Merriburn block was initially leased it was heavily pugged and pasture productivity and fertility was low. Over the last two and a half seasons, the applicants have focussed on pasture renewal and increasing fertility. The 2018/19 season has seen the benefit of pasture and soil development with a big lift in pasture production. The applicants have found that they may need to alter the activities on this block in light of the increased productivity in order to farm it sustainably and economically making use of the quantities of feed available.

10. Proposed Activities

The diagram below presents a schematic impression of the relationship between the applicants five dairy farms and WRO. The diagram shows the individual dairy platforms sending dry stock grazing to the grazing block part of WRO (hatched box). The dry stock grazing, IWG and supplement production for the five dairy farms rotates through this grazing block of WRO every year. The legal descriptions of the land within the hatched box area is included in the separate land use consents for WW1&2, WW4 and WW5. The number of dry stock sent from each dairy farm is represented by the corresponding coloured boxes within the blue hatched area. A proposed condition of consent would specify the maximum number and class of stock grazed on WRO from each farm.

The solid blue WRO box contains activities which are not part of the respective farming activities (forestry, gravel extraction and bush block) and the legal descriptions of the land within this area will not be included on the respective land use consents.



The activities on WRO which will be covered under the land use consent applications for the farming activities on WW1&2, WW4 and WW5 include the grazing of dry stock (R1, R2, mating bulls and carry over cows) all year round:

- All R1 heifers currently grazed all year round at WRO continues unchanged.
- R2 heifers currently grazed from the time of transitioning from R1s and May of the following season on WRO continues unchanged.
- For future seasons during June and July, R2s from WW1&2 will be intensively winter grazed on WRO or housed in existing wintering barns at WW1&2 dairy platform (approximately 125 R2s).
- R2 heifers from WW4 and WW5 may spend the winter period in the wintering barns on WW4 and WW5 dairy platforms in some seasons.
- R2 heifers from WW4 and WW5 may be intensively winter grazed at WRO in some seasons.
- Mating bulls required for all five dairy farms will be on WRO all year round. Mating bull numbers may fluctuate marginally in future seasons.
- Carry over cows from all five dairy farms will be on WRO all year round. Carry over cow numbers may fluctuate marginally in future seasons.

The applicant has not provided an Overseer nutrient budget which models the proposed farm system due to concerns with providing a model which is representative of a long-term scenario farm system at WRO. The reasons behind this include:

- The increasing fertility levels on WRO combined with the large size of the block make it very difficult for the applicant to predict exactly what the block is capable of in terms of stocking

rate, crop growth and pasture production much further into the future than the upcoming season.
- The siting of non-farming activities on the block which will not be covered under the land use consent applications.
- The large impact climatic conditions have on the management of a large support block which is more dramatic, variable and pronounced than a dairy farm system.
- The need and desire for flexibility (within reason) in the management of the farm system based on the above factors.

The applicant recognises that the Consent Authority needs certainty around the scale and nature of the activities proposed at WRO and the likely effects of these activities which have been detailed in the AEE. The applicant proposes the following input restrictions as consent conditions for the proposed land use consents applicable to activities at WRO. These input consent conditions are requested in place of any consent conditions referring to a nutrient output restriction based on an Overseer nutrient budget model:

For WW1&2

- A maximum of 417 R1 heifers grazed all year round at WRO from WW1&2
- A maximum of 417 R2 heifers grazed all year round at WRO from WW1&2, <u>or</u>
  A maximum of 417 R2 heifers grazed between August and May at WRO and during June and July in the WW1&2 wintering barns

For WW4

- A maximum of 286 R1 heifers grazed all year round at WRO from WW4
- A maximum of 286 R2 heifers grazed all year round at WRO from WW4 or
  A maximum of 286 R2 heifers grazed between August and May at WRO and during June and July in the WW4 and WW5 wintering barns

For WW5

- A maximum of 270 R1 heifers grazed all year round at WRO from WW5
- A maximum of 270 R2 heifers grazed all year round at WRO from WW5 or
  A maximum of 270 R2 heifers grazed between August and May at WRO and during June and July in the WW4 and WW5 wintering barns

On all land use consents

- A maximum of 100 hectares of winter fodder crop for intensive winter grazing at WRO

This recommendation to impose these input restrictions as consent conditions as opposed to an Overseer nutrient output restriction consent condition has been carefully considered by the applicant and recognises the inherent complications in including WRO on the resulting individual land use consents for WW1&2, WW4 and WW5. The primary complication that arises is that compliance and the enactment of individual consents must be able to stand alone and must not be reliant on third parties or third party actions. For example, if the land use consent granted for WW4 farming activities on WRO are restricted with a consent condition requiring an overall WRO Overseer nutrient output limit be complied with, then compliance with the land use consent relies on the actions of several third parties: WW1&2 Ltd, WW3 Ltd and WW5 Ltd. This would inadvertently link all of the dairy farm systems together and create a scenario of reliance on compliance by third parties which may deem the land use consents unenforceable. This notion has been widely considered in case law. Common law derived from the House of Lords decision in *Newbury DC v Secretary of State for the Environment* determined that any resource consent condition needs to satisfy a range of criteria in order to be valid. This created what is known as the *Newbury* validity tests, of which (b) is particularly relevant to this application:

> (a) The condition must be imposed for a [resource management] purpose and not an ulterior purpose;
>
> (b) <u>The condition must fairly and reasonably relate to the activities authorised by the consent to which the condition is attached</u>; (emphasis added) and
>
> (c) The condition must not be so unreasonable that a reasonable planning authority, duly appreciating its statutory duties, could not have approved such a condition.

The individual applications for WW1&2 and WW4 and WW5 do not seek the authorisation of activities on any of the other landholdings. Since *Newbury*, the validity tests above have been modified by New Zealand courts and a review of case law strongly indicates that consent conditions relying on the actions or compliance by third parties are not valid.

The imposition of the 100-hectare winter fodder crop restriction is linked back to the permitted activity threshold in Rule 20 (a) of the PSWLP, which WRO would otherwise be able to operate under as an individual landholding in its own right.

11. Assessment of Environmental Effects

The table below describes the proposed activities occurring on WRO under the proposal.

Activity	Potential effects	Good Management Practices adopted	Mitigations over and above GMPs	Outcome
Capital fertilizer applications to lift Olsen P levels	The 2017/18 year end Overseer model included capital phosporus fertilizer applications to lift Olsen P levels. In future, capital fertilizer applications may be undertaken for K and S also. Capital fertilizer applications will apply larger quantities of N, P, K and S to land in order to increase fertility. These applications of larger quantities of nutrients have the potential to result in losses to the environment if applied at rates which exceed the plants ability to utilize these applied nutrients. Excess applied N likely to be lost to water bodies via nutrient leaching and artificial drainage	Capital fertilizer application timings avoid high drainage periods such as late autumn and winter and periods when soil temperature is less than 7 degrees to mitigate against excess N leaching through the soil profile. All other fertilizer applications will use a little and often approach to avoid the application of excess nutrients which cannot be utilized. Regular soil testing to guide capital fertilizer requirements to avoid the application of excess N and P which cannot be used for plant uptake to mitigate against losses via artificial drainage.	Capital fertilizer applications will only be done as required by the latest soil test results and will be undertaken where P, K or S levels are below agronomical optimum levels. P = 20-30 K = 6-10 S= 10-12 The target Olsen P level on this block is 25. Capital P fertilizer applications will be applied at a maximum of 100kg P/ha which may require P fertilizer applications to be split.	Capital fertilizer applications are only undertaken where there is a nutrient deficit and are done at a rate which meets this deficit and avoids the application of excess nutrients. There is a low risks of adverse effects eventuating as application will meet pasture demand. The fertilizer regime described in the nutrient budget will be the default fertilizer regime and capital fertilizer applications will only be done according to soil test results and completed using GMP principles which should adequately mitigate adverse effects on water quality.

Activity	Potential effects	Good Management Practices adopted	Mitigations over and above GMPs	Outcome
	channels. Excess applied P likely to be lost to water bodies via overland flow, particularly on the sloping land. Excess N and P in water bodies may lead to water quality degradation resulting in ecological stresses on aquatic life and human health consequences such as blue baby syndrome.			
Cultivation of new pastures	Short term increase in potential sediment, microbial and phosphorus losses to the environment which can cause ecological stresses on plants and animals due to sedimentation, algae blooms and water temperature increases in waterways and estuaries	Re-sow bare paddocks as soon as possible Use buffer zones around critical source areas and use direct drilling if possible. Cultivation will be undertaken to meet permitted activity criteria in Rule 25(a) of the PSWLP maintaining a 5 meter buffer zone	Further mitigations not required as the imposition of buffer zones reduces the risk of overland flow of sediment and phosphorus when cultivating land. Riparian buffer zones will be installed with stock fencing and vegetated filter areas.	Adverse effects should be adequately avoided as this is a low risk activity in this location. GMPs provide adequate mitigation of effects.
Intensive winter	Potential for significant	Buffer zones maintained		

Deleted: The intensive winter grazing of R1 calves will occur on a similar scale as the 2017/18 year. Mitigation measures include choosing suitable fodder crop paddocks which are predominantly flat with no waterways, away from critical source areas and on paddocks which may require additional fertility. Paddock selection is important to avoid and mitigate the risk of the direct runoff of nutrients to water bodies (particularly P, sediment and microbials).

Deleted: Adverse effects potentially still exist from this activity due to the high level of contaminant losses which occur from intensive winter grazing despite the implementation of GMPs and mitigations. ¶
¶
The GMPs and the mitigations proposed will mitigate adverse effects to a certain extent, with the long-term goal of the applicant to abolish intensive winter grazing from the dairy platforms/Central Plains area and overall to reduce the frequency and scale of intensive winter grazing at WRO by utilizing the wintering sheds in preference to fodder crop over winter.

Activity	Potential effects	Good Management Practices adopted	Mitigations over and above GMPs	Outcome
grazing	amounts of contaminants (N, P, sediment and microbials) to be lost to both surface and groundwater bodies as a result of the complete de-vegetation of pasture/crop, treading damage on soil structure and runoff following rainfall events. Nutrient losses from this activity occur via deep drainage through the soil profile into the underlying aquifer or via overland flow into adjacent waterways or artificial drainage channels. Excessive nutrient losses can cause nutrient accumulation in groundwater and excessive nutrient load in waterways causing water	between crop cultivation and critical source areas to provide an area where runoff can be filtered and captured limiting risks of entering water. Grazing direction will be away from buffer zones/critical source areas leaving last bite to provide a buffer zone for nutrient capture through until the end of the fodder grazing period. Back fencing and portable water troughs to limit treading damage over already de-vegetated ground. Cultivation of paddocks timed to avoid paddocks sitting bare for long periods of time which reduces risks of contaminant losses through leaching and overland flow. All other GMPs listed in rule 20 will be implemented at all times.		

Deleted: The intensive winter grazing of R2 heifers will be a new activity on this block in the future and would require the cultivation of an additional approximately 48ha of fodder crop. Currently this activity is located on the WW5 dairy platform and Gladfield block. It has been located on the WW1&2 platform (Marcel/SH96) in recent years. The current location of this intensive winter grazing activity within the highly sensitive Heddon Bush/Central Plains area results in significantly higher contaminant losses due to the nutrient leaching risks of the soils in this location.

Deleted: Potential future increase in the scale of the activity

Deleted: Suitable fodder crop paddocks will be chosen which are predominantly flat with no waterways or artificial drainage channels, away from critical source areas and on paddocks which ma ...

Deleted: The siting of this activity on WRO in the future on heavier soils presents a lower risk of nitrate accumulation in groundwater and ...

Deleted: Approximately 125 R2 heifers will be wintered in existing barns at the WW1&2 dairy platform. In some years, R2 heifers will be wintered in respective ...

Deleted: by May 2019.

Activity	Potential effects	Good Management Practices adopted	Mitigations over and above GMPs	Outcome
	quality degradation and the resulting ecological stress on plants and animals when the life-supporting capacity of the water is compromised by excess nutrients.	Bare soils are cultivated using full cultivation and timed to avoid paddocks siting bare for long periods of time which reduces risks of losses of excess nutrients remaining from the grazing activity to the environment via overland flow and leaching.		
Fertilizer application regime across entire block	The application of nutrients in fertilizer has the potential to result in direct nutrient losses to the environment if fertilizer is applied either in excess to plant requirements or at a time when it cannot be utilized for pasture/crop production. Nitrogen losses from fertilizer application most likely to occur via deep drainage. Phosphorus losses from fertilizer most	Time N, P, K and S fertilizer application to meet crop and pasture demand using split applications and avoid high risk times of the year i.e when soil temperature is less than 7 degrees, during drought periods and during periods when soils are at field capacity. Reduce use of P fertilizer where Olsen P values are above agronomic optimum. Maintain Olsen P levels between 20-30. Use nutrient budgeting and annual soil testing to manage	Fertilizer applications occur in August, September, November, December and January on different blocks avoiding high drainage and high-risk periods that occur in late summer, late autumn, mid spring and during the winter. Fertilizer on crop blocks is applied in December which is considered a low risk month due to lower rainfall and higher soil temperatures. The fertilizer regime will remain flexible and will be undertaken to match pasture and crop requirements.	Adverse effects both avoided and mitigated with use of GMPs for fertilizer usage

Deleted: at around

Activity	Potential effects	Good Management Practices adopted	Mitigations over and above GMPs	Outcome
	likely to occur via soil loss and/or direct loss through runoff or erosion. Adverse effects of inappropriate fertilizer application or excess application include a loss of excess nutrients to water causing water quality degradation in both groundwater and surface water bodies. Water quality degradation can adversely impact aquatic plant and animal ecosystems and impact on human health.	nutrient inputs from fertilizer and outputs to guide farm management decisions which can maintain overall nutrient losses at desired level.		

Deleted: Potential increase in contaminant losses in the future

Deleted: The future use of WRO is highly likely to involve an increase in the scale of intensive winter grazing which is likely to increase contaminant losses. Higher contaminant loss activities increase the risk of the leaching of nutrients (N, P and microbials) through the soil profile from urine and dung spots or transported via subsurface drainage.¶

Deleted: Use of selective grazing to avoid grazing very wet paddocks during adverse weather conditions to reduce risks of pugging and treading damage to soil structure ...

Deleted: Overall stocking rate of cows grazing from August to May is kept to a level similar with an ...

Deleted: Adverse effects both avoided and mitigated with use of GMPs and mitigation measures which site activities in the ...

Deleted: Use nutrient budgeting to manage nutrient inputs and outputs to guide farm management decisions which can ...

Deleted: Increased nutrient losses as total figures to groundwater and surface water bodies may potentially cause water quality ...

12. Broad scale/cumulative effects assessment

The AEE above concludes that the implementation of targeted mitigation measures on-farm will ensure that adverse effects on water quality from activities within the proposal are either avoided or mitigated to levels that are consistent with the relevant regional plan water quality objectives whilst still maintaining a viable, efficient and profitable farm system. The amount of nutrients lost from the farm system which may end up in the receiving water bodies depends on a wide range of different factors often collectively referred to as attenuation rates. Similarly, the catchment hydrology and characteristics are critical in affecting the resultant concentration and/or mass loadings of nutrients and other contaminants in water bodies.[8]

This broad scale/cumulative effects assessment includes a catchment scale assessment in relation to attenuation and hydrology processes, characteristics of the catchment and consideration of the state of the receiving environment. This assessment also assesses the proposed activity in its entirety against the actual existing environment, i.e. not using a permitted or consented baseline approach. The term "practicable minimum" is used frequently and is used to portray the fact that any farming activity results in nutrient losses to the environment of some scale and that the applicant has reduced nutrient losses as far as they are practically able to do so given available mitigations, innovations and technology whilst still maintaining an efficient and profitable farm system that meets their social and economic needs. The term "practicable minimum" does not refer to an effect on the environment.

Attenuation

A 2011 report by Clint Rissmann undertook regional groundwater denitrification potential and aquifer sensitivity analysis throughout the Southland region. Unfortunately, the area surrounding WRO and the Orauea catchment was not analysed in this report and therefore the denitrification potential in this area remains largely unknown.

Phosphorus, Sediment and Microbial losses

The loss of P, sediment and microbials via erosion, overland flow and artificial drainage presents the highest risk on this property. Loss of contaminants via erosion and will be partly mitigated by the presence of established vegetation along the riparian margins, fencing to exclude stock and the low stocking rate.

These contaminants may also enter artificial drainage channels if applied to land inappropriately via fertilizer application, intensive winter grazing activities or by the inappropriate grazing of animals during high drainage periods (such as late autumn and mid-spring). The low stocking rate will partly mitigate potential losses via artificial drainage channels as less urine and dung deposition per hectare will occur.

Another factor to consider is the risk of P, sediment and microbial losses directly to surface water bodies within this catchment via overland flow – primarily occurring from runoff from laneways and via critical source areas. Overall losses of these contaminants directly to waterways is considered low

Deleted: The summary to this AEE concludes that water quality will be maintained in the receiving environments given the proposed mitigations, the characteristics of the catchment and the predicted changes to water quality as a result of the proposed activity.

Deleted: However, we can surmise that the risks of nitrogen losses from below the root zone ending up in groundwater and eventually surface water bodies is low in the vicinity of WRO due to the low mapped groundwater nitrate levels, the presence of heavy soils, the depth of groundwater and the general topography of the site. The applicant has recognised that this catchment is low risk for groundwater contamination and decided it is more environmentally beneficial to site higher contaminant loss activities (particularly high N loss activities such as intensive winter grazing) on WRO in the future in preference to the siting of these activities within the higher risk Central Plains area which is where these activities are currently occurring. The proposed activities located on WRO would otherwise be a permitted activity which strongly suggests that the proposed scale and nature of the activities is likely to result in less than minor adverse effects on the environment. ¶
Groundwater nitrate concentrations are of particular concern to human health. The risk of bottlefed infants getting 'blue baby syndrome' from consuming high nitrate nitrogen water is widely accepted and is the primary driver for the current NZ Drinking water standard for nitrate nitrogen. Other studies indicate that other contaminants, or dietary nitrate sources, may also play a role in the syndrome.[9] A recent Danish study suggested a link between groundwater nitrates and bowel cancer. The study found that those people exposed to nitrate levels in excess of 9.3 mg/L (NZ drinking water standard is 11.3 mg/L) had

Formatted: Space Before: 0 pt

---

[8] Enfocus, *Using Overseer in Water Management Planning*, October 2018.

risk on this property due to the low stocking rate. Overseer gives an estimate of what P may be lost directly to the

Hydrology of the catchment

The property is located in an area of unclassified groundwater management zone. This means that little information is available on groundwater and surface water connectivity, recharge and groundwater levels. Local anecdotal evidence strongly suggests that groundwater is very deep on the western side of the Longwoods ranges in the location of WRO as neighbours have had extreme difficulty drilling for groundwater. Despite the lack of knowledge and deep groundwater, there is expected to be some level of steady discharge of groundwater to surface water bodies. The discharge of groundwater to surface water bodies provides for mixing and dilution of nutrients from either source (groundwater or surface water). The dilution of nutrients can reduce the concentration of these nutrients in these water bodies which can lead to less prevalence of the adverse effects of water quality degradation.

Catchment Characteristics

The WRO farm sits within the wider Orauea catchment. The Orauea River is a cobble/gravel bedded river which drains pastoral land from near the town of Nightcaps to its confluence with the Waiau River near Tuatapere. According to a 2014 Aqualinc Report, the wider Waiau River catchment is large at 827,299 ha and is comprised of 33 dairy farms, 3 forestry blocks and 311 sheep and beef farms. Approximately 23% of the catchment is pastoral farmland. [11]

Deleted: environment from laneways, waterway crossings and critical source areas in the 'other sources' output within the model. The model does not consider sediment and microbial losses, however as all three contaminants typically enter surface water bodies via the same transport pathways then P loss modelled by Overseer can be used as a proxy for estimating sediment and microbial losses to the environment also. ¶

¶

The problem with the 'other sources' output estimated by Overseer is that it is not spatially explicit and does not account for site-specific mitigation measures which may be in place on a farm to mitigate losses directly to waterways from these laneways and critical source areas. The GMPs implemented on WRO specifically address and seek to minimise contaminant losses from these areas.¶

¶

GMPs and mitigation measures to reduce P, sediment and microbial losses¶

The applicant will be implementing specific critical source area GMPs

Deleted: Nutrient Load¶

We have used some of the workings in this Aqualinc report to illustrate how nutrient load from a particular farm impacts on the resulting concentration of nutrient within the end receiving environment.¶

¶

Total nutrient load within the Waiau River catchment have been estimated in the Aqualinc report. ¶

¶

The table estimates the total source load within the catchment at 4970 T N/year undergoing attenuation to result in an estimated 1864 T N/year as a nutrient load within the receiving waters at the Te Waewae Lagoon at the base of the catchment. Attenuation is estimated to be 62% which is the highest rate of attenuation seen across the subject catchments.¶

---

[11] Aqualinc, *Assessment of farm mitigation options and land use change on catchment nutrient contamination loads in the Southland region*, 2014

TIAKI

FARM SOURCE SUSTAINA[illegible] DAIRYING

WITHDRAWN

PHOSPHORUS MITIGATION PLAN

FARM SOURCE

Fonterra

Dairy for life

ABOUT YOUR PLAN

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

PHONE: 0800 65 65 68

EMAIL: sustainable.dairying@fonterra.com

CONTENTS:

FARM DETAILS

WITHDRAWN

FARM NAME

Woldwide Runoff

SUPPLIER NUMBER

Merrivale & Merriburn

PLAN OWNER

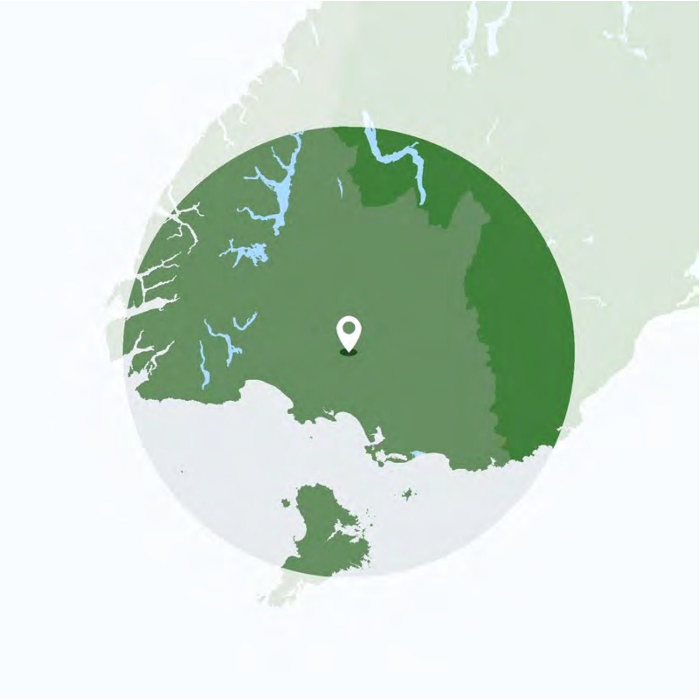
Albert De Wolde

+64 27 2272537
dewolde@farmside.co.nz

FARM ADDRESS

20 Gill Road & 1711 Otautau-Tuatapere Road

LOCATION



REGIONAL COUNCIL

Southland

PLAN LAST EDITED DATE

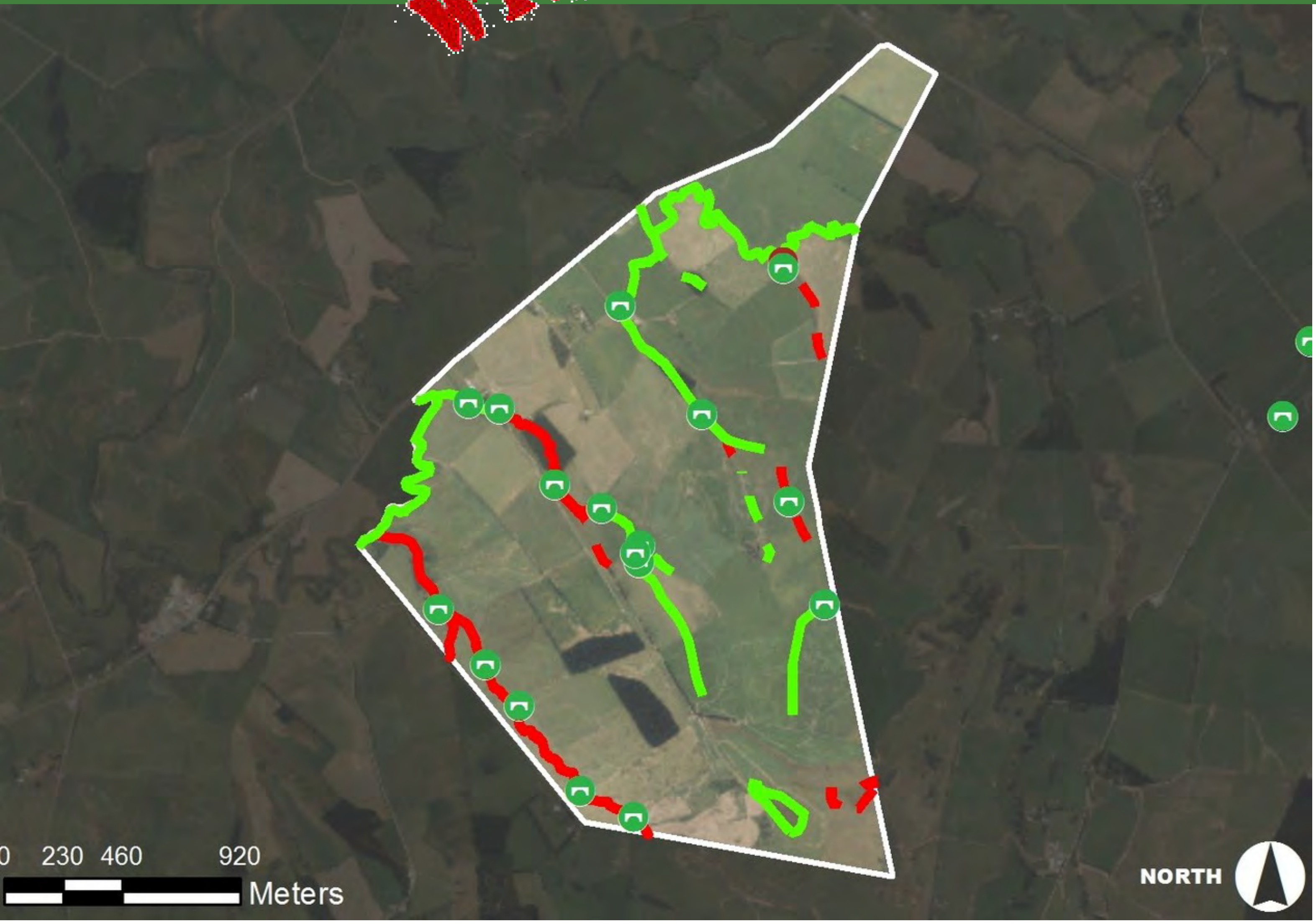
02 August 2019

POINTS OF NOTE

MERRIBURN FARM OVERVIEW MAP

WITHDRAWN

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

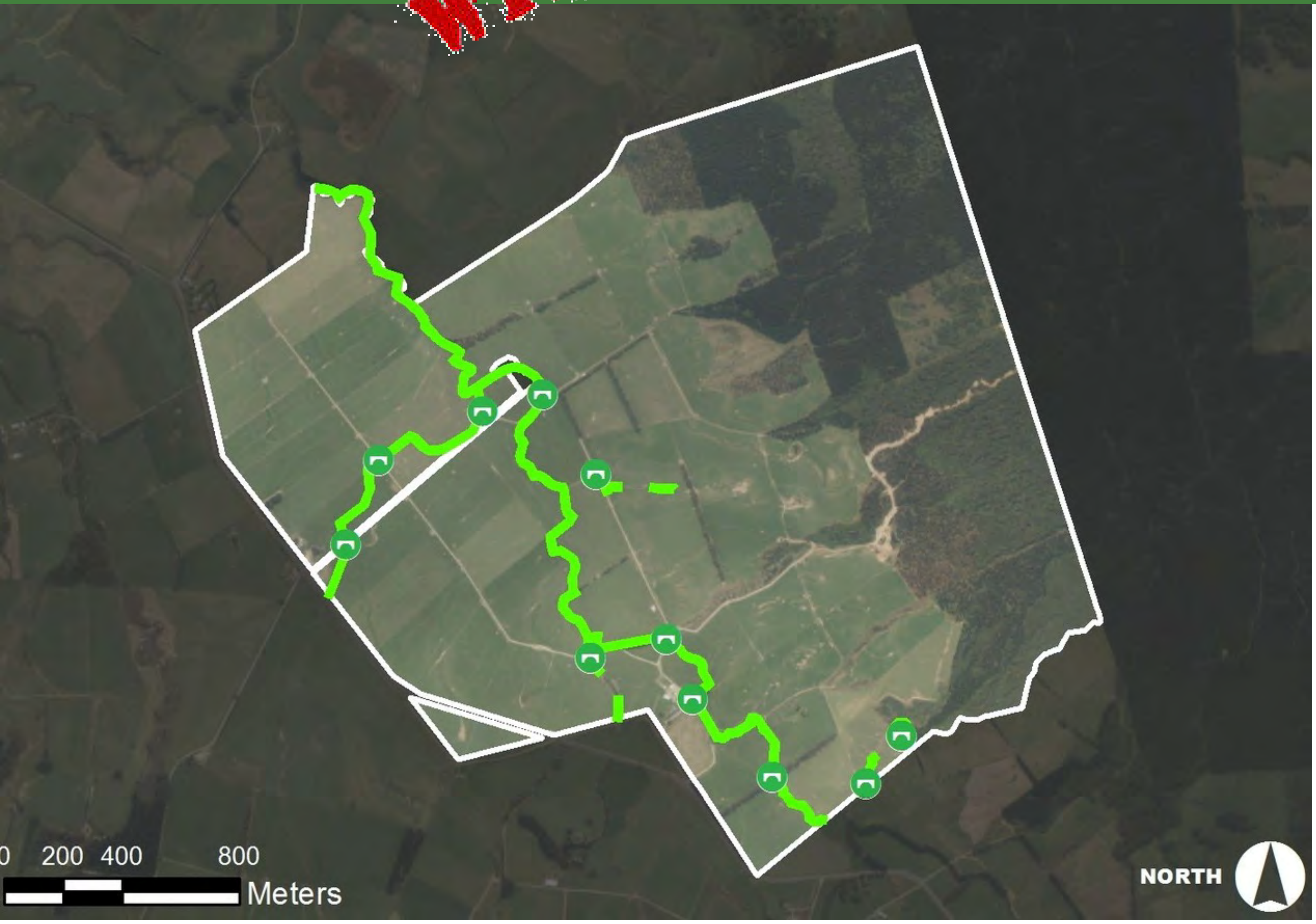


- 🟩 Accord Defined Stock Excluded Waterway
- 🟥 Accord Defined Stock Not Excluded Waterway
- ▪▪ Non-Accord Defined Stock Excluded Waterway
- ▪▪ Non-Accord Defined Stock Not Excluded Waterway
- ▭ Farm Boundary

- ● Compliant Crossing
- ● Non-Compliant Crossing
- ● Non-Compliant Non-Regular Crossing
- ● Dispensation Crossing
- ● Dairy Shed

MERRIVALE FARM OVERVIEW MAP

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



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

MERRIBURN SUMMARY OF OPEN ACTIONS

This table includes all open or ongoing actions that have been agreed as part of this Farm Environment Plan. They are organized by their target due date. Where an action has been identified as especially important an additional 'Flag' item may have been added.

CATEGORY		FEATURE TYPE & NAME	ACTION REQUIRED	TARGET DATE
≋	W1	Waterway Fencing - Foats Stream - Fencing	⚑ Fence Foats Stream - 2m Buffer	**1 Aug 20**
⛰	L3	Critical Source Area - Critical Source Areas - Overland Flow Paths	Extend Riparian Buffers - Critical Source Areas	**1 Aug 21**
≋	W2	Waterway Fencing - Fenham Creek Tributary Fencing	Fence off Fenham Creek (Central Section)	**1 Aug 21**
≋	W3	Waterway Fencing - Waterway Fencing - Other Areas	Fence Waterways - Other Areas	**1 Aug 21**
≋	W4	Waterway Fencing - Buckton Creek Tributary Fencing	Fence off Buckton Creek Tributary	**1 Aug 21**
≋	W6	Critical Source Area - Culvert - Lane Between Paddocks 11 & 19	Build Up Sides of Culvert (Sth Paddock 11)	**1 Aug 21**
⛰	L4	Race Maintenance & Management - Lane Run-off - Paddock 12	Modify Lane / Move Gateway / Install riser	**1 Feb 22**
≋	W5	Critical Source Area - Stock Ford	Re-instate Bridge between Paddocks 5 and 6	**1 Aug 22**

MERRIVALE SUMMARY OF OPEN ACTIONS

This table includes all open or ongoing actions that have been agreed as part of this Farm Environment Plan. They are organized by their target due date. Where an action has been identified as especially important an additional (Flag) icon may have been added.

CATEGORY	FEATURE TYPE & NAME	ACTION REQUIRED	TARGET DATE
L5	Culvert Management - Culvert (Paddock 101)	Unblock Culvert - Paddock 101	**1 Aug 19**
L1	Critical Source Area - Fenham Creek Tributary (Northern Section)	Extend Riparian Margin (Fenham Creek North)	**1 Aug 21**
L2	Critical Source Area - Critical Source Areas - Overland Flow	Extend Riparian Buffers - Critical Source Areas	**1 Aug 21**
L6	Erosion Control - Gully Paddock 27	Exclude Stock from Hill Face (Paddock 27)	**1 Aug 22**
L7	Critical Source Area - Crossing - Paddocks 6& 7	Extend Riparian Margin (Drain Paddock 6 & 7)	**1 Aug 22**
L4	Critical Source Area - Gully Paddocks 10 & 15	Exclude Stock from Erosion Areas (Pad 10 & 15)	**1 Aug 25**
L8	Sediment Trap - Sediment Trap (Paddock 58)	Sediment Trap Installation (Paddock 58)	**1 Aug 25**
L3	Critical Source Area - Gully Paddock 9	Re-fence Gully - Paddock 10	**Ongoing**

L1

Phosphorus Overview (Merriburn & Merrivale)

WITHDRAWN

DESCRIPTION:

Woldwide Runoff (WRO) is comprised of two farm in close proximity to each other. The Merrivale block is owned by WRO and the Merriburn block is leased. The properties have numerous waterways flowing through them and the topography is generally rolling with some area of flat land and some areas of steeper hill country. Due to the topography of the farms there are many critical source areas and these are likely to be the conduit for the majority of the farms phosphorus losses.

Overseer is not spatially explicit and is unable to take into account landscape features. It assumes a hydrological connection exists to second order streams and that there is a transport mechanism to get phosphorus to those streams (Gray, 2016).

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

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

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

Phosphorus Loss – Culverts & Small Riparian Margin Increases

There will be a reduction in phosphorus loss from mitigations applied around culverts but there is no robust research information to base an estimate on, however experience indicates these areas can result in significant losses of sediment (and associated P) to water. On this basis estimated reductions in phosphorus have been referenced as >0 Kg/P. In addition to this, small increases in riparian margins to include areas of erosion or unproductive land have also been referenced as >0 Kg/P and are not included in the overall phosphorus reduction figure.

Phosphorus Loss – Critical Source Areas & Waterway Fencing

Overseer predicts 425kg of phosphorus will be lost to water from paddocks (effective area of 647ha). Assuming phosphorus loss occurs evenly over the effective area of the farm, then critical source areas and unfenced waterways and their associated catchments would account for 32% of the phosphorus loss from blocks on the property. This equated to 136kg of phosphorus.

Assuming a 30-40% reduction in phosphorus loss occurs through waterway fencing and the implementation of wider, vegetated riparian buffers (at locations where critical source areas enter waterways) and better management of critical source areas, then a further reduction of 55.8kg of phosphorus is estimated to occur beyond that modelled in Overseer (with all mitigations implemented). See Table 1 and 2 below.

Site and Fencing Length (m)	Catchment Area (% of Catchment)	P Loss (kg)	Mitigations (% Reduction)	Reduction in P Loss (kg)
W1 (L2) – 1900	78 (12)	51	40	20.5
W2 – 800	10.5 (1.6)	6.9	40	2.7
W4 – 420	4.5 (0.7)	2.9	40	1.2
W3– 960	12 (1.9)	7.9	40	3.2
L1 – 1000 (Merrivale)	7 (1.1)	4.6	30*	1.4
				29

Table 1 – Phosphorus Loss – Unfenced Waterways (*30% as already small riparian margin in place)

Site and Catchment Area	% of Total Catchment	P Loss (kg)	Mitigations (% Reduction)	Reduction in P Loss (kg)
L3 – 42.3ha	6.5	27.8	40	11.1
L4 – 2.5ha	0.3	1.6	40	0.66
L2 – 57ha (Merrivale)	8.8	37.4	40	15
				26.8

Table 2 – Phosphorus Loss – Critical Source Areas

The 40% reduction is based on research that shows management of critical source areas and vegetated buffers can reduce phosphorus loss by 38-59% (Figure 1). A lower range reduction figure of 40% has been used to try and ensure the impact of the proposed mitigations is not over estimated.

It is acknowledged by McDowell et al, 2005 in the original design of the Overseer P sub-model that, in some areas, 90% of phosphorus loss may come from only 10% of the catchment area (Sharpley et al, 1999). McDowell states that defining and isolating critical source areas, combined with active management over the farm is the best approach to decreasing phosphorus loss. For the purposes of this analysis, it has been assumed that phosphorus loss occurs evenly over the farm as there is insufficient data to quantify phosphorus losses to a critical source area level. This means mitigations aimed at critical source areas are likely to have more of an impact than stated in this report and as such result in a larger reduction in phosphorus losses to those outlined above.

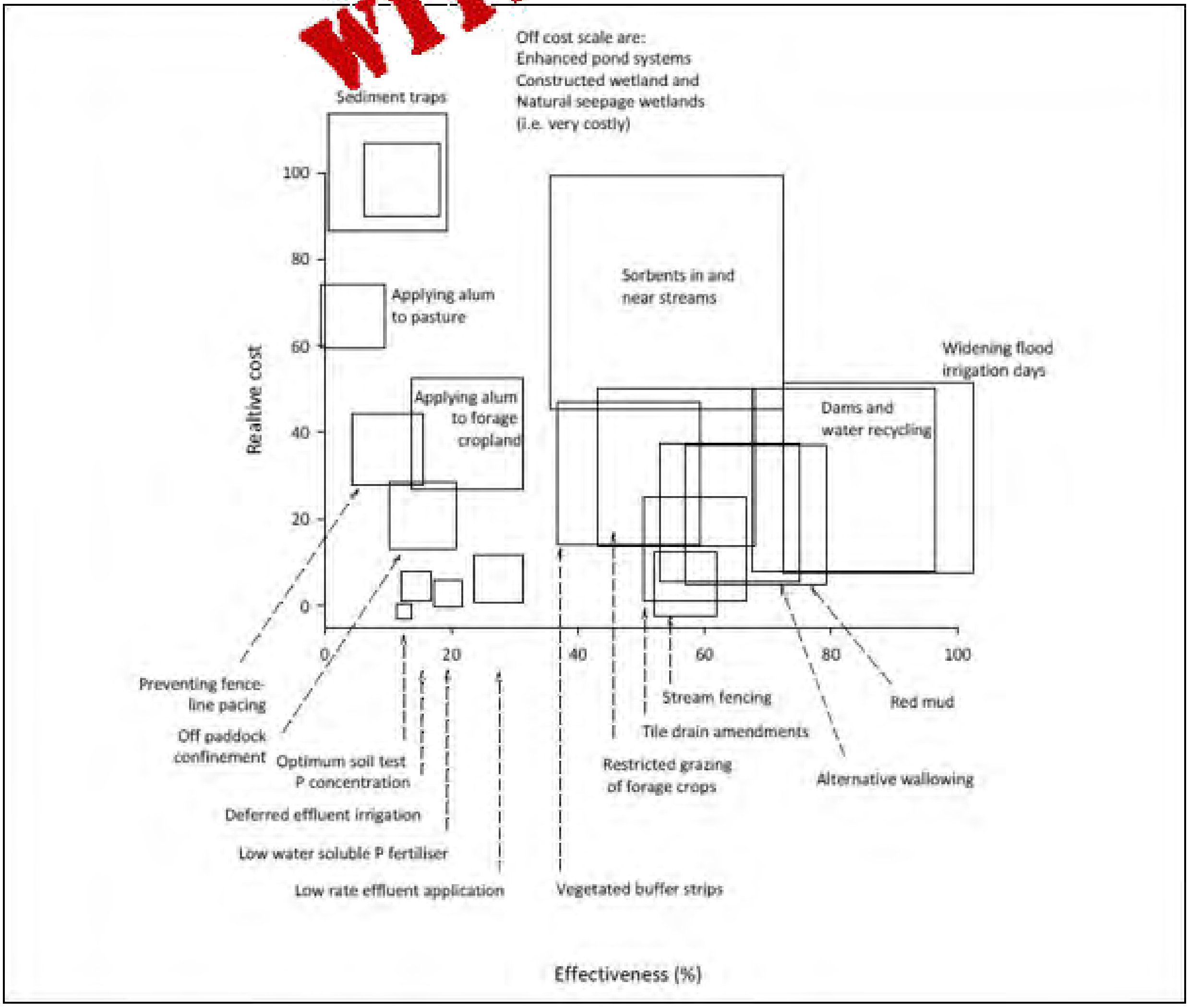


Figure 1 - Cost and effectiveness of strategies to mitigate phosphorus losses (McDowell et al, 2013)

References:

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

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

McDowell, R; Monaghan, R and Wheeler, D. (2005). *Modelling phosphorus losses from pastoral farming systems in New Zealand*, New Zealand Journal of Agricultural Research, 48:1, 131-141.

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

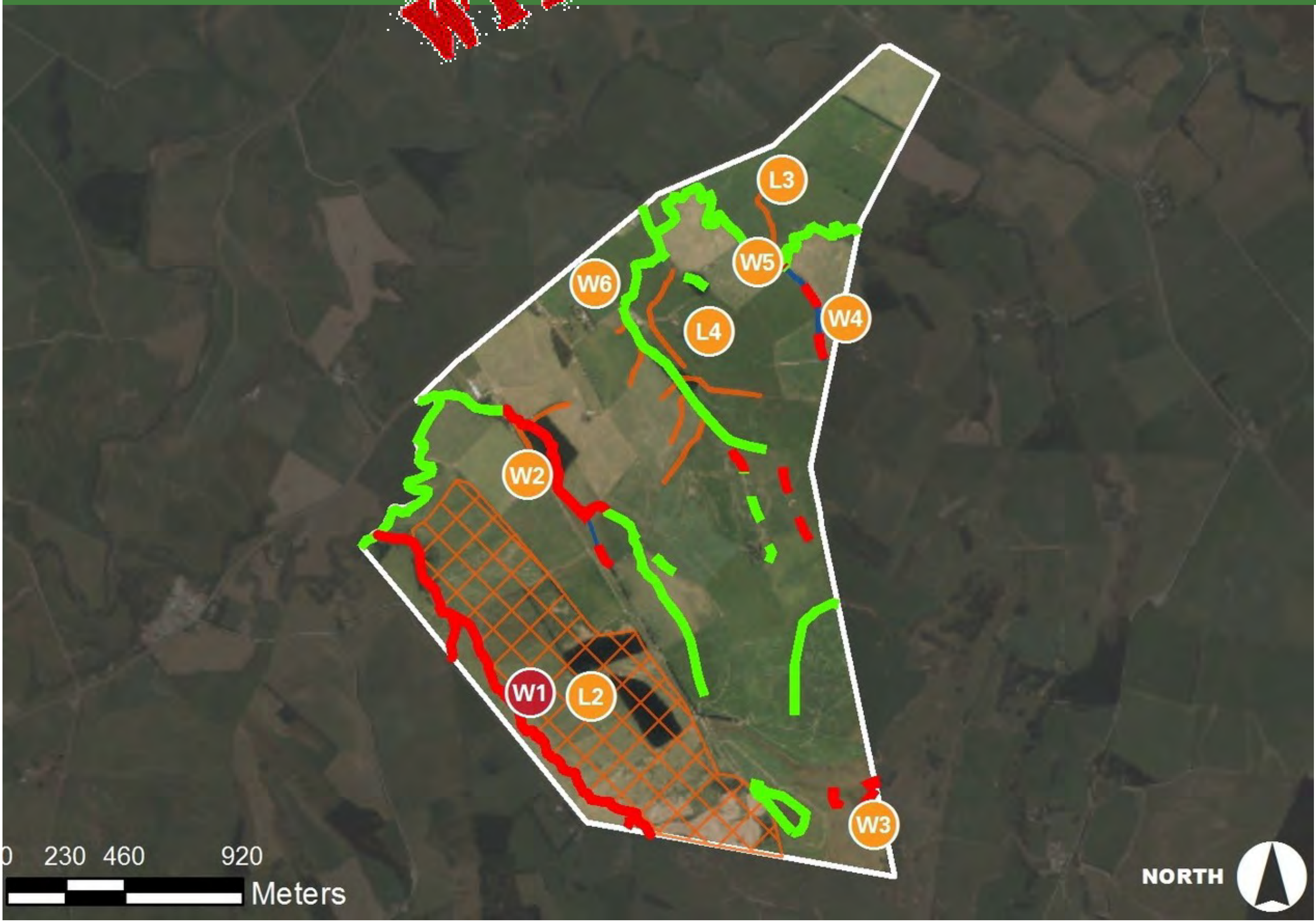
McDowell, R; Wilcock, B and Hamilton, D. (2013). *Assessment of Strategies to Mitigate the Impact or Loss of Contaminants from Agricultural Land to Fresh Waters.* Report prepared for MfE. AgResearch. Report RE500/2013/066.

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

MERRIBURN RISK RATING

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

● LOW ● MEDIUM ● HIGH ● SEVERE



L2	Critical Source Area - Western Hill Face - Critical Source Areas
L3	Critical Source Area - Critical Source Areas - Overland Flow Paths
L4	Race Maintenance & Management - Lane Run-off - Paddock 12
W1	Waterway Fencing - Foats Stream– Fencing
W6	Critical Source Area - Culvert - Lane Between Paddocks 11 & 19
W2	Waterway Fencing - Fenham Creek Tributary Fencing
W3	Waterway Fencing - Waterway Fencing - Other Areas
W4	Waterway Fencing - Buckton Creek Tributary Fencing
W5	Critical Source Area - Stock Ford

LAND MANAGEMENT

L2

Critical Source Area

Western Hill Face - Critical Source Areas

WITHDRAWN

IMPACT OF CONTAMINATION + LIKELIHOOD OF CONTAMINATION = MEDIUM RISK RATING

DESCRIPTION:

The western hill face slopes down from the top of the farm into Foats Stream. There are a multitude of critical source areas along the hill face that will collect overland flow (and associated contaminants) from surrounding paddocks and direct it down to Foats Creek. Mitigations have already been discussed as part of the actions to fence Foats Creek and include having a wider riparian buffer where critical source areas enter Foats Stream. In addition to this, some of the steeper gullies where land is marginal for production purposes could be fenced off and planted in native vegetation.

Estimated Reduction in Phosphorus: See Foats Creek Fencing

IMAGES:

L3

Critical Source Area

Critical Source Areas - Overland Flow Paths

WITHDRAWN

IMPACT OF CONTAMINATION + **LIKELIHOOD OF CONTAMINATION** = **MEDIUM RISK RATING**

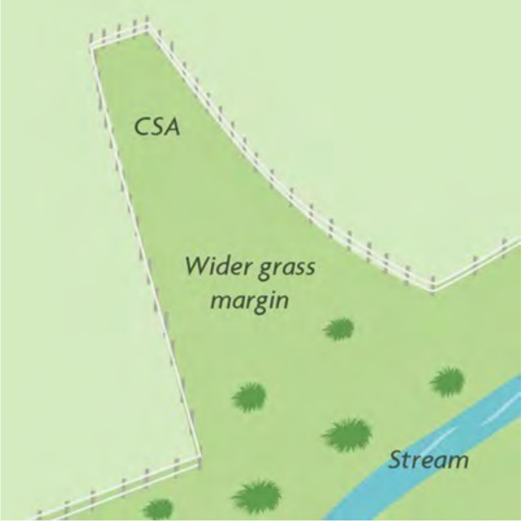
DESCRIPTION:

There are a number of critical source areas (overland flow paths) on the farm as identified on the map at the start of this section. Those shown are not an exhaustive list but form a guide to the areas that should be investigated further. Critical source areas are areas where water and contaminants off surrounding paddocks are concentrated and transported over the land surface to nearby waterways. Where these areas enter waterways a larger riparian buffer should be provided to filter sediment and associated contaminants (such as phosphorus). Buffers should be appropriately sized for the catchment area of the critical source area (normally 5m minimum). The approximate catchment area of the critical source areas identified (not including the western hill face) is 42.3ha.

Estimated Reduction in Phosphorus: 11 Kg/P

IMAGES:

WITHDRAWN



OPEN ACTIONS:

Extend Riparian Buffers - Critical Source Areas

Extend the riparian buffers where critical source areas such as gullies and swales enter waterways. Buffers should generally be a minimum of 5m or larger depending on the size of the critical source area catchment. Buffer areas should be left in rank grass or planted in native grasses such as carex secta, red tussock and toetoe.

TARGET DATE: **1 Aug 2021**

L4

Race Maintenance & Management

Lane Run-off - Paddock 12

WITHDRAWN

IMPACT OF CONTAMINATION + LIKELIHOOD OF CONTAMINATION = MEDIUM RISK RATING

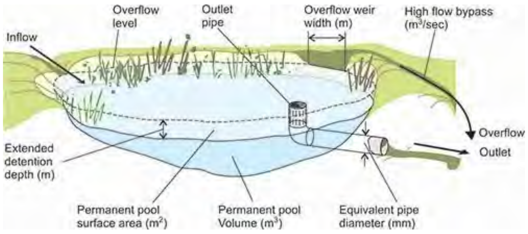
DESCRIPTION:

Lane passing between paddocks 12 and 9. The lane slopes down to a stand of pine trees that has a small waterway running through it. Run-off from the lane and paddock 12 flow down to this point. The lane should be built up in this area to avoid run-off flowing into the adjacent creek. The gateway into paddock 12 could be moved out of the low lying area to a location further up the lane and a small bund installed in the low area with a riser and pipe under the lane into the creek. The bund will allow a small amount of water to pond, settling out sediment before discharging into the creek. This will avoid run-off from the paddock flowing across the lane, causing damage and picking up more contaminants.

Estimated Reduction in Phosphorus: 0.66 Kg/P (Paddock overland flow only)

GPS Co-ordinates: 1199936, 4885360

IMAGES:



WITHDRAWN

OPEN ACTIONS:

Modify Lane / Move Gateway / Install riser

Build up the lane so it slopes away from the creek and run-off flows into adjacent paddocks. The gateway into paddock 12 could be moved out of the low lying area to a location further up the lane and a small bund installed in the low area with a riser and pipe under the lane into the creek. The bund will allow a small amount of water to pond, settling out sediment before discharging into the creek.

TARGET DATE: 1 Feb 2022

WATERWAYS MANAGEMENT

W1 Waterway Fencing - Foats Stream - Fencing

W2 Waterway Fencing - Fenham Creek Tributary Fencing

W3 Waterway Fencing - Waterway Fencing - Other Areas

W4 Waterway Fencing - Buckton Creek Tributary Fencing

W5 Critical Source Area - Stock Ford

W6 Critical Source Area - Culvert - Lane Between Paddocks 11 & 19

🟩 Accord Defined Stock Excluded Waterway

🟥 Accord Defined Stock Not Excluded Waterway

- - Non-Accord Defined Stock Excluded Waterway

Non-Accord Defined Stock Not Excluded Waterway

Compliant Crossing

Non-Compliant Crossing

Non-Compliant Non-Regular Crossing

Dispensation Crossing

WATERWAYS MANAGEMENT

W1

Waterway Fencing

Foats Stream - Fencing

WITHDRAWN

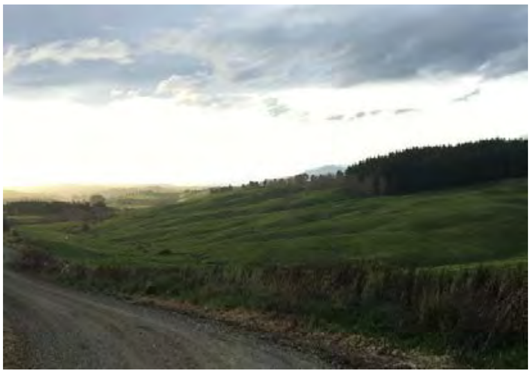
IMPACT OF CONTAMINATION + **LIKELIHOOD OF CONTAMINATION** = **HIGH RISK RATING**

DESCRIPTION:

A tributary of Foats Stream flows along the western side of the Merriburn Lease Block adjacent to Sim Road. Run-off from the steeper hill country to the east all flows down into the stream via a multitude of critical source areas. The stream is currently not fenced to exclude stock and there is no vegetated riparian margin. Fencing of the waterway will reduce phosphorus losses from the farm by preventing direct deposition into the stream by stock and filtering run-off from surrounding paddocks. Where critical source areas enter the stream it is recommended the riparian margin is maintained at 5m with a 2m rank grass margin maintained outside of these areas. Foats Stream Tributary has a catchment of approximately 78ha (located on the farm).

Estimated Reduction in Phosphorus: 20.5 Kg/P

IMAGES:



WITHDRAWN

OPEN ACTIONS:

Fence Foats Stream - 2m Buffer

Fence off the Foats Stream tributary running along the western side of the farm. A 2m riparian buffer should be established on both sides of the creek with the buffer extended to 5m in locations where swales or gullies (critical source areas) enter the stream.

TARGET DATE: 1 Aug 2020

W2

Waterway Fencing

Fenham Creek Tributary Fencing

WITHDRAWN

IMPACT OF CONTAMINATION + **LIKELIHOOD OF CONTAMINATION** = **MEDIUM RISK RATING**

DESCRIPTION:

A tributary of Fenham Creek flows down from the higher elevations of the farm out to Otautau-Tuatapere Road. The upper and lower reaches of the Creek are permanently fenced to exclude stock (although the riparian buffers should be extended when adjacent paddocks are being winter grazed). In the middle section a small forestry block has recently been removed and the creek flows down through a gully to the bottom of the farm. Run-off from surrounding paddocks flows down into the stream via the general topography of the land and critical source areas.

Fencing of the central section of the waterway will reduce phosphorus losses from the farm by preventing direct deposition into the stream by stock and filtering run-off from surrounding paddocks. Where critical source areas enter the stream it is recommended the riparian margin is increased to 5m with a 3m rank grass margin maintained outside of these areas. The steeper sections of the hill could also be fenced off as these have minimal productive value. These areas could be planted in natives such as red tussock, toetoe, cabbage trees, broadleaf, etc to prevent erosion and add to the aesthetic and biodiversity values of the farm.

The unfenced section of the Fenham Creek Tributary has a catchment of approximately 10.5ha.

Estimated Reduction in Phosphorus: 2.7 Kg/P

IMAGES:

OPEN ACTIONS:

Fence off Fenham Creek (Central Section)

Fence off the central section of the waterway. Where critical source areas enter the stream increase the riparian margin to a minimum of 5m with a 3m rank grass margin maintained outside of these areas. The steeper sections of the hill could also be fenced off as these have minimal productive value.

TARGET DATE: **1 Aug 2021**

W3

Waterway Fencing

Waterway Fencing - Other Areas

WITHDRAWN

IMPACT OF CONTAMINATION + **LIKELIHOOD OF CONTAMINATION** = **MEDIUM RISK RATING**

DESCRIPTION:

Three additional areas have been identified as requiring fencing to exclude stock. Two of these areas have not been photographed and have been identified from aerial photography. These are small ephemeral waterways or gullies in paddocks 15, 16 and 17. Fencing these areas and maintaining a minimum 2m rank grass buffer will assist with the filtering of run-off from surrounding paddocks, including phosphorus. In addition to this there is a pond and wetland area in paddock 38 that should also be fenced to achieve similar benefits (see photos).

The overall catchment for these areas is approximately 12ha.

Estimated Reduction in Phosphorus: 3.2 Kg/P

GPS Co-ordinates: 1200041, 4884705; 1200248, 4884547 & 1200520, 4883400

IMAGES:

OPEN ACTIONS:

Fence Waterways - Other Areas

Permanently fence off the waterways/gullies in paddocks 15, 16 and 17 as well as the wetland/pond area in paddock 38. A minimum 2m rank grass riparian margin should be established.

TARGET DATE: **1 Aug 2021**

W4

Waterway Fencing

Buckton Creek Tributary Fencing

WITHDRAWN

IMPACT OF CONTAMINATION + **LIKELIHOOD OF CONTAMINATION** = **MEDIUM RISK RATING**

DESCRIPTION:

Small ephemeral waterway that runs between paddocks 6, 7 and 8. The waterway is not currently permanently fenced, however there is a variable riparian margin due to the slope of the bank and the fact the stream flows through a gully. Fencing will prevent stock access and allow rank grass to better establish within the riparian margin, assisting with filtering of run-off. It is recommended a permanent fence be installed at the top of the bank/gully.

The catchment area draining into the unfenced section of the Buckton Creek Tributary is approximately 4.5ha.

Estimated Reduction in Phosphorus: 1.2 Kg/P

IMAGES:

OPEN ACTIONS:

Fence off Buckton Creek Tributary

Permanently fence off the waterway that runs between paddocks [illegible] and 8. There is a natural riparian buffer due to the topography of the land of approximately 2-4m [illegible] recommended the fence line follows this natural contour.

TARGET DATE: **1 Aug 2021**

WITHDRAWN

W5

Critical Source Area

Stock Ford

WITHDRAWN

IMPACT OF CONTAMINATION + LIKELIHOOD OF CONTAMINATION = MEDIUM RISK RATING

DESCRIPTION:

Stock ford between paddocks 5 and 6. The ford is used to access paddocks to the east of the farm and replaces an unsafe bridge. Long term the use of the ford should be discontinued (due to the direct deposition of contaminants into the waterway) and a bridge reinstated.

Estimated Reduction in Phosphorus: >0 Kg/P

GPS Co-ordinates: 1200234, 4885465

IMAGES:

OPEN ACTIONS:

Re-instate Bridge between Paddocks 5 and 6

Long term the use of the ford should be discontinued (due to the direct deposition of contaminants into the waterway) and a bridge re-instated.

TARGET DATE: **1 Aug 2022**

WITHDRAWN

W6

Critical Source Area

Culvert - Lane between Paddocks 11 & 19

WITHDRAWN

IMPACT OF CONTAMINATION + LIKELIHOOD OF CONTAMINATION = MEDIUM RISK RATING

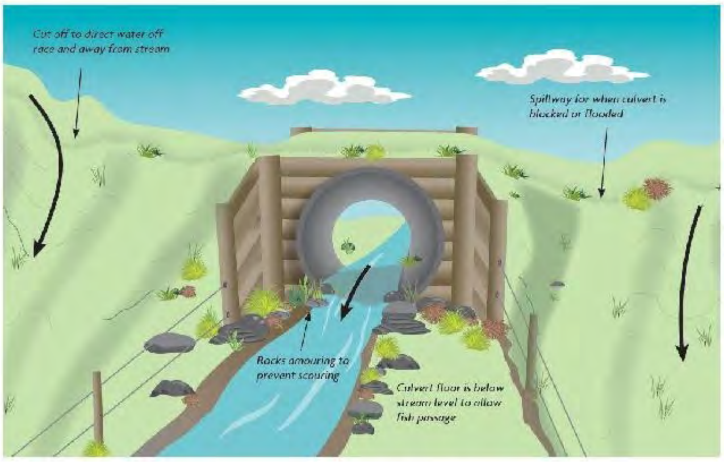
DESCRIPTION:

Lane crossing the waterway to the south of paddock 11. The culvert has no raised sides which allows any runoff to flow off the side into the underlying water. Building up the sides of the culvert and directing run-off back into the paddock or at a minimum into a grass riparian area will assist with filtering sediment and associated phosphorus.

Estimated Reduction in Phosphorus: >0 Kg/P

GPS Co-ordinates: 1199597, 4885291

IMAGES:



OPEN ACTIONS:

Build Up Sides of Culvert (Sth Paddock 11)

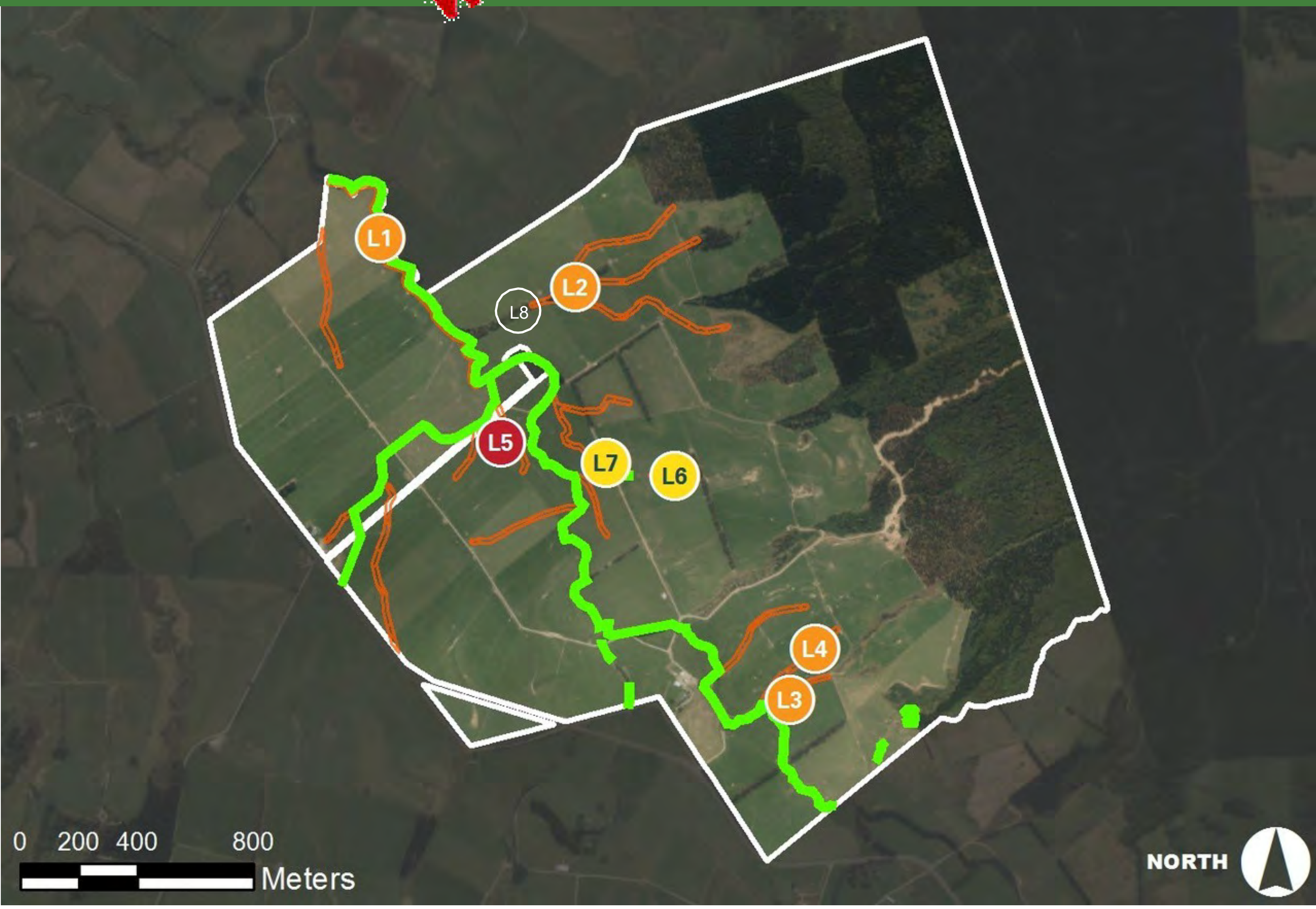
Build up the sides of the lane crossing the waterway to the south of paddock 11. This will prevent the direct deposition of sediment and associated phosphorus into the underlying waterway and allow for filtering via a grass buffer.

TARGET DATE: **1 Aug 2021**

MERRIVALE RISK RATING

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

🟡 LOW 🟠 MEDIUM 🔴 HIGH ● SEVERE



L1	Critical Source Area - Fenham Creek Tributary (Northern Section)
L2	Critical Source Area - Critical Source Areas - Overland Flow
L3	Critical Source Area - Gully Paddock 9
L8	Sediment Trap - Sediment Trap (Paddock 58)
L4	Critical Source Area - Gully Paddocks 10 & 15
L5	Culvert Management - Culvert (Paddock 101)
L6	Erosion Control - Gully Paddock 27
L7	Critical Source Area - Crossing - Paddocks 6 & 7

LAND MANAGEMENT

L1

Critical Source Area

Fenham Creek Tributary (Northern Section)

WITHDRAWN

IMPACT OF CONTAMINATION + **LIKELIHOOD OF CONTAMINATION** = **MEDIUM RISK RATING**

DESCRIPTION:

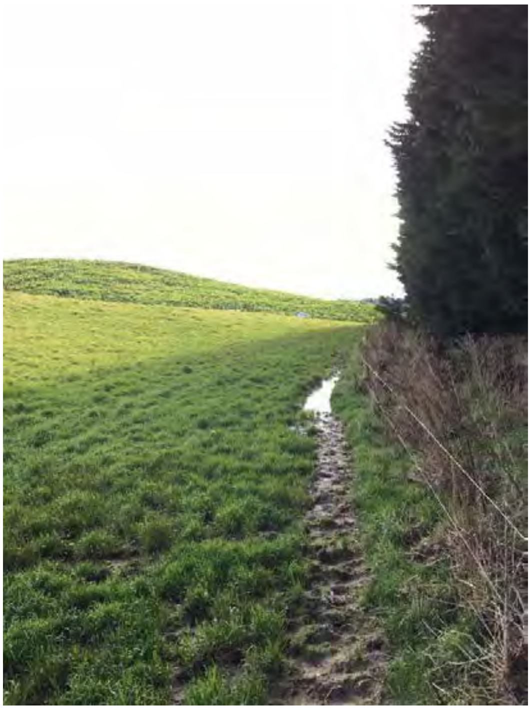
Northern end of the Fenham Creek Tributary flowing along the bottom of paddocks 88, 90, 92, 94, 96 and 98. The riparian buffer on the western side is approximately 1-1.5m yet there is a significant slope from the adjoining paddocks down to the creek. It is recommended that a 3m grass buffer is fenced off to allow for filtering of overland flow and associated contaminants off the surrounding paddocks. This is especially important when adjacent paddocks are being winter grazed (buffer should be temporarily extended to at least 5m).

The catchment flowing into the riparian buffer is approximately 7 ha over a length of approximately 1km.

Estimated Reduction in Phosphorus: 1.4 Kg/P

IMAGES:

WITHDRAWN



OPEN ACTIONS:

Extend Riparian Margin (Fenham Creek North)

It is recommended that the riparian margin of the Fenham Creek Tributary flowing below paddocks 88, 90, 92, 94, 96 and 98 be extended to 3m and maintained in rank grass to.

TARGET DATE: 1 Aug 2021

L2

Critical Source Area

Critical Source Areas - Overland Flow

IMPACT OF CONTAMINATION + **LIKELIHOOD OF CONTAMINATION** = **MEDIUM RISK RATING**

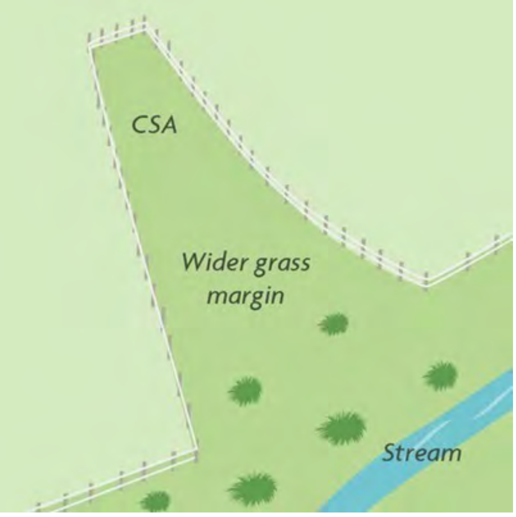
DESCRIPTION:

There are a number of critical source areas (overland flow paths) on the farm as identified on the map at the start of this section. Those shown are not an exhaustive list but form a guide to the areas that should be investigated further. The critical source areas across the farm are areas where water and contaminants off surrounding paddocks are concentrated and transported over the land surface to nearby waterways. Where these areas enter waterways a larger riparian buffer should be provided to filter sediment and associated contaminants (such as phosphorus). Buffers should be appropriately sized for the catchment area of the critical source area (normally 5m minimum).

The approximate catchment area of the critical source areas identified (not including specific areas identified elsewhere in this plan) is 57ha.

Estimated Reduction in Phosphorus: 15 Kg/P

IMAGES:


CSA
Wider grass margin
Stream

OPEN ACTIONS:

Extend Riparian Buffers - Critical Source Areas

Extend the riparian buffers where critical source areas such as gullies and swales enter waterways. Buffers should generally be a minimum of 5m or larger depending on the size of the critical source area catchment. Buffer areas should be left in rank grass or planted in native grasses such as carex secta, red tussock and toetoe.

TARGET DATE: **1 Aug 2021**

L3

Critical Source Area

Gully Paddock 9

WITHDRAWN

IMPACT OF CONTAMINATION + **LIKELIHOOD OF CONTAMINATION** = **MEDIUM RISK RATING**

DESCRIPTION:

The gully through paddock 9 has previously been fenced off (posts in place). This should be re-fenced to exclude stock. The area is of low production potential and having stock in this area is likely to cause pugging and sediment (and associated phosphorus) loss to the nearby waterway.

Estimated Reduction in Phosphorus: None - Area was previously fenced (will prevent an increase)

GPS Co-ordinates: 1203678, 4884309

IMAGES:

OPEN ACTIONS:

Re-fence Gully - Paddock 10

Reinstate the fence around the gully in Paddock 10.

TARGET DATE: **Ongoing**

L4

Critical Source Area

Gully Paddocks 10 & 15

IMPACT OF CONTAMINATION + LIKELIHOOD OF CONTAMINATION = MEDIUM RISK RATING

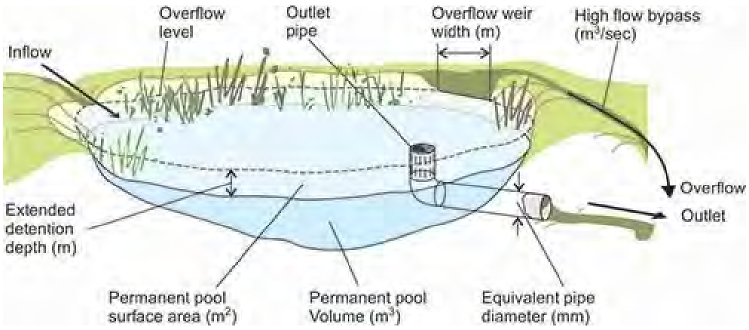
DESCRIPTION:

Gully through the center of paddocks 10 and 15. In some places erosion is occurring. These areas should be fenced off to avoid further damage (consider planting with natives to stabilise). In addition to this, the gully is a conduit for overland flow down to the waterway at the bottom. Due to the location of the lane there is minimal opportunity to extend the riparian margin, however long term there is an opportunity to install a sediment trap at the bottom of the gully with an overflow into the creek.

Estimated Reduction in Phosphorus: None Attributed - Long Term Project

GPS Co-ordinates: 1203657, 4884403

IMAGES:



OPEN ACTIONS:

Exclude Stock from Erosion Areas (Pad 10 & 15)

Fence off areas of the gully that are eroding. Long term consider the installation of a sediment trap at the bottom of the gully to remove sediment and associated phosphorus from overland flow off the adjacent paddocks.

TARGET DATE: **1 Aug 2025**

WITHDRAWN

L5

Culvert Management

Culvert (Paddock 101)

WITHDRAWN

IMPACT OF CONTAMINATION + LIKELIHOOD OF CONTAMINATION = HIGH RISK RATING

DESCRIPTION:

The culvert joining paddocks 101 and 86 is blocked resulting in the build-up of water in the surrounding paddocks. This will result in contaminants including phosphorus and sediment being washed off the adjacent paddocks in the flood waters. Unblock the culvert and ensure it is adequately sized.

Estimated Reduction in Phosphorus: >0 Kg/P

GPS Co-ordinates: 1202642, 4885331

IMAGES:

OPEN ACTIONS:

Unblock Culvert - Paddock 101

Unblock the culvert and ensure it is adequately sized.

TARGET DATE: **1 Aug 2019**

LAND MANAGEMENT

L6

Erosion Control

Gully Paddock 27

WITHDRAWN

IMPACT OF CONTAMINATION + LIKELIHOOD OF CONTAMINATION = LOW RISK RATING

DESCRIPTION:

Fencing of the gully/ephemeral waterway through paddock 27 has taken place. There is a section of hill above the fence line that is steep and suffers from erosion. This area has minimal productive value and could be fenced out to reduce sediment and subsequent phosphorus loss. Planting of the area in low natives such as red tussock and toetoe would help prevent erosion and filter run-off from the adjacent paddock.

Estimated Reduction in Phosphorus: >0 Kg/P

GPS Co-ordinates: 1203246, 4885068

IMAGES:

OPEN ACTIONS:

Exclude Stock from Hill Face (Paddock 27)

Extend the fence around the waterway flowing through paddock 27 so it excludes stock out of the steep gully face that is beginning to erode. This area could be planted in red tussock and toetoe to help with stabilisation and for aesthetic reasons.

TARGET DATE: **1 Aug 2022**

WITHDRAWN

L7

Critical Source Area

Crossing - Paddocks 6 & 7

WITHDRAWN

IMPACT OF CONTAMINATION + **LIKELIHOOD OF CONTAMINATION** = **LOW RISK RATING**

DESCRIPTION:

Crossing and low point in paddock between paddocks 6 and 7. Water and contaminants can flow of this area into the adjacent drain. The riparian buffer should be moved out at the top of the drain to allow for filtration of overland flow. Maintain this area in rank grass.

Estimated Reduction in Phosphorus: >0 Kg/P

GPS Co-ordinates: 1203014, 4885107

IMAGES:

OPEN ACTIONS:

Extend Riparian Margin (Drain Paddock 6 & 7)

Extend the riparian margin of the drain, below the crossing from Paddocks 6 & 7. Keep the riparian margin in rank grass to filter run-off from the adjacent crossing and paddocks.

TARGET DATE: **1 Aug 2022**

LAND MANAGEMENT

L8

Sediment Trap

Sediment Trap (Paddock 58)

WITHDRAWN

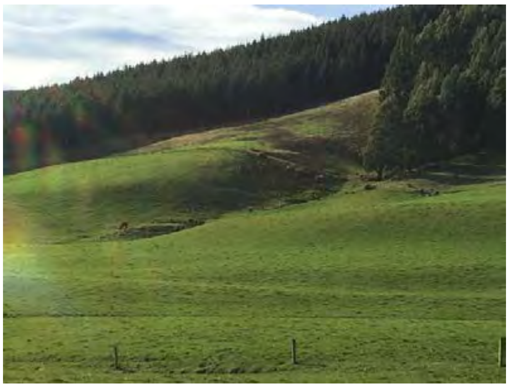
DESCRIPTION:

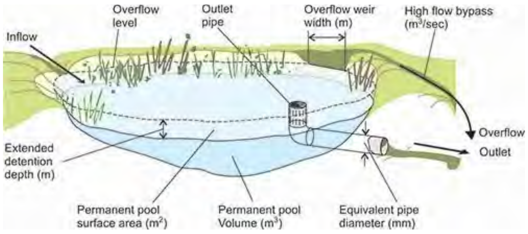
A number of critical source areas enter into a small waterway running down the side of the pine trees on the boundary of paddock 58. There is the potential to construct a sediment trap in the upper section of this area following the harvesting of the pine trees. This will assist in trapping sediment and any sediment bound phosphorus, preventing it reaching the main surface waterways on the farm. This is an aspirational, long term project and has not been factored into current phosphorus reduction figures.

Estimated Reduction in Phosphorus:	Not Calculated - Long Term Project

GPS Co-ordinates: 1202743, 4885650

IMAGES:





WITHDRAWN

OPEN ACTIONS:

Sediment Trap Installation (Paddock 58)

There is potential to construct a sediment trap in the upper section of the pine plantation on the boundary of paddock 58, following the harvesting of the trees. This will assist in trapping sediment and any sediment bound phosphorus, preventing it reaching the main surface waterways on the farm. Long term, aspirational project.

TARGET DATE: **1 Aug 2025**

Dairy Green Ltd

Practical Engineering Solutions

Consents, Effluent, Stock water, Irrigation

Design through to Installation

Irrigation NZ Accredited Designer

Woldwide Farming Group:

Woldwide One Limited and Woldwide Two Limited

27/3/2019

Application for:

- Land Use Consent for Use of Land for Dairy Farming – Replacement of **20171278-03**
- Discharge Permit – Replacement of **301663** and **20171278-01** under one discharge permit
- Water Permit – Replacement of **301664** and **20171278-02** under one water permit

Farm Location: Heddon Bush

Application prepared on behalf of applicant by:

Dairy Green Ltd

10 Kinloch Street, PO Box 5003, Waikiwi, Invercargill 9843

Phone (03) 2154381

Email scandrettrural@xtra.co.nz

Table of Contents:

Key

ES	Environment Southland
HB	Horner Block
IWG	Intensive winter grazing
pSWLP	proposed Southland Water and Land Plan (2018)
PZ	Physiographic Zone
WW1	Woldwide One Limited
WW1&2	Woldwide One and Woldwide Two dairy farm
WRO	Woldwide Runoff – Merrivale and Merriburn blocks
WW2	Woldwide Two Limited

1. Overview

1.1 Background

Background

Woldwide One Limited (WW1) and Woldwide Two Limited (WW2) operate two adjoining dairy farms situated at Heddon Bush, Central Southland. Both dairy farms are under the same ownership structure.

WW1 currently operates under an effluent discharge permit (AUTH-301663) and water permit (AUTH-301664). Both consents were granted a 15-year term and expire in 2027.

WW2 currently operates under a land use consent for expanded dairy farming (AUTH-20171278-03), effluent discharge permit (AUTH-20171278-01) and water permit (AUTH-20171278-02). All were granted a ten-year term and expire in 2027.

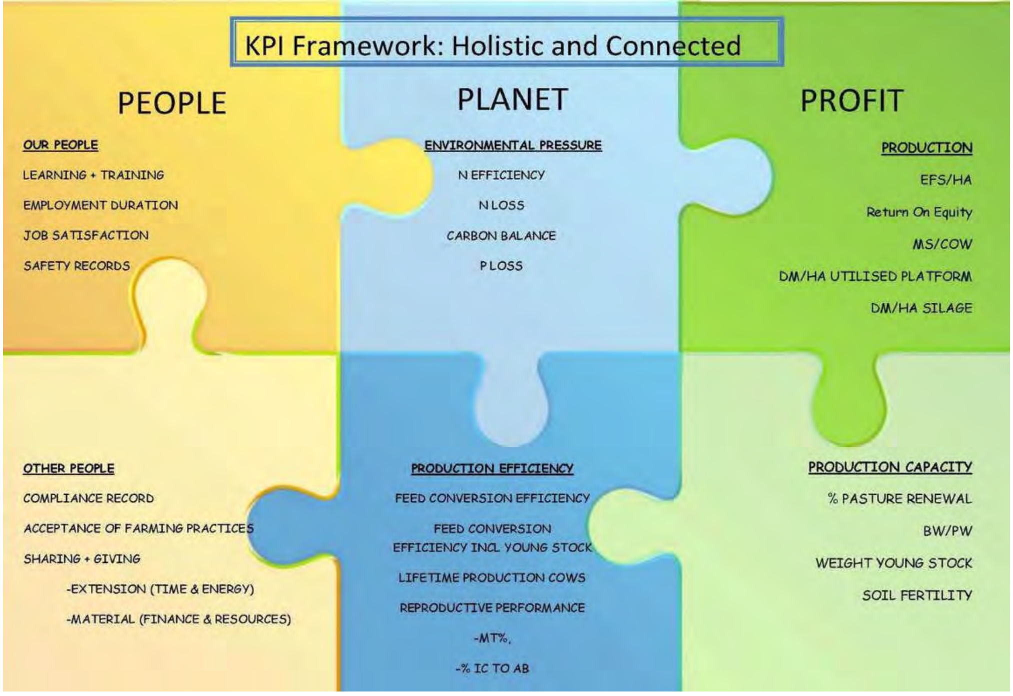
Both WW1 and WW2 utilise a nearby cut and carry block (Horner Block) to discharge pond slurry. The Horner Block is under separate ownership to the dairy platforms at WW1 and WW2 and is not part of either dairy platform. The discharge of agricultural effluent at the HB is authorised under respective effluent discharge permits for WW1 and WW2.

Both the WW1 and WW2 graze dry stock at Woldwide Runoff (WRO), which comprises the Merrivale and Merriburn blocks in the Merrivale/Western Southland area. WRO is under separate ownership to the dairy platforms at WW1 and WW2 and has significant areas under forestry.

Applicant's philosophy

In the words Abe and Anita de WW1de from the Woldwide Farming Group:

Sustainability (environmental, economic and social) has been at the core of all we do at Woldwide Farming group. To us these principles flow out of a desire to be good stewards, and they are all interlinked as shown in the picture.



KPI Framework: Holistic and Connected

PEOPLE

OUR PEOPLE
LEARNING + TRAINING
EMPLOYMENT DURATION
JOB SATISFACTION
SAFETY RECORDS

OTHER PEOPLE
COMPLIANCE RECORD
ACCEPTANCE OF FARMING PRACTICES
SHARING + GIVING
-EXTENSION (TIME & ENERGY)
-MATERIAL (FINANCE & RESOURCES)

PLANET

ENVIRONMENTAL PRESSURE
N EFFICIENCY
N LOSS
CARBON BALANCE
P LOSS

PRODUCTION EFFICIENCY
FEED CONVERSION EFFICIENCY
FEED CONVERSION EFFICIENCY INCL YOUNG STOCK
LIFETIME PRODUCTION COWS
REPRODUCTIVE PERFORMANCE
-MT%,
-% IC TO AB

PROFIT

PRODUCTION
EFS/HA
Return On Equity
MS/COW
DM/HA UTILISED PLATFORM
DM/HA SILAGE

PRODUCTION CAPACITY
% PASTURE RENEWAL
BW/PW
WEIGHT YOUNG STOCK
SOIL FERTILITY

We were the first to build free stall barns in Southland to reduce outside crop wintering and we were the first (and only) ones to feed fresh grass to our cows in winter to reduce silage making losses and runoff. In 2013 we were supreme winners of the Southland Ballance Farm Environment Awards.

Ever since we came to New Zealand we have been trying to improve the sustainability of our farms with a long decision-making horizon and an innovative mind-set. We have now come to a point in our farming career where we wish to cap our growth ambitions and truly focus on environmental sustainability. Keeping our stock off wet soils in winter is pivotal in this endeavour. We aim to have all our adult stock from all our farms indoors within five years (and work on housing all young stock after that). We believe wintering animals outside on wet soils is very damaging for the following reasons:

- *Nitrogen is lost because it is deposited on the ground (in the mud) when there are no plants actively taking it up and locking it in.*
- *Sediment and top soil are displaced because of the following reasons:*
    - *The ground is disturbed when it is wet*
    - *Root structures are destroyed*
    - *Overland flow (of Phosphate, sediment, bacteria) increases due to soil compaction*
    - *Rain events during cropping season when soils are worked up fine and crops have not yet established can be very risky*
- *Lots of chemicals are used in the cultivation of winter crops*
- *It takes 85 m of wrap to produce a bale of baleage and we want to reduce our reliance on this*

We are convinced that 90 % of the environmental issues caused by farming in Southland stem from the 10 % of ground that is winter cropped. Just because something is common practice does not mean that the effects are acceptable. It is time to change this!

It needs to be kept in mind though that land- previously used for winter cropping- is vacated under our new plans and a small increase of stock numbers is needed to make up for that.

Our passionate desire is to go beyond compliance and to produce top quality food with a reduced environmental footprint. And that is the mindset behind this application.

Application history

In 2017, WW2 was granted consent for expanded dairy farming. This involved the addition of new land previously used for dairy support (i.e. SH96 and Marcel blocks) into the milking platform. In parallel with this, some land was removed from WW2's milking platform to be added to WW1's milking platform. WW2 cow numbers did not increase as part of the dairy expansion; they remained at 800. The SH96/Marcel support block, which came into WW2's milking platform as part of the expansion, had been used to graze young stock, winter graze cows/heifers on fodder crop and grow supplement (pasture silage). The discharge permit was replaced to allow for the new boundary, effluent discharge area and an increase in the size of a wintering barn. WW2's water permit was also replaced in 2017.

Agricultural effluent from WW1 and WW2 is discharged at low depth at respective dairy farms and at the Horner Block, located to the south west. The Horner Block is a cut and carry block, used to grow grass to supply various dairy farms, and receives slurry effluent from WW1, WW2 and the Woldwide Three dairy farm (which is not included in this application). The Horner Block does not graze stock.

In 2017, an application for expanded dairy farming at WW1 was submitted to Environment Southland (ES), which was publicly notified. During the notification process, the decisions version of the proposed Southland Water and Land Plan (2018) was released. Following discussions and advice from stakeholders including Environment Southland, based on many factors including how best to model pre-expansion land use, the applicants put WW1's application on hold and opted to submit a new application. The new application was submitted to ES in August 2018 and aimed to bring the WW1 and WW2 dairy farms under a single land use consent for dairy farming. The application was accepted by ES, with extensive information provided under s92 (1), at several meetings and at a site visit.

WW1&2's 2018 consent application was publicly notified by ES. An error was made during the notification process, which made the notification illegal according to legal opinion. In view of the ES error resulting in illegal public notification and following collaborative discussions on the best way forward, the applicants agreed to withdraw the consent application, address certain issues identified by ES in the s95 report and resubmit the application. This application aims to bring the WW1 and WW2 dairy platforms under a single land use consent for dairy farming and to resolve certain issues identified by ES with the 2018 application.

As is explained in section 2.1, the name of the new consent holder on the land use consent for dairy farming, the discharge and water permits will be "Woldwide One Limited and Woldwide Two Limited."

Request for public notification of application

Based on the application's history, the applicants hereby request that the consent authority publicly notify this application in accordance with s95A of the Act.

Landholding

The pSWLP defines a landholding as land held in one or more than one ownership, that is utilised as a single operating unit. The pSWLP specifies that a "single operating unit" may include, but is not limited by, effective control by any structure of ownership of the same group of people and being operated as a single business entity.

Land utilised as a "single operating unit" is defined as a landholding, and under the definition is under the effective control of the same ground of people **and** operated as a single business entity. To be part of a given landholding, both parts of the definition must be met. Where there is effective control by the same group of people, the critical test is whether land is operated as a "single business entity" or not.

HORNER BLOCK:

- The Horner Block is a nearby 160-hectare block used for cut and carry to supply various dairy farms, including but not limited to WW1 and WW2. It is used to discharge effluent from WW1, WW2 and WW3. No stock is grazed there.

- The Horner Block is owned by Woldwide Farm Limited and forms a small part of Woldwide Farm Limited's business.

- Woldwide Farm Limited trades with all Woldwide entities as well as external farms and companies.

- Woldwide Farm Limited has its own staff, accounts and management. It owns no cows or young stock, does not need WW1 or WW2 to be a successful business and is not a dairy farm.

- Woldwide Farm Limited undertakes feed trading, contracting, logistics, supply management, machine hire, office support and knowledge support.
  Some examples:
    Feed trading: silage crops, fresh grass, hay and baleage, concentrates and grain
    Contracting: ground work and pasture renewal, digger work and lane maintenance, fencing
    Winter grazing at various locations (not Horner Block): young stock and MA cows
    Logistics: carting concentrates from Bluff and Invercargill, baleage from runoff, manure from dairy farms etc.
    Supply management: trace elements, oil,
    Machine Hire: tractors, feed augers, trailers, truck, other implements
    Office support: books are kept separate
    Knowledge support

- The only service that WW1 and WW2 exports to the Horner Block is the discharge of slurry to 97 hectares of the block. Slurry is also discharged at WW1&2. Liquid effluent from the dairy sheds is only discharged at WW1&2. No grazing of cows or IWG of fodder crop is carried out at the Horner Block. The primary purpose of the Horner Block is not to support the dairy farms at WW1&2

- Although some slurry generated at WW1&2 is discharged at the Horner Block, the use of the Horner Block is not central to operations at WW1&2 dairy farm. As such, the Horner Block does not form a single business entity with WW1&2.

- Since the Horner Block is not operated as a single business entity with WW1&2, it does not form a single operating unit with WW1&2 and is therefore not part of WW1&2's landholding.

- Actual and potential effects from the discharge of slurry from WW1&2 at the Horner Block landholding are considered in the AEE for the farming activity, since they are part of the overall farming activity.

- The discharge of slurry effluent from WW1&2 at the Horner Block will be covered by a separate discharge permit. Accordingly, an application for the discharge of slurry effluent from WW1&2 at the Horner Block is included in this application.

LEGAL OPINION

Legal opinion was sought by ES in 2018 on whether the Horner Block is part of the landholding at Woldwide 1&2. Although the LO was not sought in relation to this application, the applicants believe it is relevant to this application since it addresses the same blocks of land, activities, structures and entities.

An Addendum to an original LO was provided by Wynn Williams on 8 October 2018, which clarified that the Horner Block is not considered to form a "single operating unit" with Woldwide 1&2. The LO Addendum stated (p.8) that "*It is unlikely that by only exporting one aspect of its farming operations to the Horner Block (i.e. the discharge of sludge), Woldwide 1 & 2 is utilising the Horner Block as part of a "single operating unit." This is different than if Woldwide 1 & 2 was intending to utilise the Horner Block for multiple aspects of its farming operations and if its use of the Horner Block was central to its overall farming operation. Accordingly, we consider that the Horner Block is not part of Woldwide 1 & 2's "landholding" for the purposes of their respective applications under Rule 20 of pSWLP*."

The original LO and Addendum are appended to this application. Please see for further details.

WOLDWIDE RUN-OFF (WRO)

Environment Southland hold the view that WRO forms part of the landholding at WW1&2 and while not part of this application, ES also view that WRO is part of respective landholdings at WW4 and WW5. With respect to Council's view and for this application to be accepted by Council under s88, WRO has been included in the landholding at WW1&2 and is included in the application for the use of land for farming.

It is the applicant's view that WRO is not part of the landholding for WW1&2. The applicants wish to place this issue in front of the hearing decision maker where it provides a forum and opportunity for discussion and consideration of both points of view.

Current application

The proposal seeks to add 160 cows to WW1&2, in conjunction with making several changes to the farming activity to off-set potential effects from additional cows. The applicants believe that over time there will be a cumulative reduction in contaminant loss due to the proposed land use. Holistically, they will achieve better nutrient management on farm, improved soil organic matter content/less mineralisation, improved water holding capacity and soil structure, less N accumulation at high risk times, and less pugging of soils and runoff. Consequently, they believe there will be less contaminant loss to water and less risk of adverse effects on ground and receiving surfacewaters.

A high level of investment has been required in the planning and implementing of changes, which demonstrates the applicants' commitment and determination to achieve their aim of greater environmental sustainability in the long term. Farm profitability and economic security must be maintained for this to happen; this will be achieved through milking 160 additional cows on land previously used for activities such as IWG at WW1&2.

Nutrient budget analysis shows that the proposed land use at WW1&2 has below average N loss (kg/ha/year) compared to all Fonterra dairy farms within a 20 km radius, many of whom winter some or all MA cows off farm (see section 7.3.1). The proposal includes the wintering of 1,250 cows in barns at WW1&2 and still manages to have below average N loss compared to a regional average (20 km radius); this achievement demonstrates how the applicants mitigate and minimise contaminant losses across the whole activity, which in turn mitigates and minimises effects in groundwater and receiving surfacewaters.

WRO grazes dry stock from WW1&2, among a range of other activities not related to WW1&2. Under the proposal, WRO will continue to be used to graze dry stock from WW1&2, including IWG activities. The applicants seek to continue to manage WRO sustainably, improving soils and production while minimising contaminant losses to ground and surfacewaters.

Slurry effluent from WW1&2 will continue to be discharged at very low depth to part of the Horner Block. The applicants seek to manage the Horner Block sustainably and will reduce fertiliser inputs to account for nutrients applied from slurry. They aim to maintain soils and production at the Horner Block while minimising contaminant losses to ground and surfacewaters.

Land use consent for farming

It is proposed to replace WW2's land use consent for dairy expansion (20171278-03) with a land use consent for dairy farming to include the land areas contained by both WW1 and WW2 dairy platforms and WRO. The land area of the dairy platform is not increasing. The proposed dairy platform will contain two milking sheds and two wintering barns. At an operational level, WW1 and WW2 will be run as individual dairy units. WRO will be used to run dry stock and for supplement production (among other activities not related to the farming activity at WW1&2). Only land areas at WRO linked to operations at WW1&2 will be authorised on the land use consent, e.g. forestry land will be excluded.

It is proposed to increase cow numbers milked to 1,500. Currently a total of 1,340 cows are authorised; 540 at WW1 and 800 at WW2. The proposal represents an increase of 160 milking cows or 11% overall. The increase will occur at the WW1 unit where the herd size will go from 540 to 700. Land previously used for fodder cropping/IWG at WW1&2 has been freed up by the removal of these practices and is available to graze milking cows.

It is proposed to increase the maximum number of animals (cows/heifers) wintered in barns to 1,250. The barn and effluent system have already been upgraded to cater for the additional cows and effluent.

To allow for the proposed activity, resource consent is being sought under **Rule 20 e)** of the pSWLP, for the ongoing use of the land for dairy farming including an increase in cow numbers. The expansion does not include an increase in the dairy platform's land area as all land was either within the dairy platform prior to 30 June 2016 or was authorised for dairy farming through a dairy expansion land use consent that was granted in 2017. As is described in Section 2, **this is a discretionary activity**.

The proposed activity has been considered in terms of key pSWLP policies and based on this assessment should be granted. Effects on the existing environment have been considered and assessment in accordance with Schedule 4 of the RMA. The assessment concludes that effects on receiving surfacewaters, groundwater and soils, including cumulatively, will be no more than minor due to the proposed activity.

Overseer nutrient budgets

Overseer is a useful tool to understand the nutrient interactions of a farm system based on soil properties, rainfall, drainage, feed requirements and other factors. The output from the model gives an indication of how much nutrient may be lost to the environment. Overseer nutrient budget analysis has been carried out using Overseer version 6.3.1 and using "Overseer Best Input Standards, March 2018." The increase in cow numbers will occur in parallel with significant land use changes, which act as key mitigation measures and are modelled in Overseer where possible.

NUTRIENT BUDGETS - WW1&2 DAIRY FARM Four pre-expansion nutrient budgets were prepared and one proposed post-expansion nutrient budget for 1,500 cows. The pre-expansion nutrient budgets were derived by modelling the actual lawful use of land and not by modelling consented maximums. The inputs used in pre-expansion nutrient budgets are supported with evidence, which is appended to the nutrient budget analysis report. Where the analysis report states that the land area is being increased by bringing in support land, this refers to the SH96 and Marcel Blocks, which were authorised for dairy farming as parts of WW2's land use consent granted in 2017.

~~All nutrient budgets model the same land areas, i.e. former WW1 and WW2 milking platforms, SH96 and Marcel blocks. Overseer predicts that:~~

- ~~The average N loss will decrease slightly from 41 kg/ha/year to 40 kg/ha/year, despite an additional 160 cows; and~~
- ~~The average annual P loss will remain at 0.7 kg/ha despite an additional 160 cows.~~

~~By using P loss as a proxy for sediment and microbial losses, there will be no increase in loss of sediment or microbes.~~

NUTRIENT BUDGETS - THE HORNER BLOCK Prior to obtaining legal opinion to the contrary, ES regarded the HB to be part of the landholding at WW1&2. Based on this, one pre-expansion nutrient budget (17/18) and one proposed nutrient were prepared for the Horner Block and submitted with the 2018 consent application. Since nutrient budgets were already prepared for the HB, they are included in this application as a useful source of information and are used appropriately in the AEE.

NUTRIENT BUDGET – WORLDWIDE RUNOFF

A 17/18 year-end nutrient budget has been prepared for WRO, provides guidance on activities and nutrient losses in the 17/18 year, and is used to inform the AEE.

Discharge and water permits

It is proposed to replace existing discharge permits (301663, 20171278-01) with a single discharge permit managing effluent from the WW1 and WW2 dairy units, and to replace existing water permits (301664, 20171278-02) with a single water permit for groundwater abstraction from both WW1 and WW2. The proposed discharge permit will allow for the discharge of agricultural effluent (dairy shed, wintering barn, silage pad and underpass) to land from 1,500 cows. **It is proposed to include the current irrigation methods in the discharge permit, i.e. travelling irrigator, trailing shoe slurry tanker, umbilical system; as well as to future proof the discharge activity by also including low rate irrigation.** The proposed water permit will allow for groundwater abstraction for dairy shed and stock drinking water for 1,500 cows.

Slurry

Existing discharge permits for WW1 and WW2 authorise the discharge of herd home slurry and effluent slurry respectively. Despite this, slurry is not defined in the pSWLP or RWP. An AgResearch study[1] classifies slurry as an effluent product with 5-15% DM content. FDE is classed as having less than 5% DM content and solid manures as having greater than 15% DM content. The material stored in the ponds at WW1 and WW2 is a slurry due to the large contribution of undiluted wintering barn effluent. Since the discharge of slurry is authorised on both existing discharge permits for WW1 and WW2 and the material stored in the ponds meets the description in the AgResearch paper, the term has been used to describe pond material in the replacement discharge permit application.

Horner Block

Existing discharge permits for WW1 and WW2 authorise discharge of agricultural effluent the Horner Block. The Horner Block currently receives agricultural effluent from three dairy farms; WW1, WW2 and Woldwide Three. It is proposed that Woldwide Three’s discharge area will remain mutually exclusive.

The discharge areas currently authorised to receive effluent/slurry from WW1 and WW2 will be blocked as a single slurry receiving area. **It is proposed that the discharge of slurry effluent from WW1&2 to 97 hectares at the Horner Block will be covered by a separate discharge permit**. The Horner Block will not be authorised on the proposed discharge permit for WW1&2. The Horner Block will continue to be run for cut and carry, and as a slurry receiving area.

Land use consent for feed pad/lots - wintering barns

Under Rule 35A of the pSWLP, the use of land for two wintering barns at WW1&2 is a discretionary activity as at least one of the conditions of Rule 35A (a) is not met. Applications for consent for the use of land for two feed pad/lots accompanies this application.

---

[1] Houlbrooke, Longhurst, Orchiston and Muirhead (2011). Characterising dairy manures and slurries. AgResearch Report.

1.2 Property Details

Overview

WW1&2 is an existing dairy farm with required dairy infrastructure for two units and is located within both the Oreti River and Waimatuku Stream catchments at Hundred Line Road, Heddon Bush. It consists of 502 hectares of land, with an effective farm area of 479 hectares.

The slurry-receiving Horner Block is located within both the Waimatuku Stream and Aparima River catchments at Hundred Line Road, Heddon Bush and consists of 160 hectares of land, with an effective farm area of 155 hectares.

WRO is a dry stock grazing block (892 ha) for all Woldwide dairy farms, which also contains a commercial forestry operation, native bush block, commercial gravel extraction operation and land for supplement production. Activities at WRO are described in detail in the WRO section of this application.

Within the last five years, WW1&2 was managed as two dairy units (WW1 and WW2) and a support block (SH96 and Marcel Block). The SH96 and Marcel Block were authorised for dairy farming as part of WW2's land use consent for expanded dairy farming granted in October 2017. The Horner Block was used for winter grazing and heifer grazing in the past, but in recent years has been used for cut and carry, and as a discharge area.

It is proposed that two dairy units will continue to be operated at WW1&2. Cows will be milked for seasonal supply through two dairy sheds, 700 at the WW1 unit and 800 at the WW2 unit. All cows will be wintered in two existing wintering barns. The wintering barns will be used at times to house cows in the shoulders of the season and as stand-off pads during inclement weather throughout the year to reduce soil damage, pugging and runoff.

The Horner Block will continue to be used as an area to discharge slurry from two effluent storage ponds at WW1 and WW2. Pasture silage and fresh grass is harvested from the Horner Block and fed to cows at dairy farms, including but not limited to WW1 and WW2.

Table 1.1 General property details – WW1&2, Horner Block

Property details	
Dairy platform - total farm area (ha)	502
Dairy platform - effective farm area (ha)	479
Dairy platform - size of effluent disposal area (ha)	c.400
Dairy platform - stocking rate (cows/ha)	3.1
Horner Block – total area (ha)	160
Horner Block – effective area (ha)	155
Horner Block – slurry effluent area (ha) for dairy platform (WW1&2 only)	97
Legal descriptions – WW1&2 dairy platform	Part Lot 18 DP 942 Section 420 Taringatura SD Part Lot 1 DP 4092 Part Lot 18 DP 942

	Part Lot 2 DP 4092 Part Lot 1 DP 4092 Part Section 417 Taringatura SD Section 418 Taringatura SD Section 419 Taringatura SD Lot 1 DP 9925* (leased - Gavin Andrew Dykes) Lot 1 DP 14660 Lot 1 DP 14661 Lot 1 DP 451158 (leased - John Desmoulins Pine & Christina Florence Pine) Lot 1 DP 13077 (leased - John Desmoulins Pine & Christina Florence Pine) Lot 1 DP 5610 Lot 3 DP 5610 Lot 1 DP 10885
Legal descriptions – Effluent discharge area at WW1&2	Part Lot 18 DP 942 Section 420 Taringatura SD Part Lot 1 DP 4092 Part Lot 18 DP 942 Part Lot 2 DP 4092 Part Lot 1 DP 4092 Part Section 417 Taringatura SD Section 418 Taringatura SD Section 419 Taringatura SD Lot 1 DP 14660 Lot 1 DP 14661 Lot 1 DP 5610 Lot 3 DP 5610 Lot 1 DP 10885
Legal descriptions – Effluent discharge area at Horner Block	Lot 4 DP 399915

*Part of Lot 1 DP 9925 is leased by the applicants and is already within the boundary of the existing land use consent for dairy farming (see figure 1.1).

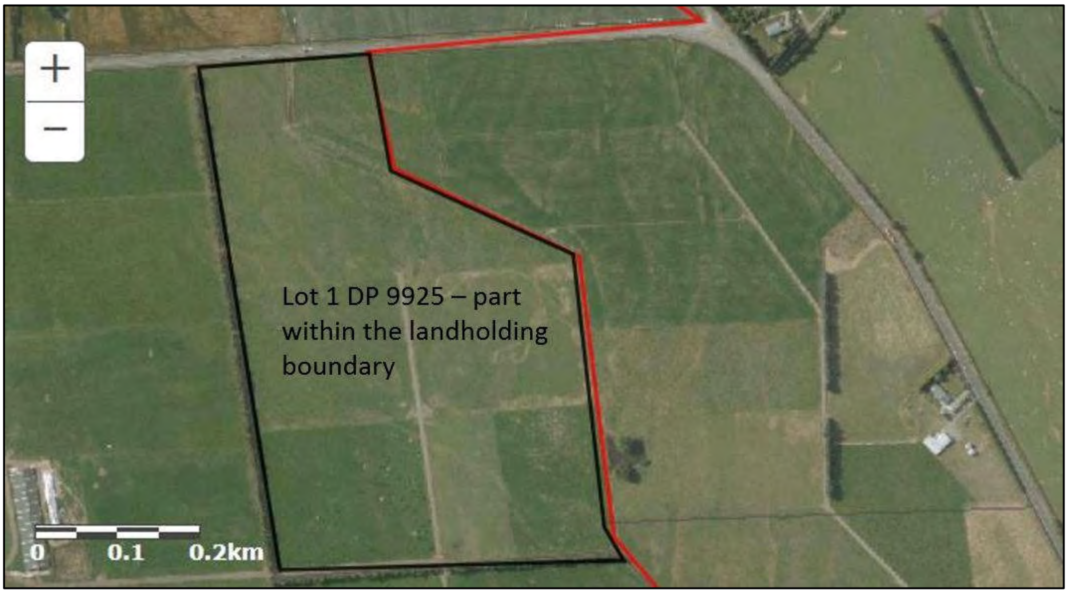


Figure 1.1 Part of Lot 1 DP 9925 within the landholding boundary at WW1&2.

Table 1.2 General property details – WRO

Property Details – WRO	
Property address	20 Gill Road – Merrivale block 1711 Otautau Tuatapere Road – Merriburn block
Property owner(s)	Woldwide Runoff Ltd
Legal Description	Merrivale Block: Part Section 7 Block XII Waiau SD Part Section 7 Block XII Waiau SD Part Section 7 Block XII Waiau SD Lot 1 DP 3537 Merriburn Lease Block: Lot 1 DP 302409 Sec 26 Merrivale Settlement No. 1 Sec 27 Merrivale Settlement No. 1
Property area (ha)	507 ha total, 321 ha effective – Merrivale 385ha total, 338 ha effective – Merriburn
Location	NZTM 1201022, 4893762 – Merrivale NZTM 1200812, 4890495 – Merriburn

Effluent

Existing discharge conditions

Agricultural effluent from WW1 and WW2 dairy operations are currently managed by way of two existing discharge permits **(301663, 20171278-01)**, which expire on the 9th of November 2027 and 18th October 2027 respectively. WW1's existing discharge consent is for a 540-cow herd milked twice a day and from herd home slurry from a maximum of 400 cows. WW2's existing discharge consent is for an 800-cow herd milked twice a day and from herd home slurry from a maximum of 640 cows. WW2's existing discharge permit also provides for effluent from an underpass and a silage pad.

The authorised discharge method at WW1 includes land disposal methods limited to maximum application depths of 10 mm and 5 mm per application. The consented discharge methods at WW2 include a low depth travelling irrigator, umbilical system and slurry tanker with a trailing shoe. The travelling irrigator has a maximum application depth per application of 10 mm. The umbilical and trailing shoe slurry tanker systems have a maximum depth per application of 5 mm.

The existing operations do not involve winter milking.

Existing FDE areas

WW2's discharge area includes 194 hectares of land at WW2, and 42 hectares of land at the Horner Block. Liquid effluent is discharged at WW2 and slurry effluent from WW2's pond is discharged at the Horner Block. Council recommended buffers are implemented at WW2, except for a buffer of 100 metres from land known as Lot 3 DP237. WW1's discharge area includes most of the milking platform and another part of the Horner Block. Council recommended buffers are implemented when discharging liquid or slurry effluent at WW1.

Existing effluent storage infrastructure

WW1 and WW2 allow for deferred irrigation when soils are near or at field capacity by storing raw effluent (slurry) in two large effluent ponds, one for each operation. Both ponds receive dairy shed effluent when soil moisture conditions are unsuitable for irrigation, and wintering barn effluent from the barns. The WW2 pond also receives silage leachate from WW2's concrete silage pad. The material in the ponds is a slurry due to the major contribution of dung and urine from the free stall wintering barns. Consequently, both ponds always have a crust.

Ancillary structures at both the WW1 and WW2 units that contain, store or treat effluent are sand traps, dairy shed pump sumps and wintering barn collection sumps.

Further information on the ponds and ancillary structures is provided in sections 2, 6 and 7.

Proposed changes to effluent management and permit

It is proposed to replace existing discharge permits **(301663, 20171278-01)** with a single discharge permit covering effluent from WW1 and WW2 at WW1&2. The proposed discharge permit will allow for the discharge of agricultural effluent (dairy shed, wintering barn, silage pad and underpass) to land from 1,500 cows; 700 cows at WW1 and 800 cows at WW2. Proposed irrigation methods are all methods described in table 1.3.

It is proposed to authorise the discharge of slurry effluent from the ponds at WW1&2 at the Horner Block through a separate discharge permit. The irrigation methods at the Horner Block will be slurry tanker with the trailing shoe and umbilical system as described in table 1.2.

Table 1.3 Proposed effluent irrigation methods

Method	Usage	Conditions
Low depth travelling irrigator	Apply dairy shed effluent to land	A maximum depth per application of less than 10 mm
Low depth slurry tanker with a trailing shoe	Apply pond slurry to land	A maximum depth per application of 2.5 mm
Low depth umbilical system	Contingency measure – apply pond slurry to land	A maximum depth per application of 3.0 mm
Low rate pods	*Future proof - Apply dairy shed effluent to land	A maximum instantaneous rate of 10 mm/hour at a depth of less than 10 mm

Low rate cannon/rain gun	*Future proof - Apply dairy shed effluent to land	A maximum instantaneous rate of 10 mm/hour at a depth of less than 10 mm

*To future proof the discharge activity, it is proposed to include low rate irrigation methods as described in the above table. This will allow the applicants to upgrade their effluent system in the future without the need to vary the discharge permit.

Overall, the proposed discharge area includes most of WW1&2 and the existing area at the Horner Block that receives agricultural effluent from WW1 and WW2, less standard buffers. Significant areas of low risk soils are available. Slurry from the ponds will be applied at very low depth via the trailing shoe slurry tanker or umbilical system at both the Horner Block and at WW1&2.

No affected party approvals are required.

No change in effluent storage is proposed. According to the Massey DESC, the 90% probability volume for 1,500 cows including wintering barn effluent and silage leachate is 6,460 m^3. The existing storage capacity is 8,032 m^3, so is sufficient to meet the above requirements. The wintering barns will house a maximum of 1,250 cows despite having capacity for 1,280. Two separate DESC reports have been run, one each for the WW1 and WW2 units respectively. This ensures that each unit has enough storage for its operation.

Wintering

WW1&2

In the past, cows and heifers have been intensively winter grazed on fodder crop and heifers also have been grazed on pasture over winter. In more recent years, cows have been wintered in barns, but in-calf R2 heifers have been IGW on fodder crop and R1 heifers have been grazed on pasture over winter. These practices are fully accounted for in respective year end nutrient budgets - please refer to section 9.3 of the nutrient budget report for details.

Under the proposal, the practices of IWG and grazing stock on pasture over winter at WW1&2 will cease. No animals will be IWG on fodder crop and no heifers will be grazed on pasture over winter at WW1&2. All cows and some heifers will be wintered in two wintering barns over June and July.

1,500 is the maximum cow number, which generally will be seen at peak milking in Oct/Nov. As is standard practice on dairy farms, cows are culled as the season progresses with the main cull occurring in May/start of June. This reduces the MA cow number significantly and accordingly, reduces the number of MA cows to be wintered from the start of June. Typically, the cull rate sits at approx. 25% with minor variation from year to year. Assuming a culling rate of 25%, then approximately 375 MA cows will be culled by the end of the season leaving 1,125 MA cows to be wintered. A maximum of 1,250 animals will be housed in the barns over June/July, leaving space in barns for 125 R2 heifers.

From May 2019, cows will also be housed in wintering barns for part of May, August and September during inclement weather as required. Early calving cows will return to pasture in August, where they calve. Late calving cows will remain in the wintering barns until they are ready to calve in September. Cows are fed freshly cut grass and pasture silage in barns. The wintering barns are also used as stand-off pads during inclement weather during the milking season.

At WW2's wintering barn, a maximum of 625 cows are housed over winter. It is proposed to increase WW1's wintering barn authorised cow number from 400 to 625, to accommodate an additional 225 animals. WW1's wintering barn has already been upgraded to meet the needs of additional animals. Effluent storage at WW1 has been increased so can accommodate effluent from additional animals in the wintering barn.

In the 17/18 winter, WW1's barn housed 400 cows and was assessed as grade 1/fully compliant at an inspection by Environment Southland.

WRO

Wintering activities include IWG by dry stock on fodder crop. Under the proposal, the annual area under IWG will not exceed 100 hectares. All R1s will be IWG at WRO. R2s will either be housed in barns at WW1&2 (c.125) or will be IWG at WRO. Please see the WRO section of the application for a detailed description of existing and proposed wintering activities.

Young stock from WW1&2

To date, grazing of young stock has been carried out as a permitted activity. The replacement rate sits at 25% with minor variation from year to year. At a 25% replacement rate, 375 R2s join the milking herd each year. Due to culling/deaths, a further 10% replacement calves are kept ensuring 375 R2s are available to join the milking herd.

R1 heifer calves leave WW1&2 to go to WRO when they reach a minimum of 90 kg live weight (~November). All R1 heifers are IWG at WRO in June/July. R1s transition into R2s, and at about 15 months of age R2s are mated.

Heifer numbers at WRO reduce by approximately 10% due to death and culling. The heifer number reduces from 417 to 375 by the time R2 heifers return to WW1&2 for calving.

To date, R2s leave WRO to be IWG over June and July at various other blocks such as SH96/Marcel and at WW5. Under the proposal, in-calf R2s are either wintered in barns at WW1&2 (c.125) or at WRO (IWG).

Existing and proposed activities at WRO are described and assessed in detail in the WRO section of this application.

Cultivation

WW1 has been dairy farmed by the applicants since 1992, and most of WW2 has been dairy farmed by the applicants since 2003. Over this time soils have been developed sustainably, which is evident in fertiliser and agronomy reports for WW1, WW2 and the Horner Block from the fertiliser supplier (Ravensdown) – see Appendix. Summer and winter fodder crop cultivation has been carried out to provide feed for cows/heifers over summer dry periods and winter respectively. It is proposed to cease the practice of growing fodder crops at WW1&2, as a key mitigation measure to off-set additional cow numbers. The re-grassing policy will meet permitted activity rules as per Rule 25, will occur by direct grass to grass cultivation and is described in respective FEMPs.

Fodder crop (kale) is grown at WRO to provide feed for dry stock over winter. Under the proposal, the area sown in fodder crop and IWG will not exceed 100 hectares. Please see the WRO section of the application for details. Cultivation practices at WRO meet permitted activity rules as per Rule 25 of the pSWLP.

Groundwater abstraction

Groundwater is abstracted from three bores at WW1&2 for use at two dairy sheds and to supply stock drinking water to 1,500 cows. The maximum daily volume of groundwater abstracted to meet the needs of 1,500 cows is 180,000 litres.

At the WW2 unit, two bores supply groundwater. One bore (E45/0083) is located to the west of the dairy shed with a second bore (E45/0727) at the north of the block, close to Wreys Bush Highway. The maximum daily volume of groundwater supplied to WW2 is 96,000 litres.

At the WW1 unit, the bore (E45/0071) is located to the west of the dairy shed and the maximum daily volume of groundwater supplied to WW1 is 91,000 litres. This represents an increase of 31,000 litres compared to the existing water permit for WW1 (#301664), which has a maximum daily take of 60,000 litres.

WRO has a stock drinking water scheme that meets permitted activity rules and does not require consent.

Table 1.4 Physical properties and information of land and water at WW1&2 and Horner Block.

<table>
<tr><td rowspan="6">Soils
Soil mapping on Topoclimate appears to be incorrect compared to actual soil types. Topoclimate maps Braxton soils as the dominant soil type, with Pukemutu being a minor soil type. Topoclimate maps an area of Glenelg on the east.
A soil survey field investigation carried out in 2017 by Scandrett Rural Limited is described in Section 5 and a separate report. It maps two dominant soil types; Braxton soils are found on the mid-west side (c.100 ha) and Drummond soils are found at the east. Drummond soils have intergrades of more shallow Glenelg soils in places. Drummond/Glenelg account for c.400 ha of soils.</td><td rowspan="2">Soil Type</td><td colspan="3">Vulnerability Factors</td></tr>
<tr><td>Structural Compaction</td><td>Nutrient Leaching</td><td>Waterlogging</td></tr>
<tr><td>Braxton</td><td>Moderate</td><td>Slight</td><td>Severe</td></tr>
<tr><td>Drummond</td><td>Minimal</td><td>Moderate</td><td>Slight</td></tr>
<tr><td>Glenelg</td><td>Slight</td><td>Very severe</td><td>Nil</td></tr>
<tr><td>Waiau</td><td>Moderate</td><td>Very severe</td><td>Nil</td></tr>
<tr><td>FDE Land Classification</td><td colspan="4">A – artificial drainage or coarse soil structure
E – other well drained but very stony flat land
Likely to be D – well drained flat land. FDE classification is primarily based on soil type. Incorrect Topoclimate mapping of WW1&2 means large areas of Braxton/Pukemutu (Category A) are mapped where a field investigation found Drummond soils (Category E).</td></tr>
<tr><td>Characteristics of FDE Classification</td><td colspan="4">A - high risk to surface water, low risk to groundwater
D, E – low risk to groundwater using low depth application, low risk to surfacewater</td></tr>
<tr><td>Topography</td><td colspan="4">Flat</td></tr>
<tr><td>Surfacewater management zone</td><td colspan="4">Waimatuku, Oreti (WW1&2)
Aparima (Horner Block)</td></tr>
<tr><td>Groundwater Zone</td><td colspan="4">Waimatuku, Central Plains</td></tr>
<tr><td>Groundwater Nitrate Levels</td><td colspan="4">0.1 – > 11.3 mg/L
A series of nitrate concentration bands are mapped with the lowest groundwater nitrate levels at the west side (0.1 – 0.4 mg/L) and the highest to the south east (modelled >11.3 mg/L). Most groundwater underlying WW1&2 has nitrate levels of 3.5 – 8.5 mg/L, indicative of moderate to high land use impacts.</td></tr>
<tr><td>FMU</td><td colspan="4">Oreti (WW1&2)</td></tr>
</table>

	Aparima (Horner Block)	
Nearest downstream registered drinking water supply	Heddon Bush School 2.3 km to the south	
Downstream Regionally Significant Wetland/Sensitive Waterbody	Drummond Peat Swamp (>10 km to south east) Bayswater Bog (>10 km to south west)	
Physiographic Zones	**Zone**	**Contaminant pathways for Physiographic Zone**
	Central Plains	When wet soils are prone to waterlogging, resulting in the installation of extensive artificial drainage networks. When dry these soils are prone to shrinking and cracking, allowing drainage to bypass the soil to the underlying aquifer. Aquifers and streams in this zone are prone to contaminant build-up as they do not experience dilution by a major river.
	Oxidising	Soil water and groundwater are well aerated, which allows nitrogen to accumulate. Oxidised soils are good at absorbing and storing water and any nitrogen it contains. During drier months, nitrogen accumulates in soil to high levels. During winter when soils are wet, any nitrogen not used by plants leaches down into the underlying aquifer (deep drainage). Artificial drainage is used where soils have low subsoil permeability to help to reduce waterlogging. Contaminant loss through artificial drains to nearby streams can be high during wetter months.

Table 1.5. Physical properties and information of land and water at WRO

Soils	**Soil Type**	**Vulnerability Factors**		
		Structural Compaction	**Nutrient Leaching**	**Waterlogging**
	Malakoff			
	Waimatuku	Slight	Moderate	Slight
	Makarewa	Moderate	Slight	Severe
	Aparima	Moderate	Moderate	Moderate

	Orawia	Slight	Moderate	Slight
FDE Land Classification	n/a			
Characteristics of FDE Classification	n/a			
Topography	Flat, rolling to steep			
Surfacewater management zone	Waiau			
Groundwater Zone	Unmapped			
Groundwater Nitrate Levels	0.01 – > 1.0 mg/L			
FMU	Waiau			
Nearest downstream registered drinking water supply	Tuatapere (~12 km to south west)			
Downstream Regionally Significant Wetland/Sensitive Waterbody	Waiau River – Te Waewae Lagoon (~20 km to south west)			
Physiographic Zones	**Zone**			
	Bedrock/Hill country Oxidising Gleyed Lignite Marine Terraces Peat Wetlands			

2. Consents

The decisions version of the pSWLP was notified on 4 April 2018. In accordance with Section 86B(1)(a) and (3) of the Resource Management Act 1991, all provisions of the Proposed Plan have had legal effect since this date. Since the Regional Water Plan (2010) and Regional Effluent Land Application Plan are still operative, all provisions in both Plans have legal effect. The provisions of these plans therefore need to be considered alongside the provisions of the pSWLP.

Consent holder name

The existing consent holders, Woldwide One Limited, Woldwide Two Limited, have changed their name to "*Woldwide One Limited and Woldwide Two Limited*." In accordance with Section 124C of the RMA, Woldwide One Limited confirms in writing that they will not be making any future applications under as *Woldwide One Limited* on this property in accordance with Section 124C of the RMA. In accordance with Section 124C of the RMA, Woldwide Two Limited confirms in writing that they will not be making any future applications as *Woldwide Two Limited* on this property in accordance with Section 124C of the RMA. Future applications will be made on behalf of "*Woldwide One Limited and Woldwide Two Limited*."

2.1 Consents

Consents

Table 2.1 provides a summary of proposed activities and whether resource consent is required or not. Further details are provided regarding the level of each activity in the following section.

Table 2.1

Proposed activity	**Consent required**	**Activity level**
Expansion of dairy farming through an increase in cow numbers	Yes - land use consent for farming	Discretionary activity
Discharge of agricultural effluent	Yes - effluent discharge permit – one each for WW1&2 and Horner Block	Discretionary activity
Use of land for maintenance and use of existing effluent storage facilities	No pathway through the rule but applicants agree to apply for consent as directed by decision maker.	No activity level available under the rule
Use of land for wintering barns	Yes - use of land for feed pad/lot	Discretionary activity
Use of land for silage storage facilities	No	Permitted activity
Silage leachate	No	Permitted activity
Cultivation	No	Permitted activity
Groundwater abstraction	Yes - water permit	Discretionary activity

Farming

Rule 20 of the pSWLP manages farming activities, including new or expanded dairy farming of cows. The proposed activity does not meet Rule 20 (a) (ii) (2) since cow numbers are increasing beyond the maximum number specified in the dairy effluent discharge permit that existed on 3 June 2016. Rule 20 (a) (ii) (6) is met, however, as all land was either in the dairy platform prior to 3 June 2016 or was authorised for dairy farming in November 2017.

Rules 20 (b) and (c) do not apply at WW1&2 since the proposal does not include any IWG nor will occur at greater than 800 metres above mean sea level. IWG is carried out at WRO so parts (b) and (c) apply. IWG activities at WRO meet permitted activity rules regarding areas, set-backs and other GMPs as directed by parts (b) and (c).

Rule 20 (d) is met except for (d) (ii) (1), since the dairy platform's assessment reflects the annual amount of N, P, sediment and microbial contaminants lawfully discharged on average over four years instead of over five years. A high level of evidence of land use activities during the four-year period has been supplied. Since the Merriburn Block at WRO only came under the control of the applicants though a lease agreement recently, only one nutrient budget could be provided for WRO for the 2017/18 year. Also, the scale of IWG activities of dry stock will increase at WRO, which is likely to increase contaminant losses from WRO to an extent but with minimal effects on the receiving environment. As the application does not meet all the provisions of Rule 20 (d), then Rule 20 (e) applies; **the use of land for the proposed farming activity is a discretionary activity and resource consent is required**.

Discharge activity

Agricultural effluent is defined as "effluent that is derived from livestock farming" in the pSWLP. It includes dairy shed, wintering barn, silage pad and underpass effluent since effluent generated at these sources is generated by livestock farming.

Rule 35 of the pSWLP manages the discharge of agricultural effluent to land. In this case the discharge activity at WW1&2 and the Horner Block does not meet all conditions of (a); part (i) is not met as the dairy shed services more than 20 cows; part (viii) is not met as the maximum N loading at the Horner Block will exceed 150 kg/year from effluent (maximum of 250 kg/ha). However, the maximum N loading from effluent at the dairy platform will not exceed 150 kg/year. The discharge activity does not meet part (b) (ii) since it is proposed to increase cow numbers above the maximum number specified on an existing discharge consent. **The discharge activities at both WW1&2 and the Horner Block meet all conditions described in Rule 35 (c) so are discretionary activities**.

Rule 50 of the RWP (2010) manages the discharge of agricultural effluent to land. In this case the discharge activity does not meet parts (a) or (b). It does not meet part (c) since it is proposed to increase the scale of the discharge activity through an increase in cow numbers. However, except for an increase in cow numbers, the discharge activity meets (c) part (i) in that it includes high rate irrigation to soil landscape categories A, D and E. The discharge activity meets part (d) as the scale of the activity is increasing with the increase in cow numbers and the discharge activity to soil/landscape categories A, E and D includes high rate irrigation by slurry tanker that does not exceed 5 mm depth per application. In fact, the discharge of effluent by slurry tanker does not exceed 2.5 mm depth per application. Rule 50 (d) does not specify a depth for high rate irrigation by travelling irrigator, so direction is taken from Policy 42 of the RWP. The discharge of effluent to category E land must be at less than or equal to 10 mm depth per application and at less than 50% of PAW. The travelling irrigators have been tested and apply effluent at less than 10 mm per application. The discharge of effluent must be at less than the soil water deficit for category A land and at a depth less than 50% of the soil water deficit for Category D land. The discharge of effluent to categories A, D and E land meets Policy 42 of the RWP.

Rule 5.4.6 of the Regional Effluent Land Application Plan provides for the discharge as a **discretionary activity**.

The discharge activities at WW1&2 and the Horner Block are therefore assessed as being discretionary activities.

Existing effluent storage facilities

Rule 32D of the pSWLP manages existing agricultural effluent storage facilities. Under Rule 32D (a) the use of land for the maintenance and use of existing agricultural effluent storage facilities that was authorised prior to Rule 32D taking legal effect, and any incidental discharge directly onto or into land from those storage facilities which are within the normal operating parameters of a leak detection system or the pond drop test criteria set out in Appendix P, are permitted activities provided that certain conditions are met.

WW2 STORAGE POND

WW2's pond is clayed lined and does not have a leak detection system. The material stored in WW2's storage pond is a slurry. Slurry is defined section 1 but is not defined in the pSWLP or RWP. The pond was drop tested in 2017 at the request of Council and a drop test report was submitted to Environment Southland who at the time accepted that the pond was not leaking. The drop test met all criteria set out in Appendix P, except for the unavoidable presence of a crust due to the nature of slurry stored in the pond. The 2017 drop test report was peer reviewed by a CPEng and is appended to this application.

The characteristics of slurry and liquid effluent in storage systems are quite different. Due to a much higher DM content [2], slurry has relatively low viscosity compared to liquid effluent. Slurry has self-sealing properties [3]. Whilst the process is not fully understood, self-sealing of slurry ponds/lagoons greatly reduces the risk of leakage through clay/earthen-lined ponds. Wind-driven wave action can cause bank erosion in ponds where wave energy carried by liquid damages the clay substrate. This does not arise when storing slurry since the pond surface is solid and does not move via wave action.

In the absence of operating within the normal parameters of a leak detection system or all pond drop test criteria set out in Appendix P, Rule 32D does not provide a pathway to an activity level for the use of land for the maintenance and use of an existing agricultural effluent storage pond at WW2. As such, the structure cannot align with Rule 32D. Since the pond stores slurry, which has self-sealing properties, meets all other Appendix P criteria and has minimal risk of bank erosion, the pond is very unlikely to be leaking. As such, the applicants believe the use of land for the pond at WW2 should be permitted by the Consent Authority. However, in being unable to meet all Appendix P criteria and without an avenue to an activity level within the rule, the applicants wish to place this issue in front

---

[2] Houlbrooke, Longhurst, Orchiston & Muirhead (2011) Characterising dairy manures and slurries. Report prepared for Surface Water Integrated Management (SWIM), AgResearch

[3] Parker, David & Schulte, D.D. & Eisenhauer, D.E. (1999). Seepage from earthen animal waste ponds and lagoons - An overview of research results and state regulations. Transactions of the ASABE (American Society of Agricultural and Biological Engineers). 42. 485-493. 10.13031/2013.13381.

of the hearing decision maker where it can be discussed, considered and resolved. They agree to apply for consent as and when directed to by the hearing decision maker.

WW2's storage pond meets Rule 32D (a) (i) (1) in that its construction was lawfully carried out without a consent. In accordance with Rule 32D (a) (ii) (2), a visual assessment of WW2's pond was carried out by a SQP in 2018. The assessment found that the pond shows no cracks, holes or defects that would allow effluent to leak. A report certifying WW2's pond by a SQP is appended to this application.

WW1 STORAGE POND

WW1's effluent pond stores slurry and was lawfully upgraded in autumn 2018 to increase its storage capacity, install a synthetic liner and leak detection system. The pond design was certified by a CPEng as meeting Practice Note 21 standards and was approved the Council engineer in 2018. The liner is composed of 1.5 mm HDPE, overlies a leak detection drain system the specification for which was provided by a CPEng. CPEng guidance determined a suitable design to meet PN21 standards for small ponds. The leak detection system is a ring drain that terminates at a 400 mm diameter inspection well (piezo). The liner supplier confirmed that the liner was correctly installed and is not leaking. The CPEng confirms that the pond is structurally sound following the upgrade. The CPEng report was submitted to Environment Southland as required in 2018.

In meeting the aforementioned-design and construction requirements to meet Practice Note 21, we conclude that WW1's pond is operating within the normal operating parameters of a leak detection system; there is no effluent leaking from the pond. The piezo has been inspected regularly when it either has had no liquid or had liquid following heavy rainfall when the water table was high. By checking the liquid in the piezo for signs of effluent (i.e. odour and clarity), it has been confirmed that there is no effluent in the leak detection system and no effluent leaking from the pond.

In accordance with Rule 32D (a) (ii) (2), a visual assessment of WW1's pond was carried out by a SQP in 2018. The assessment found that the pond shows no cracks, holes or defects that would allow effluent to leak. A report certifying WW1's pond by a SQP is appended to this application.

We conclude that in accordance with Rule 32D of the pSWLP, the use of land for an existing effluent storage pond at WW1 is a permitted activity; resource consent is not required. However, Council's interpretation of PN21 requirements for leak detection systems differs from CPEng guidance on PN21 received during the design and construction of WW1's pond. The applicants wish to place this issue in front of the hearing decision maker where it can be discussed, considered and resolved. They agree to apply for consent as and when directed to by the hearing decision maker.

ANCILLARY EFFLUENT STRUCTURES AT WW1 AND WW2

At both WW1 and WW2, other structures that contain, treat or store effluent include a sand trap and concrete effluent sump at the dairy shed and concrete collection sump at the wintering barn. These structures have been visually assessed by a SQP and certified as having no visible cracks, holes or defects that would allow effluent to leak. A report prepared by a SQP detailing the structures is appended to this application.

An Appendix P drop test for dairy shed ancillary structures will be carried out on in the off-season. These structures cannot be diverted during the milking season. Drop testing of the wintering barn collection channel sumps will be carried out at the earliest opportunity, with drop test reports submitted to ES prior to the wintering barns being used in May 2019.

Feed pads/Lots

Rule 35A of the pSWLP manages the use of land for feed pads/lots including wintering barns. In this instance the use of land for two wintering barns at the dairy platform does not meet all conditions set out in Rule 35A (a) as each barn houses more than 120 cattle. The use of land for a feed pad/lot that does not meet one or more conditions of Rule 35A (a) is classed as a discretionary activity. Accordingly, resource consent application for the use of land for two wintering barns at WW1 and WW2 is also submitted (in a separate document) to Environment Southland.

Groundwater abstraction

Under Rule 54 (d) of the pSWLP, groundwater abstraction for 1,500 cows on the WW1&2 is a discretionary activity as a maximum of 180,000 litres per day is abstracted. This allows for 120 litres per cow per day. Under Rule 23 (c) of the Regional Water Plan, a groundwater take of 180,000 litres per day is a restricted discretionary activity provided the rate of take is less than or equal to 2 L per second; resource consent is required. **The groundwater abstraction is assessed as a discretionary activity and resource consent is required.**

Permitted activities

Silage storage - WW1 and WRO

The use of land for silage storage facilities at WW1 and WRO is a permitted activity as it meets all conditions specified in **Rule 40 (a)** of the pSWLP; resource consent is not required.

The use of land for silage storage facilities at WW1 and WRO is a permitted activity as it meets all conditions specified in **Rule 51 (a)** of the RWP (2010); resource consent is not required.

Surplus grass is harvested and generally stored as baleage at WRO, However, occasionally it may be stored as silage. Where this occurs, the applicants ensure that permitted activity rules regarding the use of land for silage storage are always met.

Both rules are met as follows:

Silage pads are situated on dry sites; the underlying substrate is well compacted and sealed (see figures 6.4 and 6.5 for the permanent pad at WW1). There is no overland flow of stormwater into silage pads and silage pads are not situated within a critical source area. Silage pads are not located on land that is made permanently or intermittently wet by the presence of springs, seepage, high groundwater, ephemeral rivers or flows of stormwater other than from any cover of the silage.

No part of any silage pad is within 50 metres of a lake, river, artificial watercourse, modified watercourse (see figure 6.6 for WW1), natural wetland or any potable water abstraction point. The nearest waterway to the WW1 pad is a fenced off open drain, which is approximately 60 metres to the east of the silage pad.

No silage pad is within 100 metres of any dwelling or place of assembly, on another landholding.
No silage pad is not within 100 metres of the microbial health protection zone of a drinking water supply site identified in Appendix J of the pSWLP, or within 250 metres of the abstraction point of a drinking water supply site identified in Appendix J.

Cattle do not graze directly from any silage pad, rather silage is carted to cows in the wintering barn or on paddocks at WW1 and to stock on paddocks at WRO. No silage pad is located on contaminated land.

Silage storage - WW2

The use of land for a silage storage facility at WW2 meets the conditions stated in Rule 40 (a) of the pSWLP (2018), so is classed as a permitted activity and resource consent is not required. The use of land for a silage storage facility meets the conditions stated in Rule 51 (a) of the RWP (2010), so is classed as a permitted activity and resource consent is not required.

Silage leachate - WW1 & WRO

The discharge of silage leachate onto or into land at WW1 and WRO is a permitted activity as it meets all conditions specified in Rule 51 (d) of the Regional Water Plan (2010); resource consent is not required.

The activity meets Rule 41 (a) (iia), (iii) and (iv) of the pSWLP and is therefore a permitted activity and resource consent is not required. There is no discharge of leachate directly to groundwater via a pipe, soak pit or other soil bypass mechanism and there is no overland flow or ponding of silage leachate outside of the silage storage facility.

Silage leachate - WW2

In accordance with Rule 41 (a) of the pSWLP, the discharge of silage leachate onto or into land in circumstances where contaminants may enter water is a permitted activity since part (i) is met and resource consent is not required; the discharge is via an agricultural effluent discharge system authorised under Rule 35.
In accordance with Rule 50 (d) of the RWP (2010), the discharge of silage leachate at WW2 is a permitted activity since all conditions set out in Rule 50 (d) are met; resource consent is not required.

Intensive winter grazing

IWG is carried out at WRO so Rule 20 parts (b) and (c) apply. IWG activities at WRO meet permitted activity rules regarding areas, set-backs and other GMPs as directed by parts (b) and (c).

Cultivation

Cultivation at WW1&2 and WRO meets permitted activity rules described in Rule 25 of the pSWLP. Cultivation is not carried out within a bed or within 5 metres of from the outer edge of the bed of any waterways. It does not occur on land with a slope of greater than 20 degrees.

In the future, if a setback of less than 5 metres is implemented when cultivating at the WW1&2 dairy platform, the activity will meet permitted activity rules described in part (b) of Rule 25. A minimum setback of 3 metres from the outer edge of any stream bed will be implemented, cultivation will not occur more than once in any 5-year period and it will be for the purpose of renewing pasture and not for any fodder crop/IWG activity.

2.2 Duration

Consent durations of 15 years are proposed for all consents, which aligns with Woldwide One's discharge and water permit terms. Special consideration is given to Policy 40 of the pSWLP and Policies 14A and 43 of the Regional Water Plan in determining the duration. The duration sought is considered consistent with these policies given the replacement nature of consents for an activity that is already well established, has benefited from a significant degree of capital investment and is operating within limits established by its existing consents and associated conditions. Considerable investment in farm infrastructure has been made to take the final steps towards future proofing the dairying operation; eliminating winter grazing of adult cattle on beet/brassica crops from high risk soils in the sensitive Heddon Bush area altogether. The level of investment demonstrates the applicant's belief in and commitment to sustainable farming and land management. The applicants believe that their presence at this location since 1992 (over 25 years) has not had a detrimental effect on the local environment, and that the proposed changes will mean a further reduction of that impact. They are likewise committed to the sustainable management of WRO with minimal adverse effects on the receiving environment. A 15-year consent term will mean that the management of the resources under the same proven stewardship will be ensured into the future.

2.3 Proposed consent conditions

The applicants propose to agree conditions once draft conditions are issued, including the conditioning of various mitigation measures where appropriate. Draft conditions will recognise the following:

Land use consent for farming

1. The land area will include WW1&2 and WRO.

   Environment Southland regard WRO to be part of the landholding at WW1&2. The applicants hold a different view as mentioned in section 1. However, in respect of Environment Southland's view and for the application to be accepted under s88 by the consent authority, WRO has been included in the landholding in this application and therefore is included in the land use consent for farming.

2. That activities at WW1&2 dairy platform are restricted using the N output from the proposed Overseer nutrient budget as a limit. The below example can be used as guidance. Using an N output figure provides Council with certainty that N losses will not increase due to future farming activities at WW1&2, while providing the applicants with flexibility to farm according to climatic and economic conditions, and to respond to unforeseen challenges as they arise (e.g. biosecurity/*M. bovis*). An output-based consent is preferable since it allows for innovation by restricting the N loss from the whole activity at the dairy platform rather than specific activities.

3. For reasons explained in the WRO section of the application, only input-based conditions are proposed for WRO.

4. To provide additional certainty over the scale of the activity, mitigations and effects that the following inputs are conditioned:

   WW1&2:
   a. Land area;
   b. Effluent discharge area;
   c. Peak cow numbers milked (1,500); and
   d. Maximum number of cows housed in wintering barns (1,250).

WRO:

- e. Land area;
- f. Maximum area in winter crop (beet or brassica) to be intensively winter grazed is 100 hectares;
- g. A maximum of 417 R1 heifers grazed all year round at WRO from WW1&2;
- h. A maximum of 417 R2 heifers grazed all year round at WRO from WW1&2, **<u>or</u>**
  A maximum of 417 R2 heifers grazed between August and May and during June and July in the WW1&2 wintering barns.

5. The Consent Holder shall maintain records of the following for each year between 1 June and 31 May:
   - a. Fertiliser application, including rates;
   - b. Supplements imported;
   - c. Types of crops and total area of cropping if any;
   - d. Cultivation methods;
   - e. Stock units by references to type, age and breed;
   - f. Effluent application areas (WW1&2 only);
   - g. All other inputs to the OVERSEER nutrient budgeting model.

6. Install a new monitoring bore in the same area as bore E45/0622, to monitor groundwater quality flowing south from WW1&2.

Example – WW1&2 year-end nutrient budget:

Nitrogen Loss Rate and Nutrient Budget

1. The Consent Holder shall ensure nitrogen losses from farming activities undertaken at the WW1&2 are maintained at or below the following nitrogen loss rate of 40 kg/ha/yr, or as amended in accordance with Condition X.

Advice Note: *The nitrogen loss rates represent the modelled discharge of nitrogen below the root zone as modelled with OVERSEER version 6.3.1 in accordance with the OVERSEER Best Practice Input Standards as of 11 May 2018.*

The determination of whether the nitrogen loss rates have been met will be made using the nitrogen loss from the most recent year, modelling using the latest version of OVERSEER®.

2. The Consent Holder shall prepare an annual nutrient budget for the period of 1 June to 31 May for the subject land using OVERSEER in accordance with the OVERSEER Best Practice Input Standards, or an equivalent model approved by the Chief Executive of the Consent Authority.

3. The nutrient budget required by Condition 2 shall be accompanied by a report that includes:
   - *a. A review of the input data to ensure that the nutrient budget reflects the farming system;*
   - *b. An explanation of any differences between the budgets of the previous year; and*
   - *c. A comparison of the nitrogen loss from the current year with the nitrogen loss rates in Condition 2.*

4. *The nutrient budget and accompanying report shall be provided to the Consent Authority by 30 September each year.*

5. *The nutrient budget shall be prepared by a Certified Nutrient Advisor or the budget may be prepared by suitably experienced person and reviewed by a Certified Nutrient Advisor.*

6. *The nitrogen loss rates described in Condition 2 shall be amended following the release of a new version of OVERSEER or the Best Practice Data Input Standards. Following the update of the nitrogen loss rates, the Consent Holder shall provide the updated OVERSEER files to the Consent Authority with the report required by Condition 5.*

Discharge permits

WW1&2

The below draft conditions are proposed for the discharge of agricultural effluent at WW1&2.

This consent shall be exercised in conjunction with Land Use Consent AUTH-X.

(a) This consent authorises the discharge of dairy shed effluent, wintering barn effluent, silage pad effluent and underpass effluent ("agricultural effluent") onto land, via a land disposal system consisting of two effluent storage ponds, two sand traps, two dairy shed pump sumps, two wintering barn concrete collection sumps, low depth travelling irrigator, low rate (pods and/or rain-gun) irrigation, slurry tanker with a trailing shoe and umbilical system, as described in the application (X) for resource consent dated X 2018 and further information dated X.

The activity shall be limited to:

- *i. The discharge to land of agricultural effluent generated from milking of up to 1,500 cows milked twice daily;*
- *ii. The discharge to land of agricultural effluent from the housing of up to 1,250 cows inside two purpose built barns;*
- *iii. The discharge of agricultural effluent to land via low depth travelling irrigator, slurry tanker with a trailing shoe, umbilical system and low rate irrigation;*
- *iv. The discharge of agricultural effluent to an area of no more than X hectares at the WW1&2 dairy platform as per the plan attached as Appendix 1;*
- *v. The discharge of effluent from a 1,200 m^2 silage pad; and*
- *vi. The discharge of effluent from a 200 m^2 underpass.*

***Advice note**: "Effluent slurry" refers only to the contents of the effluent storage ponds. "Agricultural effluent" refers to effluent from all sources (the dairy shed, yard, barns, ponds, silage pad and underpass).*

(b) This consent excludes the discharge of effluent from winter milking from June 20 to July 20 (winter milking refers to cows milked to supply a winter milking contract), or from any feed pad/calving pad/structure not listed in condition 2(a).

2. *The discharge authorised by this consent shall not exceed the following rates and/or depths at any time:*

  - (a) *For the travelling irrigator: A maximum depth of less than 10 millimetres for each individual application;*
  - (b) *For the slurry tanker with trailing shoe: A maximum depth of 2.5 millimetres for each individual application;*
  - (c) *For the umbilical system: A maximum depth of 3.0 millimetres for each individual application; and*
  - (d) *Low rate system: a maximum depth of 10 millimetres for each individual application, and a maximum rate of 10 millimetres per hour.*

3. *The maximum loading rate of nitrogen from effluent onto any land area as a result of the exercise of this consent shall not exceed:*
    - (a) *150 kilograms of nitrogen per hectare per year at the dairy platform.*

4. *The minimum return period for the discharge of effluent to land shall be no less than 28 days.*

5. *Effluent shall not be discharged within:*
    - (a) *20 metres of any surface watercourse;*
    - (b) *100 metres of any water abstraction point;*
    - (c) *200 metres of any place of assembly or dwelling not on the subject property;*
    - (d) *20 metres from any property boundaries.*

Where there is inconsistency between the plan attached as Appendix 1 and the conditions of this consent, the conditions of this consent shall prevail.

6. *The application of effluent to land shall not occur when:*
    - (a) *the moisture content of the soils is at or above field capacity,*
    - (b) *soils within the discharge area are 'cracked'; and*
    - (c) *during wind conditions that may result in odour or spray drift beyond the property boundary.*

Horner Block

The below draft conditions are proposed for the discharge of agricultural effluent at the Horner Block.

1. *The discharge of effluent slurry to an area of no more than 97 hectares at the block known as the "Horner Block" as per the plan attached as Appendix 1.*

2. *The discharge authorised by this consent shall not exceed the following depths at any time:*
    - a. *For the slurry tanker with trailing shoe: A maximum depth of 2.5 millimetres for each individual application; and*
    - b. *For the umbilical system: A maximum depth of 3.0 millimetres for each individual application.*

3. *The maximum loading rate of nitrogen from effluent onto any land area as a result of the exercise of this consent shall not exceed:*
    - a. *250 kilograms of nitrogen per hectare per year at the Horner Block (Lot 4 DP 399915).*

i. *The annual slurry volume applied at the Horner Block shall be recorded and reported to the Consent Authority upon request.*

Other conditions for land use, discharge and water consents – to be agreed with Consent Authority once draft conditions are issued.

3. Statutory Considerations

3.1 Statutory considerations:

Environment Southland must consider the following matters when they consider an application. The application is consistent with all of these relevant plans and policies because effects on water quality and quantity and the soil resource should be less than minor.

Resource Management Act 1991:

- The provisions of section 104 of the Resource Management Act 1991;
- Part 2 of the Resource Management Act;
- The applicant's assessment of effects on the environment;
- The provisions of Sections 104B, 104C, 105 and 107 of the Resource Management Act 1991.

Schedule 4 of the RMA requires that an assessment of the activity against the matters set out in Part 2 and any documents referred to in Section 104. Sections 104B and 104D of the Act set out the matters that, subject to Part 2, the Consent Authority must have regard to when considering an application for discretionary activities. Sections 105 and 107 set out additional matters the Consent Authority must have regard to when considering applications to do something that would otherwise contravene Section 15. An assessment of each of these matters follows:

Part 2 of the RMA

The activity is considered to represent an efficient use of natural resources that will give rise to significant positive benefits in terms of providing for the social and economic wellbeing of the applicants and the wider regional economy. There is, however, the potential for adverse effects on the environment to arise, including on water quality. However, it is considered that the effects of the activities have been adequately identified and assessed in the Assessment of Environmental Effects in Section 7 below and that such effects will be no more than minor.

Section 6 of the RMA lists the matters of national importance that a Consent Authority shall recognise and provide for when considering applications for resource consent. The relevant matters under Section 6 to this proposal are considered to be:

(a) the preservation of the natural character of the coastal environment (including the coastal marine area), wetlands, and lakes and rivers and their margins, and the protection of them from inappropriate subdivision, use, and development:
(c) the relationship of Maori and their culture and traditions with their ancestral lands, water, sites, waahi tapu, and other taonga:

It is considered that the proposed activities do not impact directly on the coastal environment, wetlands, and lakes and rivers and their margins, although there is potential for adverse effects on the wider receiving environment which is inclusive of some of these features. However, as is discussed in Section 7 below, the actual and potential adverse effects of the activities are considered to be no more than minor.

Section 7 of the Act lists a number of other matters that a Consent Authority must have particular regard to when considering applications for resource consent. The matters in Section 7 that are considered relevant to this application are:

(a) kaitiakitanga:

(aa) the ethic of stewardship:

(b) the efficient use and development of natural and physical resources:

(c) the maintenance and enhancement of amenity values:

(d) intrinsic values of ecosystems:

(f) maintenance and enhancement of the quality of the environment:

(g) any finite characteristics of natural and physical resources:

(h) the protection of the habitat of trout and salmon:

For the reasons discussed in Section 7 of this report below, the proposal is considered consistent with relevant provisions of Section 7 of the RMA.

Section 8 sets out a Consent Authority's responsibilities in relation to the Treaty of Waitangi. The proposal is considered consistent with the provisions of all regional planning documents, including Te Tangi oTauira, and Sections 6(c) and 7(a) of the Act. Therefore, the proposal can also be considered consistent with Section 8 of the Act.

To avoid repetition, the following documents have been grouped together under common headings in the sections that follow.

The final part of this section of the application focuses on why the activity is consistent with key policies in the proposed Southland Water and Land Plan (2018).

Table 3.1: Ngai Tahu Values

Regulatory Document	Relevant Sections
National Policy Statement for Freshwater Management 2014	• Objectives C1, D1 • Policies C1, D1
Southland Regional Policy Statement 2017	• Objectives TW.2, TW.3, TW.4 and TW.5 • Policies TW.3, TW.4 and TW.5
Regional Water Plan 2010	• Objective 9C • Policy 1A
Regional Effluent Land Application Plan 1998	• Objectives 4.1.4, 4.1.5 • Policies 4.2.4, 4.2.7,4.2.8, 4.2.9

Proposed Southland Water and Land Plan 2018	• Objectives 3, 4, 5, 15 • Policies 1, 2, 3
Te Tangi a Tauira:	• Whole Document

Tangata Whenua values have been considered when preparing this application including reference to Te Tangi a Tauira (Iwi Management Plan). The principles of protection of the mauri of the water and mana of the land while minimising adverse effects on mahinga kai will continue to be recognised and have regard to in the exercise of the consents and the operation of the dairying activity. There are no known wahi tapu, ancestral sites, heritage sites or other taonga associated with the landholding.

Table 3.2 Water Quality

Regulatory Document	Relevant Sections
National Policy Statement for Freshwater Management 2014	• Objectives A1, A2, B1, B2, B3, B4, • Policies A3, A4, B5, B6, B7
Regional Policy Statement for Southland 2017	• Objectives WQUAL.1 and WQUAL.2 • Policies WQUAL.1, WQUAL.2, WQUAL.3, WQUAL.7, WQUAL.8, WQUAL.12
Regional Effluent Land Application Plan 1998	• Objectives 4.1.2 • Policies 4.2.3, • Rule 5.4.5
Regional Water Plan 2010	• Objectives 3,4,8 • Policies 1, 4, 6, 7, 13
Proposed Southland Water and Land Plan 2018	• Objectives 1, 2, 6, 7, 8, 9, 13, 18 • Policies 5, 10, 13, 14, 15, 16, 17, 18, 39A, 40
Te Tangi a Tauira	• Policies 1, 4, 5, 6, 11, 16, 17, 18

Dairy and dry stock farming are carried out following good management practices relevant to the physiographic zones present at the WW1&2 (Oxidising and Central Plains) and WRO (Bedrock/Hill Country, Gleyed, Oxidising, Peat Wetlands, Lignite Marine Terraces). These practices are recommended by Council and are implemented on farm to mitigate the risk of adverse effects on water quality from contaminants transported via artificial drainage, deep drainage and overland flow where relevant. Deep drainage and artificial drainage are recognised by the applicants as key contaminant pathways at WW1&2 and are managed as such. Artificial drainage and overland flow are recognised as key pathways at WRO, with deep drainage also a risk but to lesser extent. Good management practices and specific mitigation measures implemented on farm are described in this application (sections 6, 7, WRO section), and in the Appendix N Farm Environmental Plans for the WW1 and WW2 units and for WRO.

At WW1&2 there will be no increase in contaminant loss and no increase in effects on receiving water quality due to additional cows. This expansion will be achieved through the implementation of key mitigation measures to off-set additional cows, alongside the implementation of a suite of good management practices. Practices such as IWG, which generally have high rates on N loss to receiving ground and surfacewaters, are being eliminated from a sensitive area in Central Southland.

At WRO, proposed activities will result in minimal adverse effect on receiving waters.

At WW1&2 and the Horner Block, the discharge is to land rather than water and is undertaken in a manner to minimise adverse effects on water quality. Good management practices for the management of the effluent system and mitigation measures have been included in the application and respective Farm Management Plans. By only irrigating effluent to land when ground conditions are less than field capacity, and by ensuring that irrigation of effluent to land does not result in the soils reaching field capacity, the risks of leaching through the soil profile or via overland flows are mitigated. The use of very low depth irrigation, as discussed in the AEE, should reduce the risk of exceeding a soil's infiltration rate, thus preventing ponding and surface runoff of freshly applied effluent (slurry). The recommended buffer zones from waterways are adhered to when applying effluent.

Table 3.3 Water Quantity

Regulatory Document	Relevant Sections
National Policy Statement for Freshwater Management 2014	• Objectives A1, A2, B1, B2, B3, B4, • Policies A3, A4, B5, B6, B7
Southland Regional Policy Statement 2017	• Objectives WQUAN.1 and WQUAN.2 • Policies WQUAN.1, WQUAN.2, WQUAN.5, WQUAN.6, WQUAN.7 and WQUAN.8
Regional Water Plan 2010	• Objectives 5,7,8 and 9 • Policies 21, 22, 23, 28, 29, 30, 31, • Rules 16C, 23, 50
Proposed Southland Water and Land Plan 2018	• Objectives: 7, 9, 11, 12, 18 • Policies 20, 21, 22, 23, 25, 42
Te Tangi a Tauira:	• Policies 1, 4, 5, 6, 11, 16, 17, 18

The groundwater take reflects standard volumes for a dairy farm at WW1&2. The proposed volume of take is consistent with Environment Southland's guidelines of 120 litres per day per cow, which is considered reasonable for the intended end use. The maximum groundwater take is 180,000 litres per day, allowing for 120 litres per day per cow for 1,500 cows.

Groundwater is abstracted for dairy shed use and stock drinking water from three bores at the landholding. The rate of take does not exceed 2 L/sec and should not result in more than minimal stream depletion and interference effects.

Table 3.4 Soil Health and Effluent Management

Regulatory Document	Relevant Sections
Regional Policy Statement for Southland 2017	• Objectives WQUAL.1 and WQUAL.2 • Policies WQUAL.1, WQUAL.2, WQUAL.3, WQUAL.7, WQUAL.8, WQUAL.12
Regional Effluent Land Application Plan 1998	• Objectives 4.1.1 • Policies 4.2.1, 4.2.2
Regional Water Plan 2010	• Policy 41 • Rule 49
Proposed Southland Water and Land Plan 2018	• Objectives 13, 13A, 14, 15, 18 • Policies 5, 17, 33 • Rule 32D, 35, 40, 41
Te Tangi a Tauira	• Policies 4, 7, 8, 9, 11, 13, 14, 15

The applicants seek to ensure the life supporting capacity of the soil is safeguarded, along with the sustainability of the soil ecosystem by utilising land treatment of effluent without significant adverse effects. At WW1&2, soils are suitable for effluent irrigation and the discharge follows current good management practice, which is described in Section 6 and in the FEMP. These include practices of a general nature and those specific to the key contaminant transport pathways for the physiographic zones.

Two existing storage ponds allows for deferred storage of dairy shed, wintering barn and silage pad effluent until the soil moisture content is suitable for irrigation. The land disposal area meets the best practice recommendation of 8 hectares per 100 cows. The nutrient loading of soils will not exceed 150 kg N/hectare at WW1&2 dairy farm and 250 kg N/hectare at the Horner Block. The higher strength nature of slurry has been recognised and fully considered in the AEE. Slurry from the ponds will be applied at a maximum depth of 2.5 millimetres per application using the slurry tanker with the trailing shoe to avoid overloading soils with nutrients and microbes. This system is sustainable in the long term and allows the effluent to be used both as a fertiliser and a soil conditioner.

In addition to the matters in Section 104 of the Act, when considering an application for a discharge permit a Consent Authority must also have regard to Section 105. As is discussed in the assessment under Section 7, it is considered that provided the discharge is undertaken in accordance with the conditions of the consent and the best practice management techniques outlined in Section 6 of the application and in the FEMP, the adverse effects of the activity should remain no more than minor. The best method for dealing with effluent from the dairy operation is considered to be discharging to land.

There are not considered to be any matters under Section 107 of the Act that would require the Consent Authority to decline the application for discharge permit.

3.2 Proposed Southland Water and Land Plan (2018)

The application meets the relevant objectives and policies described in the pSWLP (2018). The policies are numerous; however, the following policies are particularly relevant because of their focus on good practice management in the appropriate physiographic zones; effects including cumulatively, on water quality and quantity, and the soil resource should be less than minor.

Objectives and Policies relevant to land-use and discharges at WW1&2 & Horner Block

- **Objectives 6, 7, 8, 9, 13, 18**
- **Policies 5, 10, 13, 14, 15, 16, 17, 18, 39A, 40**

Policies 5 and 10 are physiographic zone policies. Policy 5 gives direction on the land located in the Central Plains physiographic zone; Policy 10 gives direction on land located the Oxidising physiographic zone.

Under **Policy 5.1**, adverse effects on water quality from contaminant loss via artificial drainage and deep drainage in the Central Plain's physiographic zone must be avoided, remedied or mitigated by the implementation of good management practices. The Central Plain's physiographic zone is mapped as a major physiographic zone at both the WW1&2 dairy farm and Horner Block. The applicants implement a wide range of good management practices at both locations to mitigate contaminant loss via artificial drainage and deep drainage, which is demonstrated in section 6 and 7 and in the FEMPs. They have been leaders in the dairy industry in Southland, being the first to build free wintering barn stalls to reduce outside crop-based wintering, and the first to feed fresh grass to cows in winter to reduce silage making losses and run-off.

In order to meet **Policy 5.2,** this application and accompanying FEMPs have particular regard to adverse effects on water quality from contaminants transported via artificial drainage and deep drainage.

Policy 5.3 gives direction to decision makers on generally not granting resource consent for additional dairy farming of cows or additional winter grazing where contaminant losses will increase as a result of the proposed activity. *Note: Much of the following assessment also applies to Oxidising land.*

In the absence of making other changes to the farming system, an additional 160 cows would be expected to increase contaminant losses from the activity. However, other changes are being made, such as the phasing out of IWG at WW1&2 and increased capacity and use of the wintering barns. Overseer nutrient budget analysis has been carried out to determine pre-expansion nutrient N and P losses. In the absence of a suitable alternative method, P loss has been used as a proxy for sediment and microbial loss, as they generally move from land to water in a similar way (i.e. via overland flow, and via artificial drainage at times). The post-expansion nutrient budget includes an additional 160 cows. Several key mitigation measures will be implemented and are modelled in Overseer, to ensure that nutrient losses (and by proxy sediment and microbial contaminants) will not increase post expansion. Some measures are not modelled in Overseer but will also mitigate contaminant losses and associated effects. Collectively the changes will lead to increased soil organic matter content, increase soil water holding capacity, improved soil structure and less accumulation of N in high risk soils at high risk times. This should reduce the risk of contaminant loss to groundwater via deep cracks that potentially can form in Braxton soils due to swell/shrink properties, which is a risk not particularly addressed by Overseer. A field investigation by M. Killick from Environment Southland in January 2018 showed that Braxton soils at the landholding may not in fact form deep cracks due to soil, pasture type and management, which reduces the background risk of contaminant loss to groundwater in the Central Plains PZ to a degree.

The applicants will provide Environment Southland with certainty that contaminant losses will not increase through the implementation of consent conditions and by submitting a year-end Overseer nutrient budget annually. As the proposed activity will not result in an increase in contaminant losses (N, P, and by proxy sediment and microbes), the application is in line with Policy 5.3 and should be granted.

Under **Policy 10**, adverse effects on water quality from contaminant loss via deep drainage, and via artificial drainage and overland flow where relevant, in the Oxidising physiographic zone must be avoided, remedied or mitigated by the implementation of good management practices. The Oxidising physiographic zone is mapped as a major physiographic zone at WW1&2 and the Horner Block with Oxidising areas generally found on the east side of the dairy platform where free draining soils are found. Due to the nature of its topography and soils, artificial drainage or overland flow pathways are not believed to be a particular risk for Oxidising areas. Deep drainage of contaminants, particularly nitrate loss to groundwater, is a risk for Oxidising areas and must be managed under Policy 10.

The assessment provided in Policy 5 relating to the management of the risk of contaminant loss via deep drainage to groundwater also applies to the management of Oxidising soils. Rather than repeating the policy assessment, please see the above assessment provided for Policy 5.1, 5.2 and 5.3. Improved soil structure, better nutrient management and particularly less N mineralisation and N accumulation at high risk times will see less nitrate loss to groundwater via deep drainage in Oxidising areas. Oxidising soils do not have similar swell/crack properties as Central Plain's soils, so the risk of deep crack formation and subsequent by-pass drainage to the underlying aquifer is not believed to be a risk for Oxidising soils. As has been explained in Policy 5.3 above, potential contaminant losses from additional cows will be off-set through the implementation of several key mitigation measures. This will result in a small reduction in N and P loss. The applicants will provide Environment Southland with certainty that contaminant losses will not increase through the implementation of consent conditions and by submitting a year-end Overseer nutrient budget annually. Under Policy 10, the proposed activity should be granted.

Policy 13 gives direction on the management of land use activities and discharges. In line with Policy 13.1 the proposed expansion will better enable the applicants to provide for their social, economic and cultural well-being. The increase in herd size by 160 will allow changes in management practice to be made, whilst also operating a profitable and sustainable business model. The maintenance of a profitable and sustainable business model is central to the success of the business, and provides social, economic and cultural benefits to the applicants, their employees, families and whanau, and to the wider community. In the context of an agricultural-based local economy, the use and development of land and water resources at WW1&2 for primary production should be recognised. In line with Policy 13.2, land use activities and discharges (point source and non-point source) are managed to enable the achievement of Policies 15A, 15B and 15C.

In line with **Policy 14,** the discharge is to land and there is no discharge to water.

Policy 16 gives direction on farming practices that affect water quality.

Policy 16.1 (a) discourages the establishment of new dairy farming of cows in close proximity to Regionally Significant Wetlands and Sensitive Waterbodies. The nearest Regionally Significant Wetland is Dunearn Wetland, located approximately 4 km to the north west. As the direction of ground and surfacewater flow is to the south, there is no risk to water quality at Duneran Wetland from the proposed activity. Drummond Peat Swamp is located approximately 12 km to the south east of WW1&2, and Bayswater Peat Bog is located approximately 10 km to the south west of the property. Neither Drummond Peat Swamp nor Bayswater Peat Bog are *in close proximity* to the dairy farm so have little or no risk due to the proposal. Under Policy 16.1 (a) the proposed activity can be established.

Policy 16.1 (b) ensures that until the development of freshwater objectives under FMU processes, applications to establish new, or further intensify existing dairy farming of cows, or to intensify winter grazing activities will generally not be granted under certain situations. The situations relate to different effects on and measures of water quality. This application is for an increase of 160 cows (11%) on land that has been dairy farmed for between 17 and 26 years to date, or on land that has been used for dairy support and was consented for dairy farming in October 2017. As such this application is not to establish new dairy farming of cows but is to intensify through an increase in cow numbers.

In parallel with additional cows, it proposed to implement many key mitigation measures, such as the removal of all winter and summer fodder cropping, removal of IWG, expansion of size and use of wintering barn facilities and more efficient use of N fertiliser at WW1&2. The cessation of IWG is an important mitigation in a sensitive part of Central Southland since it has high N loss, especially where free draining soils are sown in fodder beet and subsequently IWG. IWG is specifically included in Policy 16 as an activity that affects water quality. The removal of this practice from WW1&2 means that cultivation practices will move to direct grass to grass methods in a sensitive area, with less disturbance of soil structure and less mineralisation processes occurring. This will lead to increased soil organic matter content and water holding capacity and reduce N loss to ground and surfacewaters over time. It is explained in the following three paragraphs why the proposed further intensification of existing dairy farming should be granted in this instance.

Policy 16.1 (b) (i) gives direction on generally not granting further intensification of existing dairy farming of cows where the adverse effects, including cumulatively, on the quality of groundwater and receiving surface waterways such as rivers, wetlands and estuaries cannot be avoided or mitigated. Section 7 of the application provides an in-depth assessment of effects (AEE) of the proposed activity on groundwater and receiving surface waters. The AEE addresses the potential for adverse effects on already elevated groundwater to the south east of WW1&2, on groundwater to the south including at Heddon Bush School, which has a registered bore for drinking water supply and on receiving surfacewaters including the Waimatuku Stream, Estuary, Lower Oreti and New River Estuary. The assessment includes contaminants N, P, sediment and microbes and their related effects in receiving waters, with P used as a proxy for sediment and microbes and supports the conclusion that adverse effects, including cumulatively, from the whole activity at WW1&2 will be mitigated.

Policy 16.1 (b) (ii) gives direction on generally not granting further intensification of existing dairy farming of cows where existing water quality is already degraded to the point of being over-allocated. There is a high degree of variation in existing groundwater quality in the area, with an area to the south east of WW1&2 showing high groundwater nitrate concentrations, above the New Zealand Drinking Water Standard of 11.3 ppm. Particularly, groundwater at an ES monitoring bore at Boyle Road to the south east has shown high nitrate-N concentrations, indicative of groundwater degradation due to land use effects in the area, such as IWG on free draining soils. This matter is assessed in depth in the AEE.

Groundwater flow for much of WW1&2 is believed to be to the south[4]. Groundwater quality measured at the southernmost bore (E45/0622) shows relatively low levels of nitrate, as does a bore located ~2.3 km due south at Heddon Bush School (1.8 – 2.0 ppm in 2017/2018). Bore E45/0622 is an indicator of groundwater quality at the base of WW1&2. It should capture the cumulative effect of land use on water quality in the groundwater stream to the north, upstream of groundwater flow including some Braxton and Drummond soils. If deep cracks form in Braxton soils, then contaminants such as nitrate can bypass the soil matrix and move to groundwater or move via subsurface drains into surfacewaters. Water quality at bore E45/0622 does not show evidence of nitrate reaching groundwater via this process, as despite occasional well-head contamination issues, nitrate levels have been consistently low at the bore. In conjunction with the low nitrate levels measured at the Heddon Bush School bore,

---

[4] Hitchcock (2014). Characterising the surface and groundwater interactions in the Waimatuku Stream, Southland (Thesis, Master of Science). University of Otago. Retrieved from http://hdl.handle.net/10523/5087

data from bore E45/0622 indicate that groundwater groundwater flowing south from WW1&2 is not degraded to the point of being overallocated.

There is an increasing gradient in groundwater nitrate concentration from west to east towards Terrace Creek, which flows approximately north to south, and is located approximately 1 km beyond the eastern boundary of WW1&2. This concentration gradient is reflected by data from other bores at WW1&2 (E45/0665 and E45/0727), where the increasing gradient corresponds to a transition from heavier to lighter soils towards the east. Average groundwater nitrate concentrations at these two bores are considerably lower than concentrations seen further east and south east beyond the boundary. Due south of WW1&2, groundwater nitrate levels are predominantly low for approximately 10 km, which includes the area around Heddon Bush School.

Based on the above factors in conjunction with changing on farm practices, it is proposed that under Policy 16.1 (b) (ii), the activity should be granted. The cumulative effect of changing on farm practices over time, should see a further reduction in nitrate loss to groundwater at WW1&2. The applicants believe that farming under the current system, with a maximum of 1,340 cows but using practices such as IWG causes more cumulative loss of N to groundwater due to increased N accumulation and more mineralisation of N in soils and more soil damage. They propose to install a new bore at the south of WW1&2, which will be used to monitor groundwater quality over time. They are prepared to use data from the bore to inform future decision making. In this case, granting this application to increase cow numbers by 160 will allow the applicants to facilitate these management changes, which cumulatively should cause less N loss to groundwater and degradation of groundwater.

Policy 16.1 (c) gives direction on processes after the development of freshwater objectives under FMU processes. As freshwater objectives have not yet been developed, this policy does not apply at the present time.

Policy 16.2 gives direction on farming activities, including existing activities.

Under **part (a)**, all such activities are required to implement a farm environmental management plan (FEMP), as set out in Appendix N. The applicants implement a FEMP as set out in Appendix N, so meet part (a) of Policy 16.2.

Under **part (b)**, sediment run-off risk must be actively managed by identifying critical source areas (CSAs) and implementing practices such as setbacks from waterbodies, riparian planting, sediment traps, preventing stock from entering the beds of surface waterbodies and limiting the duration of exposed soils. WW1&2 and the Horner Block are predominantly flat with minimal CSAs. Where CSAs are found close to where tiles have outfalls to surface drains, they have been mapped and are actively managed to minimise the risk of sediment loss. See FEMPs for locations of CSAs. Practices such as fencing off waterways are implemented and have been for many years as part of the Dairy Accord. Stock do not have access to waterways at any time. Farm infrastructure such as tracks, lanes and sheds can act as critical source areas following periods of prolonged rainfall, where water can pool and move via overland flow to waterways, carrying contaminants such as sediment and microbes with it. Farm infrastructure is managed to ensure that surface drainage does not flow via overland flow directly into waterways, but is directed through pasture or riparian strips, where run-off is filtered, and sediment and microbes are trapped before reaching waterways. The applicants endeavour to limit the duration where soils are bare as much as possible and under the propoal, fallow periods will be eliminated. This will help to further reduce the risk of sediment run-off further.

Under part (c) of Policy 16.2, collected and diffuse run-off must be managed, as well as leaching of nutrients, microbial contaminants and sediment through the identification and management of CSAs *within individual properties*. The applicants manage their farm layout, infrastructure, soil types, drainage, CSAs and overall farming system to control and minimise collected and diffuse run-off, leaching of nutrients, microbial contaminants and sediment from such sources. These are explained in the FEMPs. Particularly, lanes close to waterways are appropriately managed to avoid the runoff reaching waterways.

Policy 17 gives direction on agricultural effluent management.

In line with Policy 17, significant adverse effects on water quality from the operation of, and discharges from, the effluent management system at WW1&2 and the Horner Block are avoided.

Other adverse effects are also avoided, remedied or mitigated. The effluent management system, including storage ponds, low depth and very low depth irrigation systems, follows best industry practice for effluent storage and discharge given the nature of soils and topography at WW1&2 and at the Horner Block. The systems have been designed, constructed and located in accordance with best industry practice including the relevant practice notes and guidelines, and systems are maintained and operated in accordance with best practice guidelines. By only irrigating effluent to land when ground conditions are at less than field capacity, and by ensuring that irrigation of effluent to land does not result in soils reaching field capacity, the risks of nutrient rich effluent leaching through the soil profile or moving via overland flow are mitigated.

The slurry tanker with the trailing shoe will apply slurry at depths of less than or equal to 2.5 mm per application to allow for the higher nutrient loading in slurry. It can apply slurry at depths as low as 1 mm per application, which further minimises the risk of adverse effects and increases the number of irrigation days available. It applies slurry directly on the ground, which minimises the risk of adverse odours. The recommended buffer zones from waterways are adhered to when applying effluent, effluent is not discharged over tile drains when the soil is at or near field capacity nor is effluent applied to areas where cracks in the top soil have formed.

The effluent receiving area is sufficiently large to ensure that the N loading to land from dairy shed effluent and slurry does not exceed 150 kg N/hectare at WW1&2, and that it does not exceed 250 kg N/hectare at the Horner Block. Applying a higher N loading from slurry at the Horner Block allows nutrients in slurry to be used efficiently as fertiliser with reduced risk of N loss to groundwater. This is because plants take up N efficiently from slurry applied at very low depth while N fertiliser application is reduced accordingly to ensure the input of N overall is sustainable and does not lead to leaching losses. Importantly, since there is no grazing of stock at the Horner Block there are no urine patches, which otherwise leach N at high rates from urine, slurry and fertiliser.

In line with **Policy 18**, all stock is excluded from waterways.

The range of the good management practices implemented on farm, result in improved integrated management of freshwater through good dairy farm land management practices. This is in line with **Policy 39A**.

In line with **Policy 40**, the applicants seek a term of 15 years for the activities, which aligns with Woldwide One's discharge and water permit terms. There is good certainty regarding the nature and scale of the activity going forward; there will be an increase in cow numbers as well as implementation of good management practices and specific mitigation measures to ensure that the activity is sustainable in the long term. Considerable investment in farm infrastructure has been made to take the final steps towards future proofing the dairying operation at WW1&2; eliminating IWG from a sensitive part of Central Southland altogether. The level of investment demonstrates the applicant's belief in and commitment to sustainable farming and land management. The applicants believe that their presence at this location since 1992 (over 25 years) has not had a detrimental effect on the local environment, and that the proposed changes will mean a further reduction of that impact. A 15-year consent term will mean that the management of the resources under the same proven stewardship will be ensured into the future while allowing the applicants to operate a sustainable farming and business model. As 2013 supreme winners of the Southland Ballance Farm Environment Awards, their commitment to operating a sustainable farming model has been demonstrated.

Objectives and Policies relevant to land-use at Woldwide Runoff (WRO)

- **Objectives 6, 7, 8, 9, 13, 18**
- **Policies 6, 10, 11, 13, 16, 18**

Policies 6, 10 and 11 are met ensuring adverse effects on water quality from contaminants are avoided, remedied or mitigated:

- Required GMPs are implemented to manage adverse effects on water quality from contaminants transported via artificial drainage, overland flow, deep drainage and lateral drainage.
- FEMPs and respective applications have considered the aforementioned-contaminant pathways.

Policies 10 (3) and 11(3) give direction to decision makers on **generally** not granting resource consents for additional dairy farming of cows or additional IWG where contaminant losses will increase as a result of the proposed activity in the Oxidising and Peat Wetlands PZs respectively. In assessing whether the proposal is in line with guidance provided in these policies, some considerations are relevant:

- The term **generally** is used, which is understood to mean "broadly" "in most cases" or "without regard to particulars or exceptions." By including the term **generally**, the policies clearly allow for situations where resource consent can be granted where contaminant losses from additional cows or additional IWG increase in these PZs. In accordance with the intent of the RMA, consent can reasonably be granted be granted where effects on the receiving environment are shown to be minimal.
- WRO is not a dairy farm.

- WRO is a dry stock farm supporting five dairy farms, including WW1&2. It predominantly grazes R1 and R2 heifers with a small number of carryover cows and mating bulls. It has large areas under forestry, both commercial and indigenous.
- Under the proposal, IWG at WRO is operating at a permitted activity level. The applicants are not required to apply for resource consent for IWG activities at WRO since they meet permitted activity rules set out in Rule 20.
- However, WRO is part of WW1&2's landholding and will be on WW1&2's land use consent for farming, although many activities at WRO do not relate to the farming activity at WW1&2. Some farming activities at WRO will be conditioned on WW1&2's land use consent for farming.
- The proposal will maintain a similar stocking rate to the current rate but will see an increase in IWG activities at WRO, which is expected to result in a small increase in contaminant losses, predominantly via artificial drainage and overland flow pathways. Only a portion of these losses can be attributed to IWG of dry stock from WW1&2.
- Increasing IWG at WRO will see its removal from more sensitive catchments in Central Southland, where there is greater land use intensity and elevated groundwater nitrate levels.
- The applicants propose to limit the area under IWG annually at 100 hectares, which caps it at the permitted activity level under Rule 20.
- The AEE demonstrates that the proposed activity at WRO, including an increase in IWG, will have minimal effect on the nutrient loading in receiving waters and accordingly will have minimal effect on the Waiau catchment and Te Waewae Lagoon.
- The AEE demonstrates that there is minimal risk to groundwater at WRO due to the proposal, including from additional IWG activities.

In view of the above considerations, the applicants believe the decision-maker should grant resource consent for the proposed farming activity on Oxidising and Peat Wetlands PZs.

Policy 13 gives direction on the management of land use activities and discharges. In line with Policy 13.1 the proposal will better enable the applicants to provide for their social, economic and cultural well-being. The proposed land use at WRO will allow the applicants to sustainably manage the land while operating a profitable and sustainable business model. The maintenance of a profitable and sustainable business model is central to the success the business, and provides social, economic and cultural benefits to the applicants, their employees, families and whanau, and to the wider community. In the context of an agricultural-based local economy, the use and development of the land and water resources at WRO for primary production should be recognised. In line with Policy 13.2, land use activities and discharges (non-point source) are managed to enable the achievement of Policies 15A, 15B and 15C.

Policy 16 gives direction on farming practices that affect water quality.

WRO is not in close proximity to any regionally significant wetlands or sensitive waterbodies identified in Appendix A.

The AEE demonstrates how adverse effects on receiving waters, including cumulatively, due to proposed activities at WRO will be avoided or mitigated. Existing water quality in the Waiau catchment is not degraded to the point of being overallocated.

WRO operates under a farm environmental management plan, as set out in Appendix N. Sediment runoff risk is actively managed by identifying CSAs, implementing practices including setbacks from waterbodies, limits on areas or duration of exposed soils and the prevention of stock entering the beds of surface waterbodies. The individual layout, topography, soils and drainage properties of both Merrivale and Merriburn blocks are identified and managed by the applicants.

In line with **Policy 18**, all stock is excluded from waterways at WRO.

Having assessed the matters above, it is considered that both the application for the expansion of dairy farming, the discharge and the water abstraction are generally in accordance with the relevant policies and objectives of the documents set out above, and having regard to Section 104, the proposal achieves the purpose of the RMA.

4. Notification

Section 95A of the Act requires that the Consent Authority must publicly notify an application if the applicant has requested that the application be publicly notified*. The applicant hereby requests that the application be publicly notified.*

5. Receiving Environment

WRO's receiving environment is described in the WRO section of the application.

5.1 Soils

WW1&2 - soils

WW1&2 - soils

Topoclimate soil data shows that WW1&2 primarily overlies Braxton soils, with intergrades of Pukemutu soils in places. Topoclimate maps some areas of shallow stony Glenelg soils on the east side.

Topoclimate mapping of soils types for appears to be incorrect. Mr. John Scandrett (Scandrett Rural Limited) carried out a field investigation and has mapped soils at the WW1&2. Please refer to the appended report prepared by Mr. Scandrett for methodology, results and conclusions from the soil type and boundary field investigation. Mr. Scandrett dug at total of 28 test holes during his field investigation at WW1&2.

Mr. Scandrett reports that the west of WW1&2 overlies predominantly Braxton soils, and mid to east predominantly overlies Drummond soils. This is shown in figures 5.1, 5.2-5.4. Glenlg soils are found at the north east, north of Wreys Bush Highway.

The findings from the field investigation are supported by on-farm observations by the applicants, who report there is no subsurface drainage at the mid-east of WW1&2. Soils found mid-east are free-draining, which is characteristic of Drummond and Glenelg soil types and not of Braxton soils, which have been mapped by Topoclimate for much of the area. ***Braxton soils are less extensive than mapped on Topoclimate.***

Findings from the 2017 soil field investigation with support from applicant's knowledge from over 25 years of farming the land, provides a more accurate map for WW1&2 than is provided by Topoclimate, which sought to update Soil Bureau Bulletin 27 maps and is incorrect for land at WW1&2. The soil information and map from the 2017 field investigation have been adopted in this application as they truly reflect land at WW1&2. As such, they form the basis of the nutrient budget analysis and AEE. However, for Council to adopt the evidence from the field investigation, certain conditions must be met. Mr. Scandrett has extensive knowledge of and experience in working with soils but is not a qualified pedologist. Since Mr. Scandrett is not a qualified pedologist, we do not formally request that Council adopt his evidence over what is mapped. Council should recognise that Topoclimate mapping of soils at WW1&2 is incorrect, and informally accept the Mr. Scandrett's evidence as the best soil information available for WW1&2.

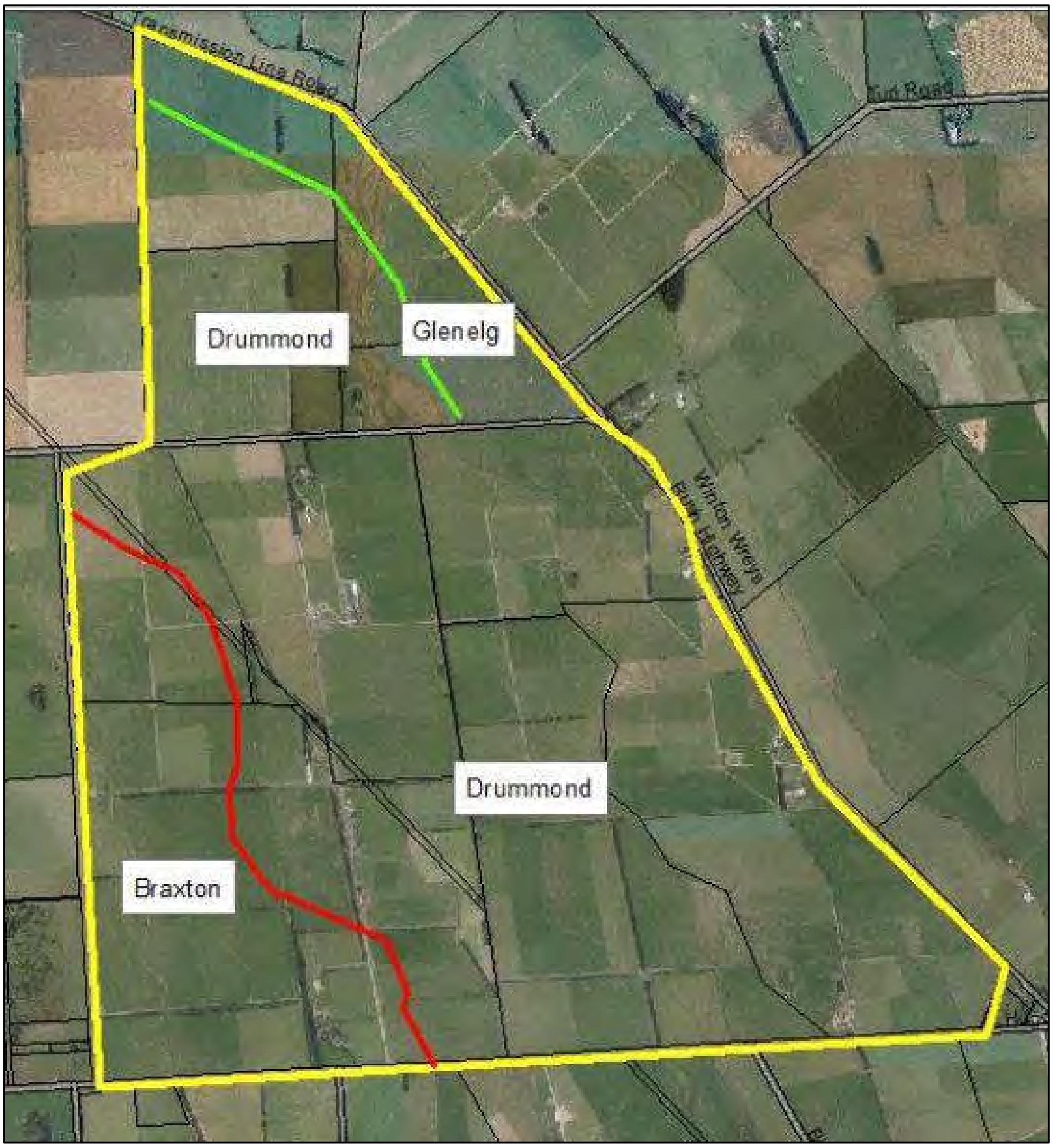


Figure 5.1 Soil types and boundaries at the WW1&2 according to field investigation by J. Scandrett, January 2017. Map sourced from Environment Southland.

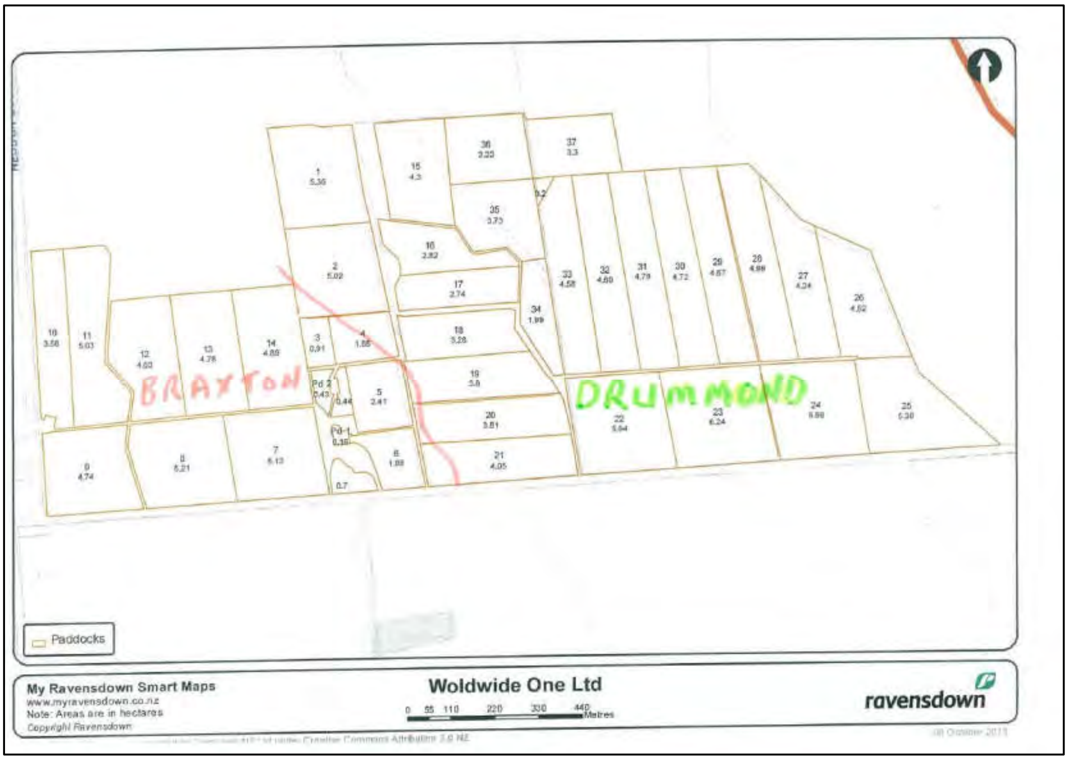


Figure 5.2 Soil mapping of WW1 area (note: this is an historic farm map).

Figure 5.3 Soil mapping of WW2 area (note: this is an historic farm map).

Figure 5.4 Soil mapping of former SH96 and Marcel blocks, now part of the WW1&2 (note: this is an historic map).

Soil vulnerability factors

Braxton soils have moderate risk of structural compaction, slight risk of nutrient leaching and severe risk of waterlogging. Drummond soils have minimal risk of structural compaction, moderate risk of nutrient leaching and slight risk of waterlogging. Glenlg soils have slight risk of structural compaction, very severe risk of nutrient leaching and nil risk of waterlogging.

Braxton soils types – swell/crack characteristics

Braxton soils have swell/crack properties. They can become waterlogged in wet conditions so tend to have subsurface drainage installed. They can crack during dry summer conditions. Deep cracks can provide a pathway for contaminants to reach groundwater via bypass drainage to the underlying aquifer. A site investigation of cracking soils was carried out in January 2018 by Environment Southland. The report by Michael Killick is appended to this application. Several sites were investigated, with some soils showing cracks (10 mm wide or less, with most cracks in the range of 2 – 4 mm wide) and others showing no cracks. The investigation occurred during a prolonged drought, with relatively high temperatures so if large/deep cracks were to form, they would have been expected to form in January 2018. Mr. Killick concluded:

> *It seems reasonable to conclude that the occurrence of very large cracks such as feature in some anecdotes about the soils (e.g. 'to reach your arm into') would now be rare in the soils observed for this investigation, and might not occur. Continued development or changes in management of the soils e.g. the ongoing effects of drainage, or conversion from sheep to dairy, may have influenced the historical pattern of soil behaviour. Or it may be that occurrences of Braxton soils other than those described here, crack more.*

Horner Block – soils

Topoclimate mapping of soils at the Horner Block shows that Braxton/Pukemutu soils are found on the east side, Drummond/Glenelg soils are found mid farm, and Waiau/Tuatapere soils are found on the west side towards the Aparima River. See figure 5.5 for Topoclimate mapping of soils at the Horner Block.

Braxton and Drummond soil properties are described in the previous paragraph. Pukemutu soils have very severe risk of structural compaction, slight risk of nutrient leaching and severe risk of waterlogging. Waiau soils have moderate risk of structural compaction, very severe risk of nutrient leaching and nil risk of waterlogging.

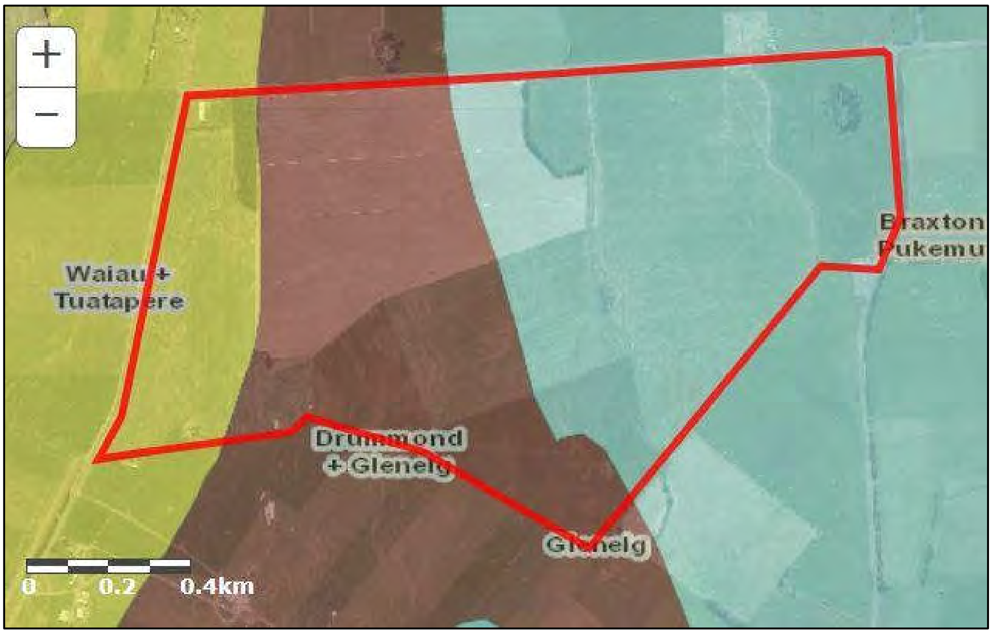


Figure 5.5 Topoclimate mapping of soils at the Horner Block (approximate boundary is outlined in red).

FDE risk

According to Beacon, the soil FDE Risk categories for WW1&2 comprise both Category A (artificial drainage/coarse soil structure) and Category E (other well drained but very stony flat land). See figure 5.6 for Beacon mapping of soils FDE risk at the dairy platform. Braxton soils are classed as Category A land and Glenelg soils are classed as Category E land.

Given the presence of Drummond soils, there are likely to be areas of Category D (well drained flat land) land, although these are not mapped on Beacon. Since Braxton soils are less extensive than mapped on Topoclimate, there is in fact less area of Category A land and more area of Category E and D land than mapped on Beacon.

The Horner Block comprises both Category A soils and Category E soils (see figure 5.6).

The soil FDE risk for both WW1&2 and the Horner Block comprise areas of both low and high risk for effluent discharge assuming low depth irrigation. These soils are suitable for dairy farming and receiving effluent provided that their vulnerabilities are recognised and that they are managed appropriately.

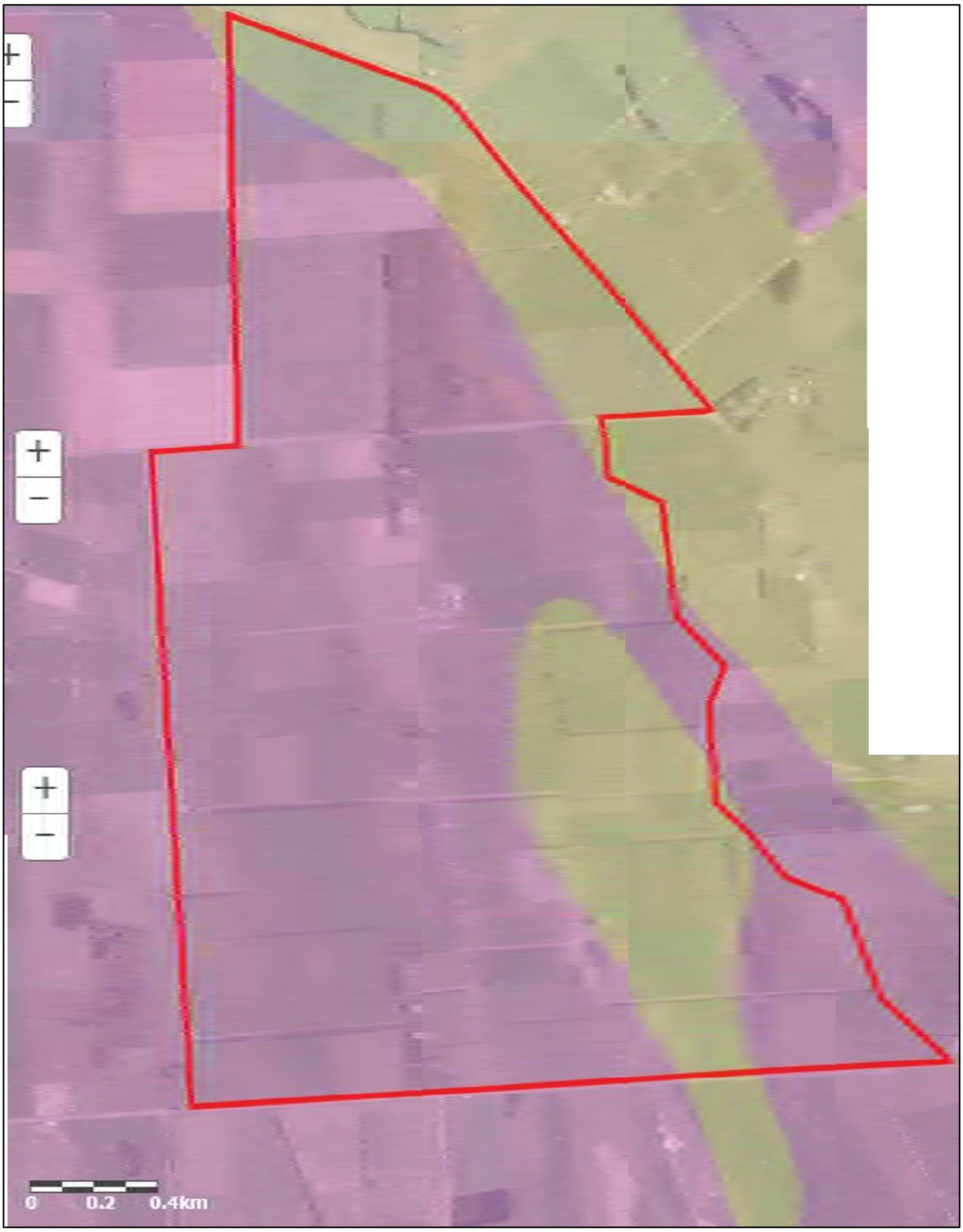


Figure 5.6 Soil FDE risk for the WW1&2 (approximate boundary is outlined in red).

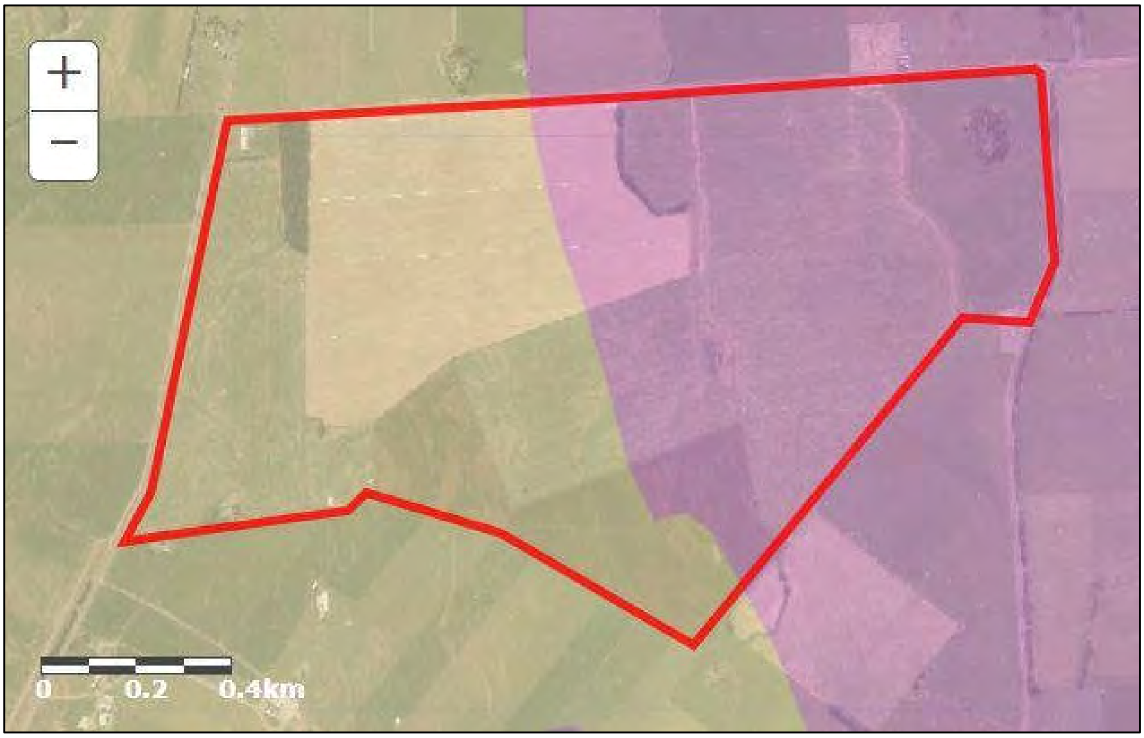


Figure 5.7 Soil FDE risk for the Horner Block (approximate boundary outlined in red).

Table 5.1. Physical properties of soils.

Soil type	Profile drainage	Plant readily available water	Potential rooting depth	Rooting restriction
Braxton	Poor	High	Deep	Limited subsoil aeration during sustained wet periods
Drummond	Well drained	High	Deep	No significant restriction
Glenelg	Well drained	Moderate-low	Shallow	Gravelly and cemented subsoil
Waiau	Well drained	Moderate	Slightly deep	Extremely gravelly subsoil

5.2 Surface water

The dairy platform lies in both the Waimatuku Stream and Oreti River catchments (see figure 5.7). The Horner Block lies predominantly in the Waimatuku Stream catchment, with its westernmost area lying in the Aparima River catchment (see figure 5.8).

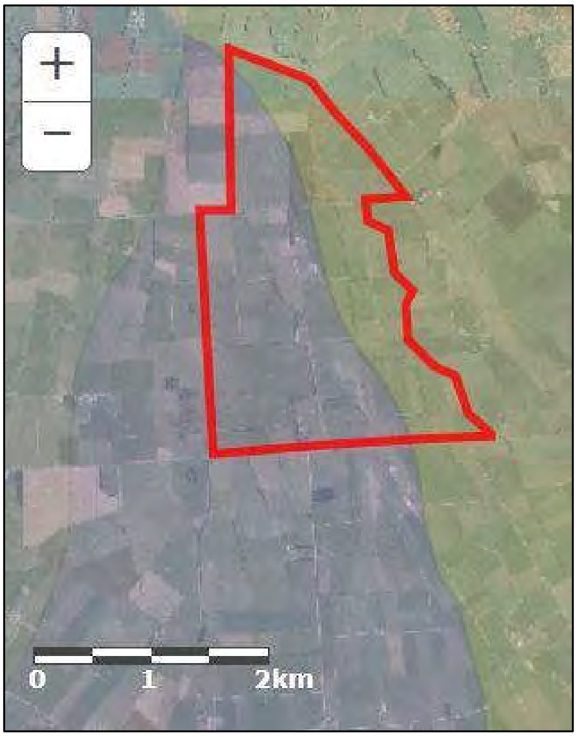


Figure 5.8 Major catchments: Waimatuku (mid-west) and Lower Oreti (east); approximate boundary is outlined in red.

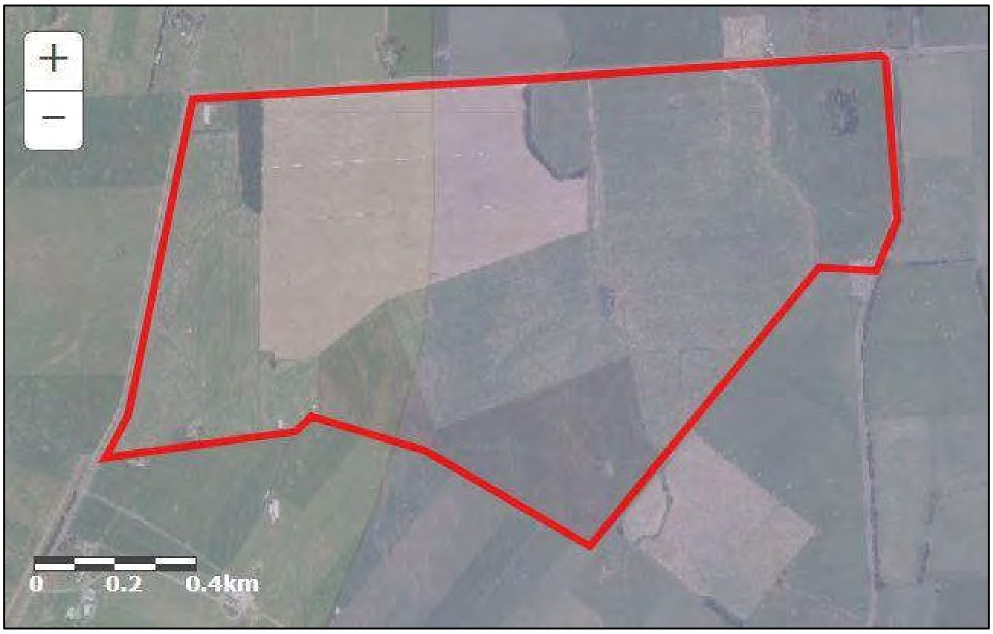


Figure 5.9 Horner Block; Waimatuku Stream (mid-east), Aparima (west); approximate boundary outlined in red.

Minor catchments

Minor catchments for WW1&2 are Terrace Creek, Oreti River and Middle Creek.

Minor catchments for the Horner Block are Middle Creek and the Waimatuku River.

Waterways are best described as surface drains. Riparian buffers are fenced off and vegetated with good grass cover.

See the accompanying FEMPs for the location of major tiles.

WW1&2 -surfacewater

Waterways generally flow in a north to south/southeast direction (see figure 5.10), are fully fenced off and culverted (see figure 5.11). One waterway flows along the eastern boundary, on to Terrace Creek to the south east and eventually to the Oreti River. Two waterways flow through the centre, on to Middle Creek and eventually the Waimatuku Stream to the south.

Subsurface drainage is installed at the west with outfall to surface drains. Subsurface drainage is only installed in heavier Braxton type soils except for one tile drain at the north east of Wreys Bush Highway. Subsurface drains (tiles) generally underlie hollows, which may act as critical source areas close to surface drains in times of prolonged heavy rainfall.

Horner Block

One waterway bisects and flows to Middle Creek to the south.

There is one swale at the Horner Block, which is found in a paddock that is not grazed by stock.

Figure 5.11 Waterway at the WW1 dairy unit.

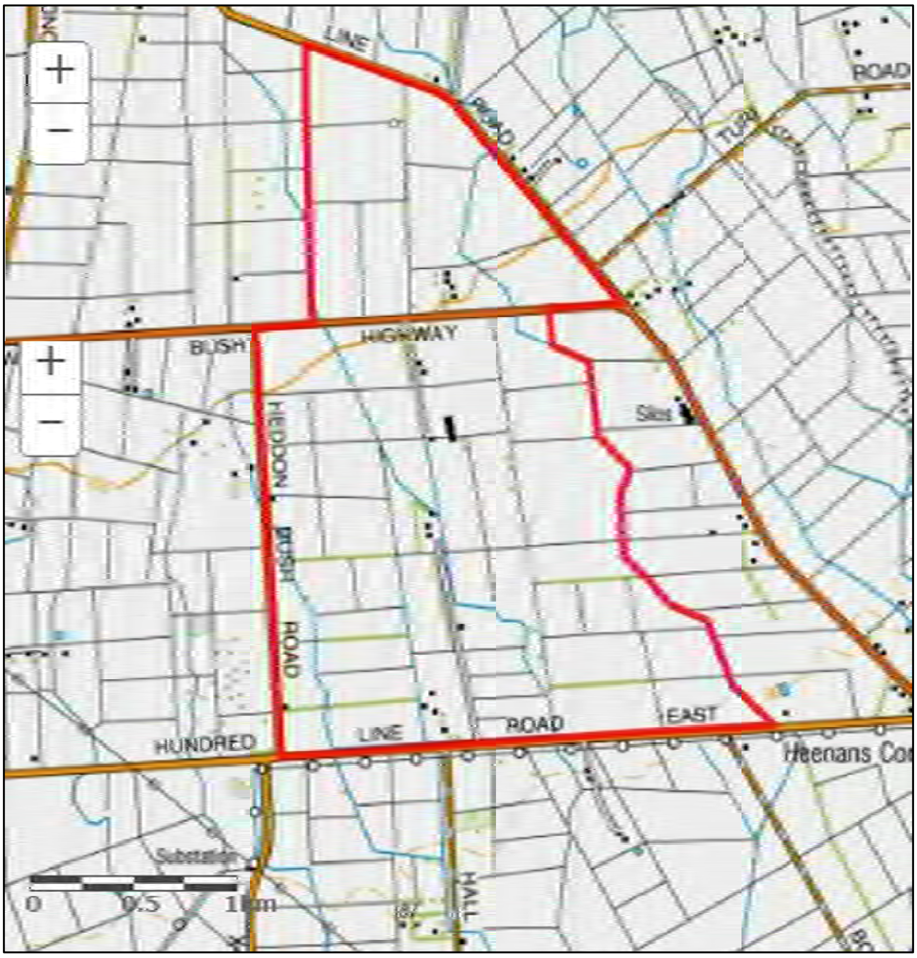


Figure 5.10 Topomap (with approximate boundary outlined in red).

Waimatuku Stream catchment

Most of WW1&2 and Horner Block are located at the northern most end of the Waimatuku Stream catchment according to Beacon. The Waimatuku Stream flows into the sea at Waimatuku Estuary in the Oreti Beach embayment. The Waimatuku Stream is located between the Oreti and Aparima catchments. Its headwaters are fed by a large swamp area (the Bayswater Peat Bog) with small springs in the Drummond district also contributing to the base flow. The catchment contains a variety of land uses including dairy farming, and dry stock farming. According to LAWA, the Waimatuku Stream was channelised in the 1920s. It typically has moderate flows, with few flood or extreme low flow events because of base flow contributions from swamp and spring areas.

~~SOE monitoring – Lower Waimatuku Stream~~

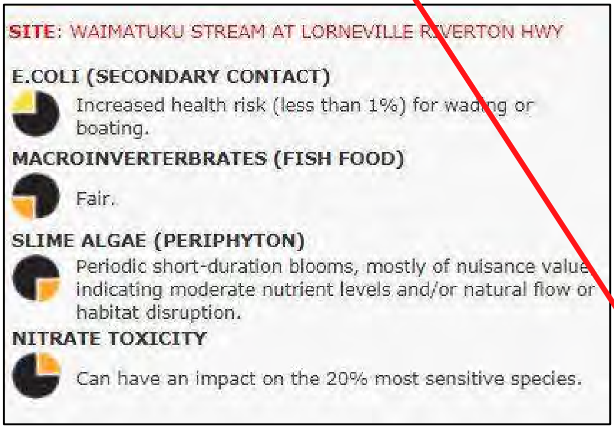
~~The closest downstream SOE water quality monitoring site for which data could be obtained in the Waimatuku catchment is the Waimatuku Stream at Lorneville Riverton Highway so it has been used as a reference. The Lorneville Riverton SOE monitoring site is classified as a lowland rural site. It is a lower-catchment site so captures the entire Waimatuku Stream catchment above Waimatuku Township.~~

~~Data obtained from The Land and Water website show evidence of cumulative effects on water quality for the Waimatuku Stream at the Lorneville Riverton site. The 5-year median black disc value is in the worst 50% of like sites. The 5-year median *E. coli* value of 450 n/100 ml is in the worst 25% of like sites~~

with a very likely improving ten-year trend. When assessed against the National Objective's Framework (NOF), the 5-year median *E coli* score is ranked in Band E. 5-year median concentrations for both Total Nitrogen and Total Oxidised Nitrogen are in the worst 25% of like sites, **however, both have a very likely improving ten-year trend.** The Total N 5-year median concentration is 3.65 g/m^3, which is above the ANZECC guideline of 0.614 g/m^3. The Total Oxidised N 5-year median concentration is 3.0 g/m^3, which is above the ANZECC Guideline value of 0.44 g/m^3 but below New Zealand Drinking Standards Maximum Acceptable Level (MAV) of 11.3 g/m^3 for nitrate nitrogen. When assessed against the NOF, the Total Oxidised Nitrogen value is classed in Band C; water quality at this site is considered "suitable for the designated use," but there may be effects on growth of up to "20% of species, mainly sensitive species such as fish." The 5-year median is below the National Bottom Line median of 6.9 g/m^3 for nitrate. The 5-year median DRP value shows meaningful degradation over ten years, with a value of 0.0425 g/m^3 is in the worst 25% of like sites. However, Total P shows a likely improving ten-year trend.

The closest downstream SOE site for which ecological data could be obtained in the Waimatuku catchment is the Waimatuku Stream at Rance Road. This SOE monitoring site is downstream of the water quality monitoring site at Lornville Riverton Highway and is close to the Waimatuku Estuary. The 5-year median MCI score was classed as fair, although there is evidence of a decreasing trend in recent years. The 5-year median Taxonomic Richness score was 20, with evidence of a slight increasing trend in more recent years. The median %EPT score was 40% over the same five-year period, with a slight drop in later years.

The nearest National Objectives Framework (NOF) site is the *Waimatuku Stream at Lorneville Riverton Highway* site. NOF water quality indicators show that generally water quality is fair to poor at the site (see figure 5.12 below). The MCI score is fair. Slime algae/periphyton is indicative of high nutrient levels or significant natural flow/habitat disruption at the site. The *E. coli* score indicates "low risk of infection (less than 1% risk) from contact with water during activities with occasional immersion (such as wading and boating)." The Total Oxidised Nitrogen score indicates that there may be an impact "on the 20% most sensitive species."



SITE: WAIMATUKU STREAM AT LORNEVILLE RIVERTON HWY

E.COLI (SECONDARY CONTACT)

Increased health risk (less than 1%) for wading or boating.

MACROINVERTERBRATES (FISH FOOD)

Fair.

SLIME ALGAE (PERIPHYTON)

Periodic short-duration blooms, mostly of nuisance value indicating moderate nutrient levels and/or natural flow or habitat disruption.

NITRATE TOXICITY

Can have an impact on the 20% most sensitive species.

Figure 5.12 NOF indicators for *Waimatuku Stream at Lorneville Riverton Highway* site.

The lower catchment SOE site for the Waimatuku Stream shows evidence of land use in the catchment with high levels nutrients and contaminants dominating. This relates to the intensity of land use in the catchment, local hydrology, attenuation of nutrients and the physiographic land types found in the catchment. Artificial drainage and deep drainage to shallow aquifers, as well as the low to moderate denitrification potential of some soils and aquifers, and the lack of a major river for diluting contaminants are factors that combine to produce this outcome. The Waimatuku catchment has shown recent improvement for nutrient N, with the 5-year median concentration for both Total N and Total Oxidised N decreasing over the last two reporting years. This is significant as it indicates that N losses and related effects in the catchment may recently have started to decrease.

Waimatuku Estuary

Coastal waters (the Waimatuku Estuary and coastal waters at the Oreti Beach Embayment) are the receiving environments for the Waimatuku Stream and catchment. The Waimatuku Estuary is a small, shallow, "tidal river mouth" estuary that drains to the sea through a sand dominated barrier beach and modified marram grass duneland. It has relatively small intertidal flats, while the estuary mouth periodically constricts, naturally reducing flushing and according to a 2012 study[5] has "very elevated nutrient inputs make the estuary highly susceptible to eutrophication as the assimilative capacity of the estuary is very quickly exceeded when the mouth is constricted. Currently, despite most catchment inputs flowing directly to the sea, nuisance macroalgal growths (e.g. *Ulva intestinalis*) are common, particularly in summer in the middle estuary, while algal blooms also occur at the mouth and along Oreti Beach." The major threat to the estuary is eutrophication due to elevated nutrient inputs, exacerbated by periodic mouth constriction to the sea and consequent restricted flushing.

A 2018 Fine Scale Monitoring and Macrophyte Mapping study[6] reported that" Despite receiving a high nutrient load from both riverine and groundwater sources……., when its mouth is open for exchange with the sea, the Waimatuku has a relatively low susceptibility to eutrophication. This is primarily because of its highly flushed nature, given that it is strongly channelised with very few poorly flushed areas, and has high freshwater inflow. However, the assimilative capacity of the estuary with regard to nutrients is very quickly exceeded when the mouth is constricted. Since monitoring began in 2008, the estuary mouth has been driven approximately 1 km to the east by long shore drift, potentially further constricting the mouth, restricting flushing, and therefore increasing the likelihood of eutrophication issues. Currently, nutrients retained in the estuary contribute to the growth of attached macrophytes and associated nuisance macroalgae, while the presence of elevated chlorophyll a levels at times may be attributable to phytoplankton blooms in saline bottom waters and from freshwater sources upstream of the estuary."

Lower Oreti catchment

The easternmost part of the property is found in the Lower Oreti Catchment. Surfacewater drainage from the eastern side of the property flows via Terrance Creek to the Lower Oreti River below the Oreti Plains.

The Oreti catchment is Southland Region's third largest. It runs from the Thomson Mountains in the north of the region to the New River Estuary. The upper catchment maintains much of its natural qualities and is internationally renowned for its trophy brown trout fishing. The mid and lower reaches of the Oreti catchment have been substantially modified for drainage, flood control and channel clearance work. Oreti River tributaries, such as the Winton and Waikiwi Streams and the Makarewa River, are each subject to point-source discharges of effluent from industry and municipal sewage treatment. Potential impacts to water quality may also arise through tile drain and non-point source discharges. In addition, stock access to waterways, drainage maintenance and gravel extraction activities can adversely affect water quality in the Oreti River.

---

[5] Stevens & Robertson (2012). Waimatuku Estuary 2018. Fine Scale Monitoring and Macrophyte Mapping

[6] Robertson & Robertson (2018). Waimatuku Estuary 2018. Fine Scale Monitoring and Macrophyte Mapping

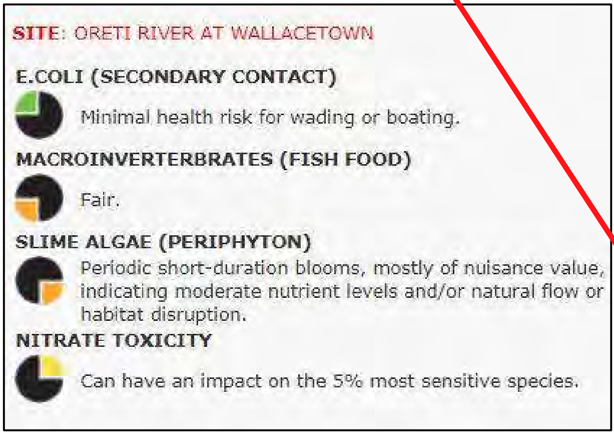
SOE monitoring – Lower Oreti River

The closest current SOE water quality monitoring site downstream of the property is at the Oreti River at Wallacetown. This SOE monitoring site is classified as a lowland rural site with a gravel bed and is the lowest SOE site in the Aparima River catchment. It is a lower-catchment site so captures the entire Oreti River catchment above Wallacetown Township.

Data obtained from LAWA's website show evidence of cumulative effects on water quality for the Oreti River at the Wallacetown site. The median black disc value (1.815 m) is in the best 50% of like sites with an indeterminate ten-year trend. The 5-year median *E. coli* value of 130 n/100 ml is in the worst 50% of like sites with a likely improving ten-year trend. When assessed against the National Objective's Framework (NOF), the 5-year median *E coli* score is ranked in Band D. Median concentrations for both Total Nitrogen and Total Oxidised Nitrogen are in the worst 25% of like sites, however, trend analysis is unavailable for both N parameters. The Total N median concentration is 1.13 g/m^3, which is above the ANZECC guideline of 0.614 g/m^3. The Total Oxidised N median concentration is 0.94 g/m^3, which is above the ANZECC Guideline value of 0.44 g/m^3 but well below New Zealand Drinking Standards Maximum Acceptable Level (MAV) of 11.3 g/m^3 for nitrate nitrogen. When assessed against the NOF, the annual median Total Oxidised Nitrogen value is classed in Band B; water quality at this site is considered "suitable for the designated use," and is regarded to have high conservation values; it is likely to have some effect on growth of up to 5% of species. The annual median DRP value of 0.006 g/m^3 is in the best 50% of like sites, however no trend analysis is available.

The closest downstream SOE site for which ecological data could be obtained in the Oreti River catchment is the *Oreti River at Wallacetown*. The 5-year median MCI score (95) was classed as fair. The 5-year median Taxonomic Richness score was 21. The 5-year median %EPT score was 40%.

The nearest National Objectives Framework (NOF) site is the *Oreti River at Wallacetown* site. NOF water quality indicators show that generally water quality is reasonable to fair at the site (see figure 5.13 below). The MCI score is fair. Slime algae/periphyton is indicative of high nutrient levels or significant natural flow/habitat disruption at the site. The *E. coli* score indicates "minimal risk of infection for wading or boating." The Total Oxidised Nitrogen score indicates that there may be an impact "on the 5% most sensitive species."



SITE: ORETI RIVER AT WALLACETOWN

E.COLI (SECONDARY CONTACT)

Minimal health risk for wading or boating.

MACROINVERTERBRATES (FISH FOOD)

Fair.

SLIME ALGAE (PERIPHYTON)

Periodic short-duration blooms, mostly of nuisance value, indicating moderate nutrient levels and/or natural flow or habitat disruption.

NITRATE TOXICITY

Can have an impact on the 5% most sensitive species.

Figure 5.13 NOF indicators for *Oreti River at Wallacetown* site.

The lower catchment Oreti River shows evidence of land use in the catchment with elevated nutrients and contaminants dominating, as well as impacts on biological indicators. This relates to some point source discharges from sewage treatment plants and industry, the intensity of land use in the catchment, local hydrology and the physiographic land types found in the catchment. Artificial drainage and deep drainage to shallow aquifers, as well as the low to moderate denitrification potential of some soils and aquifers are factors that combine to produce this outcome.

New River Estuary

The New River Estuary and coastal waters are receiving environments for the Oreti River and catchment. New River Estuary is a relatively large estuary, which receives the Oreti and Waihopai Rivers, and their tributaries. According to a 2012 Fine Scale Habitat Mapping study[7] "eutrophication and sedimentation have been identified as a major issue since at least 2007-8." The major threats to the estuary are eutrophication due to elevated nutrient inputs and elevated sediment inputs. Eutrophication triggers nuisance micro and macro algal growth. Conditions in the well flushed central basin and lower estuary are reasonable, however, gross nuisance algal conditions and sulphide rich sediments are causing problems in more sheltered, poorly flushed areas.

A 2018 Macro Algal Monitoring study[8] concluded that the "estuary is eutrophic, with conditions consistently worsening since monitoring commenced in 2001. The area of the estuary with gross eutrophic conditions has now expanded from 23ha in 2001 (1% of the estuary) to 428ha in 2018 (15% of the estuary). This has caused a significant loss of dense (>50% cover) high value seagrass from the estuary (a 94% loss in the Waihopai Arm). In short, the estuary is exhibiting significant problems associated with excessive macroalgal growth and likely represents the largest impact of this type to have occurred in a NZ SIDE estuary. Unless nutrient inputs to the estuary are reduced significantly, it is expected that there will be a continuation of these difficult to reverse adverse impacts within the estuary."

New River Estuary is the receiving environment for Invercargill City, which includes urban, industrial and storm water discharges.

Aparima River catchment

The westernmost part of the Horner Block is found in the Aparima River Catchment. The Aparima River is the smallest of Southland's four main catchments. It extends from the Takitimu Mountains west of Mossburn to the Jacobs River Estuary at Riverton and the headwaters drain alpine, native tussock and forested land. According to LAWA, the upper Aparima catchment maintains much of its natural qualities, whereas the mid and lower reaches have been substantially modified for drainage, flood control and channel clearance work. The catchment contains a variety of land uses including dairy farming, and dry stock farming. Major tributaries include the Hamilton Burn in the upper reaches and the Otautau Stream in the lower reaches, which is known to have poor water quality. According to LAWA, the main pressures on water quality in the Aparima catchment are due to dairy farm intensification as drain networks in the lower catchment can discharge degraded water to receiving streams. Overland flow and nutrient loss from wintering practices contribute significantly, particularly when soils are saturated. Flood and drainage works also potentially impact water quality in the Aparima catchment.

---

[7] Robertson & Stevens (2012/1013). New River Estuary. Report prepared for Environment Southland.

[8] Stevens (2018). New River Estuary 2018 Macroalgal Monitoring. Report prepared for Environment Southland.

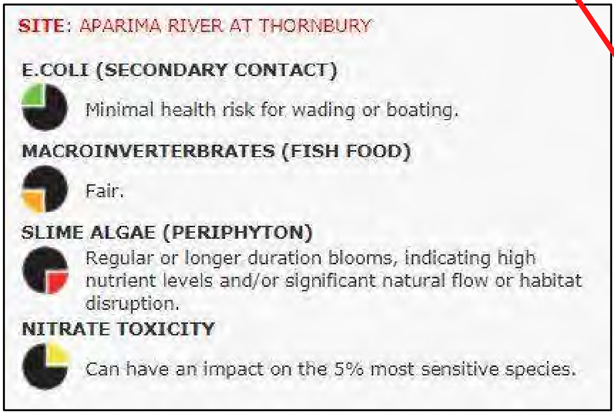
SOE monitoring – Lower Aparima River

The closest current SOE water quality monitoring site is at the Aparima River at Thornbury. This SOE monitoring site is classified as a deep, fast flowing lowland rural site with a gravel bed and is the lowest SOE site in the Oreti River catchment.

As is evident on LAWA's website, key SOE indicators for the Aparima River at Thornbury indicate that the lower catchment river is in reasonable health with trends for most indicators showing improvement. This includes trends for visual clarity, *E.coli*, nitrogen and phosphorous. The 5-year median turbidity and black disc visibility values are in the best 50% of like sites. The 5-year median *E. coli* value is 130 n/100 ml and is in the worst 50% of all lowland rural sites. *E coli* is classed in band D for the National Objectives Framework (NOF). The 5-year median Total Phosphorous concentration was 0.014 g/m^3, which is below the ANZECC Guideline value of 0.033 g/m^3. It is in the best 50% of all lowland rural sites. Dissolved Reactive Phosphorous (DRP) median concentration was 0.006 g/m^3 and is below the ANZECC Guideline value of 0.01 g/m^3. It is in the best 50% of all lowland rural sites. The median Total Nitrogen concentration was 0.91 g/m^3 putting it in the worst 50% of all lowland rural sites and slightly above the ANZECC Guideline value of 0.641 g/m^3 for this indicator. The Total Oxidised Nitrogen median concentration was 0.665 g/m^3 putting it in the worst 50% of like sites. It is slightly above the ANZECC Guideline value of 0.444 g/m^3 for nitrate nitrogen. Total Oxidised Nitrogen is classed in band B for the National Objectives Framework (NOF), and is assessed as being "suitable for designated use" but there may be growth effects on up to 5% of species. No ecological data for the Aparima River at Thornbury SOE site were available at the time of writing.

The closest downstream SOE site for which ecological data could be obtained in the Aparima River catchment is the *Aparima River at Thornbury*. The 5-year median MCI score (100) was classed as good. The 5-year median Taxonomic Richness score was 16. The 5-year median %EPT score was 43.8%.

The nearest National Objectives Framework (NOF) site is the *Aparima River at Thornbury* site. NOF water quality indicators show that generally water quality is reasonable to fair at the site (see figure 5.14 below). The MCI score is fair. Slime algae/periphyton is indicative of high nutrient levels or significant natural flow/habitat disruption at the site. The *E. coli* score indicates "minimal risk of infection for wading or boating." The Total Oxidised Nitrogen score indicates that there may be an impact "on the 5% most sensitive species."



SITE: APARIMA RIVER AT THORNBURY

E.COLI (SECONDARY CONTACT)

Minimal health risk for wading or boating.

MACROINVERTERBRATES (FISH FOOD)

Fair.

SLIME ALGAE (PERIPHYTON)

Regular or longer duration blooms, indicating high nutrient levels and/or significant natural flow or habitat disruption.

NITRATE TOXICITY

Can have an impact on the 5% most sensitive species.

Figure 5.14 NOF indicators for *Aparima River at Thornbury* site.

~~The lower catchment SOE site for the Aparima River shows evidence of land use in the catchment with slightly elevated levels of N and some contaminants present. This relates to the intensity of land use, local hydrology and the physiographic land types found in the catchment. Artificial drainage and overland flow, as well as the low to moderate denitrification potential of some soils and aquifers are factors that combine to produce this outcome. Wintering practices in the wider catchment have also been identified as a factor for the Aparima River catchment.~~

~~Jacobs River Estuary~~

~~The Aparima River is part of the Jacobs River Estuary catchment, which is considered a sensitive environment due to the accumulation of nutrients and sediment. Jacobs River Estuary is a medium-sized (720 ha) tidal lagoon estuary near Riverton. Broad scale and fine scale monitoring studies (Stevens & Robertson 2003, 2007-2011, 2013) have indicated variable levels of eutrophication and sedimentation across the estuary, with some parts being highly muddy and anoxic, eutrophic and having associated nuisance algal growth. The most recent study in 2013 revealed that "although large sections of the lower estuary remain in good condition, there has been a significant decline in estuary quality since 2003, and especially over the past five years. In particular, the poorly flushed parts of the Aparima and Pourakino arms were excessively muddy, had high nuisance macroalgal growths, and contained poorly oxygenated sediments with toxic sulphides. These gross eutrophic areas are displacing high value seagrass beds and stressing saltmarsh habitat." Other values that were identified in the study as being adversely affected by the degrading estuary were biodiversity, aesthetic, amenity and recreational values.~~

Regionally Significant Wetlands

There is one Regionally Significant Wetland in the vicinity of the property; Dunearn Wetland is approximately 4 km to the north east of the property. Given drainage from the property is in a southerly direction, no further description of Dunearn Wetland is required.

Two Regionally Significant Wetlands lie south of the property; Bayswater Peat Bog lies approximately 10 km to the south west of the property, and Drummond Peat Swap lies approximately 12 km to the south east of the property. Both are remnant peat bogs, which once had a much greater extent in Southland.

Bayswater Peat Bog

The Bayswater Peat Bog is classified as a "lowland rushland shrubland on peat domes" peatland and is representative of peatland ecosystems, which formerly had a much greater extent in Southland[9]. Raised bogs such as the Bayswater Bog are rainfed, i.e. they derive their water and nutrients solely from rainfall. They are characterised by plants and animals adapted to the waterlogged and nutrient-poor conditions. On the Southland Plains they are dominated by peat-forming species such as *Empodisma minus* (wire rush) and Sphagnum moss species, which are characteristic of the flat, poorly drained areas.

AEE on Bayswater Peat Bog

Surfacewater drainage from both WW1&2 and the Horner Block is in a southerly direction towards Middle Creek (and Terrace Creek further east). Bayswater Peat Bog lies to the south west of the property. Middle Creek flows approximately 5 kilometres to the east of Bayswater Peat Bog (see figure

---

[9] Clarkson (2003). Significance of peatlands in Southland Plains Ecological District, New Zealand. DOC Science Internal Series 116.

5.15). As surfacewater drainage does not flow in the direction of Bayswater Peat Bog, the risk of adverse effects on Bayswater Peat Bog from the proposed activities (land and discharge) is considered to be less than minor.

Furthermore, water at the 210-hectare raised bog is only derived from rainfall. As such the risk to water quality at the Bayswater Bay is further lowered. Surfacewater drainage in the vicinity of the Bog, drains through land <u>surrounding</u> the Bog, and on to the Waimatuku Stream; it does not drain through the Bog itself.

Groundwater flow in the Waimatuku Groundwater Zone is due south[10] and does not flow towards Bayswater Peat Bog but flows in a southerly direction to the east of the Bog. Furthermore, Hitchcock refers to a report by Robertson (1983), "*previous analysis of groundwater levels in the bog concluded that the water table domes with the bog but is a separate system is probably fed by rainfall*." Hitchcock found that that groundwater in the Waimatuku GW zone is recharged from the Bog. The risk of adverse effects related to groundwater on Bayswater Peat Bog from the proposed activities (land use and discharge) is considered to be less than minor.

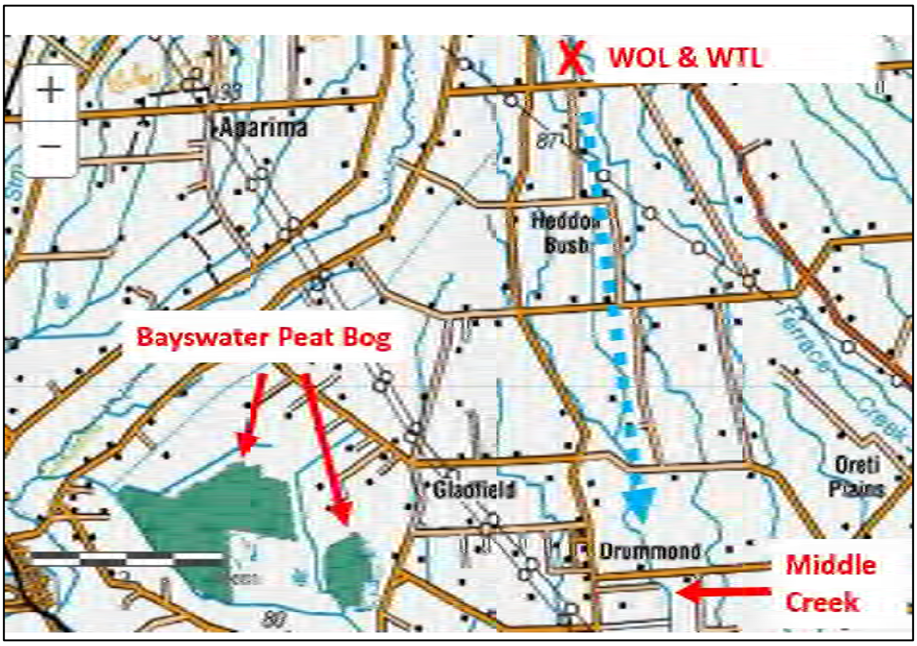


Figure 5.15 Topomap showing location of Bayswater Peat Bog, Middle Creek, property location and direction of surfacewater drainage from property (indicated by blue hatched line).

Drummond Swamp

According to Rance (2008), "Drummond Swamp is classified as a Wildlife Management Reserve and is located c.4 km south-east of Drummond. Drummond Swamp is one of the larger reserves on the Southland Plains (256.42ha). It is one of only two peatland reserves on the Southland Plains." The wetland is intact and has a modified central area due to a former gull colony. The major management challenge is weed control, with several weeds present; gorse, grey willow, silver birch, service berry, rowan and blackberry are examples of weed species present. The peatland plant community is dominated by wirerush (*Empodisma minus*), as well as tangle fern (*Gleichenia dicarpa*), sphagnum

---

[10] Hitchcock (2014). Characterising the surface and groundwater interactions in the Waimatuku Stream, Southland. MSc Thesis. University of Otago.

moss (*Sphagnum cristatum*) and swamp inaka (*Dracophyllum oliveri)*. A copy of Rance's report is appended to the application.

AEE on Drummond Swamp

Surfacewater drainage is in a southerly direction towards Middle Creek (and Terrace Creek further east). Drummond Swamp lies to the south east of WW1&2 (see figure 14.16). Middle Creek flows approximately 1 kilometre to the west of Drummond Swamp. An un-named tributary of Middle Creek flows from WW1&2 to within 330 metres (west) of Drummond Swamp, where it flows along Kennedy Road (see figure 14.17). As surfacewater drainage flows close to but not through Drummond Swamp, the risk of adverse effects relating to surfacewater on Drummond Swamp from the proposed activities (land use and discharge) approximately 12 kilometres to the north west is considered to be minor.

Drummond Swamp is also a peat bog, and on that basis is expected to derive its water from rainfall. This further lowers the risk to Drummond Swamp from surfacewater drainage from surrounding land use as drainage does not flow through the Swamp itself. It is noted that Rance (2008) discusses pest plants, pest animals and fire as risks to Drummond Swamp.

There is a lack of specific information available on groundwater interactions at Drummond Swamp. Groundwater underlying is unlikely to flow to the Swamp, however, there is some uncertainly around this given the location of the Swamp and Ww1&2, and the lack of information of groundwater interactions at the Swamp. A study by Hitchcock (2014) on the Bayswater Bog referred to a study by Robertson (1983) and reported that *"previous analysis of groundwater levels in the bog concluded that the water table domes with the bog but is a separate system is probably fed by rainfall."* Since Drummond Swamp is a similar system and is partly in the same groundwater zone, it is reasonable to draw a similar conclusion. Hitchcock found that groundwater in the wider aquifer is recharged from the Bog. It is likely to also be the case for Drummond Swamp, i.e. Drummond Swamp discharges to the wider groundwater resource. The effect on Drummond Swamp due to groundwater related effects from the proposed activities (land and discharge) is minor.

Figure 5.16 Topomap showing location of Drummond Swamp, Middle Creek, property location and direction of surfacewater drainage from property (indicated by blue hatched line). Se figure 5.17 for area around Drummond Peat Swamp.

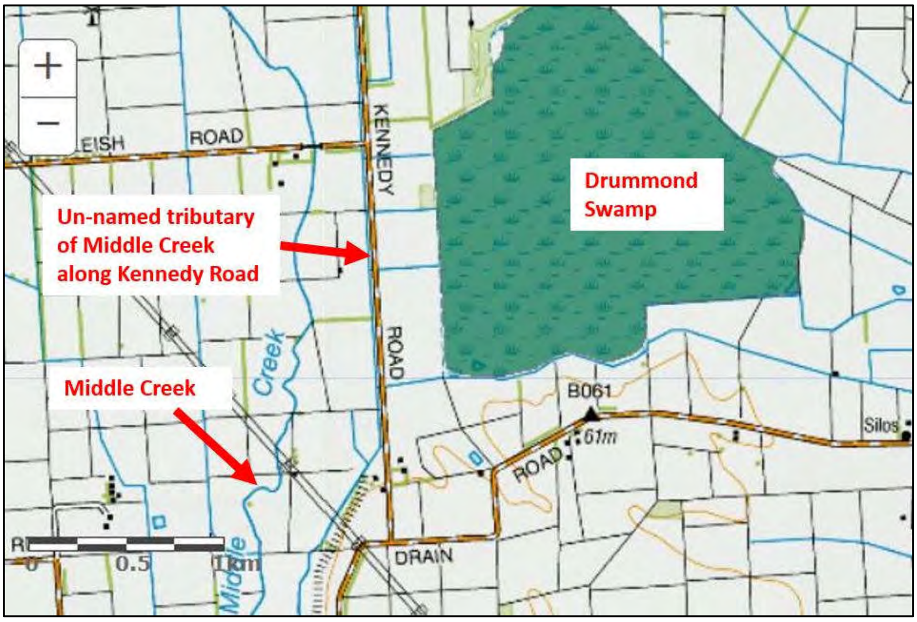


Figure 5.17 Topomap showing location of Drummond Swamp, Middle Creek and un-named tributary of Middle Creek adjacent to Kennedy Road.

5.3 Groundwater

Most of WW1&2 and Horner Block overlie the Waimatuku Groundwater Zone. Heddon Bush School 2.3 kilometres to the south also overlies the Waimatuku Groundwater Zone. The eastern WW1&2 overlies the Central Plains Groundwater Zone. The western part of the Horner Block overlies the Upper Aparima Groundwater Zone.

In this section, all three groundwater zones are firstly described. Following this, groundwater nitrate and groundwater microbial contaminants in the vicinity of WW1&2 and Horner Block are described.

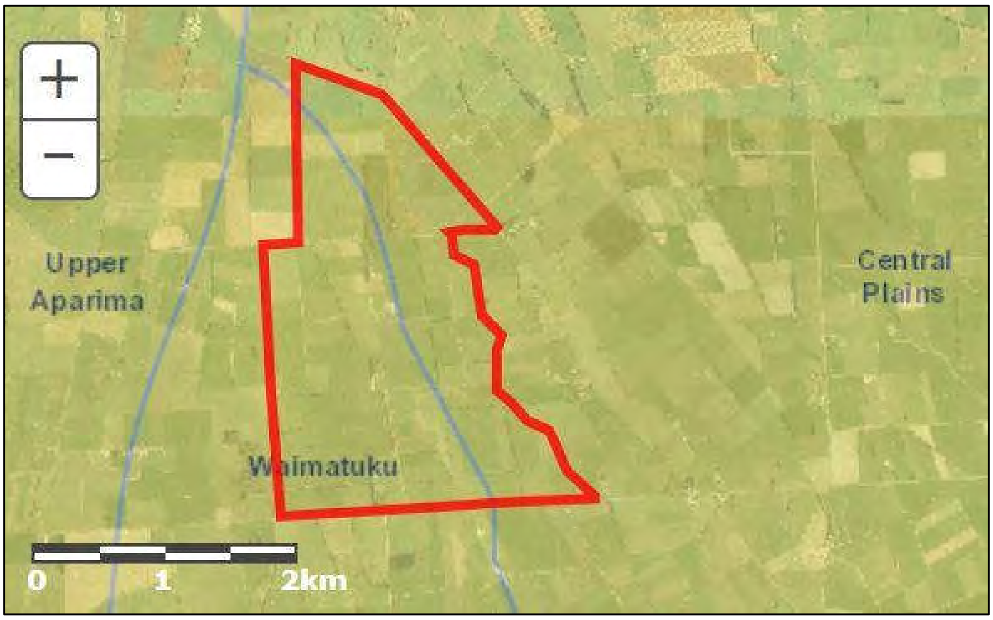


Figure 5.18 Groundwater zones in the vicinity of the WW1&2 dairy platform (approximate boundary is outlined in red).

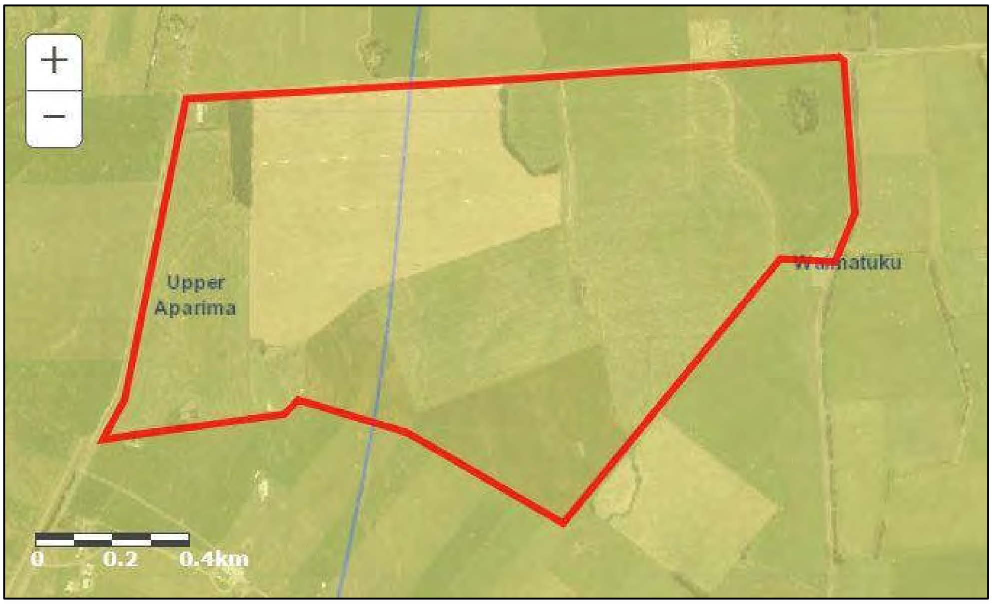


Figure 5.19 Groundwater Zones at Horner Block (approximate boundary outlined in red).

The Waimatuku Groundwater Zone

The Waimatuku Groundwater Zone is classified as a lowland aquifer type according to Environment Southland's Information Sheet and has low allocation status. The diagram below gives a schematic cross section of the Waimatuku Groundwater Zone; recharge to the Waimatuku groundwater zone is principally derived from rainfall recharge. Annual land surface recharge is estimated to be 467 mm/year. According to Environment Southland, available flow gauging and water quality information suggest that shallow groundwater makes a significant contribution to baseflow discharge in the Waimatuku catchment with recharge circulating relatively rapidly through upper levels of the unconfined aquifer and discharging via the local stream network. Groundwater circulation through deeper levels of the aquifer system is likely to be relatively slow and follow the more general southward topographic gradient.

According to Environment Southland's Information Sheet, groundwater quality in the Waimatuku Groundwater Zone is generally good, although it does vary according to source aquifer and location. Some areas of elevated nitrate concentrations are observed in shallow groundwater reflecting infiltration from surrounding land use.

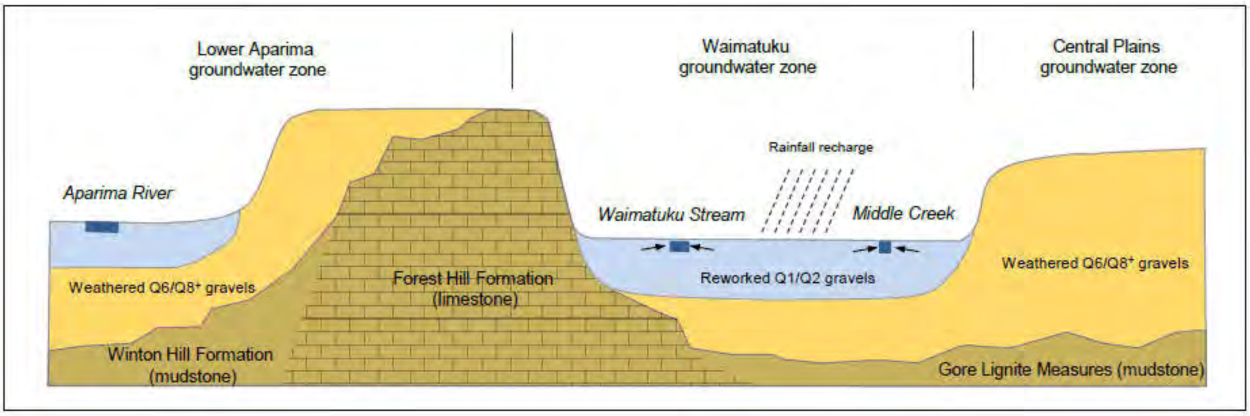


Figure 5.20 Schematic cross-section of the Waimatuku Groundwater Zone[11]

Groundwater flow

Hitchcock characterised surface and groundwater interactions in the Waimatuku Stream catchment in a master's thesis[12]. The study reported that from Wreys Bush down to Drummond "groundwater flow is from north to south down the catchment." See figure 4.7 in Hitchcock's thesis for a map depicting groundwater flow in the Waimatuku Catchment. Heddon Bush School, which has a bore for drinking water supply (HED001), is c.2.3 km due south of the WW1&2 dairy platform (see figure 5.21) and lies in the Waimatuku Groundwater Zone. Based on Hitchcock's report, groundwater underlying much of WW1&2 flows south, so flows in the direction of Heddon Bush School.

An estimate of the average linear velocity of groundwater moving south was calculated by hydrologist Mark Flintoft from Aqualinc Limited (personal communication). Using a porosity of 0.3, K of either 26 or 2,600 m/day, an average linear velocity of 0.5 to 40 m/day was estimated. Mr. Flintoft has stated that the figure provided is an approximation of linear velocity. In the absence of other references for the velocity of groundwater in the area, this estimate can be used to approximate groundwater movement.

~~Land use in wider area since 1980s – potential for effects on GW~~

~~The WW1 dairy unit was established in 1992 and the WW2 dairy unit was officially established in 2003. Land use activities in the wider area since the 1980s (if not before) include sheep farming, dairy farming, intensive winter grazing of dairy stock and cereal cropping. Dairy farming has expanded since the mid-2000s. In line with land use activity in the Central Southland area, cereal cropping was formerly a significant activity with cereal crops (barely/grain) typically being grown and harvested annually. Sheep farming and cereal cropping often went together on individual farms. Cereal cropping reduces soil organic matter content and water holding capacity so has relatively high N loss to water. IWG of fodder crops also has relatively high N loss to water. The presence of these activities in the area during the 1980s, 1990s and beyond is of note when considering N loss to groundwater, lag times and groundwater flow. Over decades, these activities can be expected to have lost N to groundwater where free draining soils are found or where there is an alternative pathway to groundwater (e.g. bypass drainage via deep cracks in Braxton soils). N signals in groundwater from these activities would be expected to have been seen for some time in the Waimatuku zone if they were present.~~

---

[11] Waimatuku Gourndwater Zone Information Sheet. http://gis.es.govt.nz/apps/groundwater/zones/Waimatuku.pdf

[12] Hitchcock (2014). Characterising the surface and groundwater interactions in the Waimatuku Stream, Southland. MSc Thesis. University of Otago.

~~Using the estimate for groundwater movement of 0.5 to 40 m/day, land use effects on groundwater due to the WW1 and WW2 dairy platforms and prior activities such as intensive winter grazing and cereal cropping, if they are present will have been seen at the Heddon Bush School area for some time.~~

Figure 5.21 Topomap showing groundwater zones and location of Heddon Bush School (approximate WW1&2 boundary outlined in red).

Central Plains Groundwater Zone

The Central Plains Groundwater Zone is classified as a lowland aquifer type according to Environment Southland's Information Sheet and has low allocation status. The diagram below gives a schematic geologic cross section of the Groundwater Zone. Recharge to the underlying groundwater zone is primarily via rainfall infiltration with some infiltration of runoff along the lower slopes of the Tauringatura Hills. Mean annual land surface recharge in the Groundwater Zone is estimated to be 470 mm/year. According to Environment Southland's Information Sheet, groundwater quality in the Central Plains Groundwater Zone is generally good, although it does vary according to source aquifer and location. There are some "hotspot" areas where nitrate values are particularly high.

There are no Central Plains Groundwater Zone registered drinking water supplies within 10 kilometres of the property.

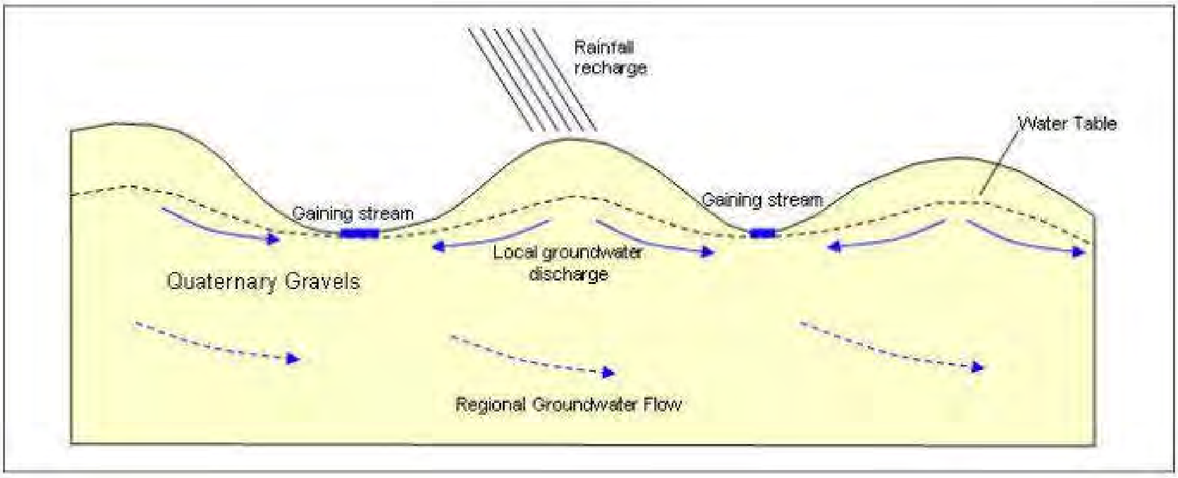


Figure 5.22 Schematic cross-section of the Central Plains Groundwater Zone[13]

Groundwater drainage occurs via the numerous small streams which cross the Central Plains groundwater zone. This drainage is aided by extensive mole, tile and artificial drainage networks which act to both intercept soil drainage and control the water table. By this mechanism a large portion of annual recharge is rapidly routed from the catchment with a much small component of deeper groundwater flow following the overall catchment drainage.

Upper Aparima Groundwater Zone

The Upper Aparima Groundwater Zone encompasses the flat-lying portion of the Upper Aparima River catchment. It is a terrace aquifer type and according to Environment Southland's Information Sheet, has low allocation status. Terrace aquifers are recharged by direct rainfall recharge and infiltration of runoff from the surrounding hills and streams, which drain the hills. There is limited riparian recharge from the Aparima River except along the riparian margins. Mean annual land surface recharge in the Aparima groundwater zone is estimated at 417 mm/year. Groundwater is discharged into the Aparima River via spring-fed streams or throughflow through the unconfined aquifer along the riparian margin of the river. The Aparima River is largely influent over much of the reach upstream of Wreys Bush, reflecting drainage of groundwater from the surrounding terrace aquifers. Groundwater quality is generally good, although it does vary according to source aquifer and location. There are minimal "hotspot" areas where nitrate values are particularly high.

There are no Upper Aparima Groundwater Zone registered drinking water supplies located within 35 kilometres of the property.

---

[13] Central Plains Groundwater Zone Information Sheet. http://gis.es.govt.nz/apps/groundwater/zones/Central_Plains.pdf

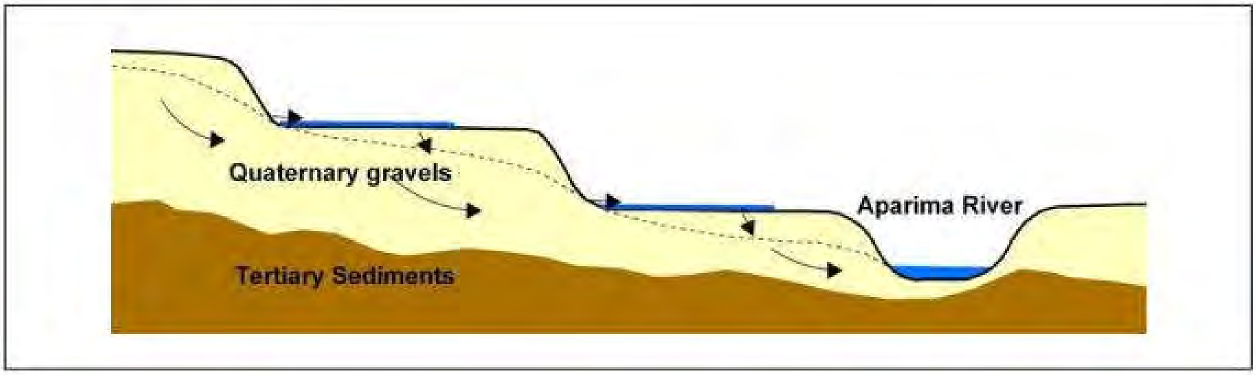


Figure 5.23 Schematic cross section of The Upper Aparima Groundwater Zone[14].

Groundwater lag times

Shallow groundwater lag times for nitrate response in Southland were estimated in a 2014 study prepared for Environment Southland[15]. 0 – 1 years was reported as an estimate of the time taken for the percolation of water through the unsaturated zone and reach the water table. The study reports that localised nitrate effects on groundwater can be expected within one year in the vicinity of WW1&2 and the Horner Block. 3 - 5 years was reported as the “total lag time” in the area (see figure 12 of report). 2.5 – 3 years was reported as an estimate for the time taken for a year of rainfall recharge to mix with the shallow aquifer.

~~Groundwater Nitrate – dairy platform~~

~~Groundwater in gravel deposits is susceptible to nitrate leaching. This reflected in the observed gradient in groundwater nitrate concentrations; groundwater nitrate concentrations are low at the west (0.4 – 3.5 g/m^3) and increase towards the east (3.5 – modelled >11.3 g/m^3) where lighter soils are found. See figure 5.24. Most of Ww1&2 is modelled as having groundwater nitrate levels in the range of 1.0 – 8.5 g/m^3, indicative of minor, moderate to high land use impacts.~~

~~Groundwater nitrate levels south of WW1&2, overlying the Waimatuku Groundwater Zone, are generally low, in the range of 0.01 – 8.5 g/m^3.~~

~~There is a nitrogen “hotspot,” where groundwater nitrate levels regularly exceed New Zealand Drinking Water Standard’s MAV of 11.3 ppm centred at Boyle Road/Heenans Corner immediately to the south east of WW1&2 and overlying the Central Plains Groundwater Zone (see figures 5.24, 5.26, 5.27).~~

---

[14] Central Plains Groundwater Zone Information Sheet. http://gis.es.govt.nz/apps/groundwater/zones/Central_Plains.pdf

[15] Wilson, Chanut, Rissman & Ledgard (2014). Estimating time lags for nitrate response in shallow Southland groundwater. Technical report prepared for Environment Southland.

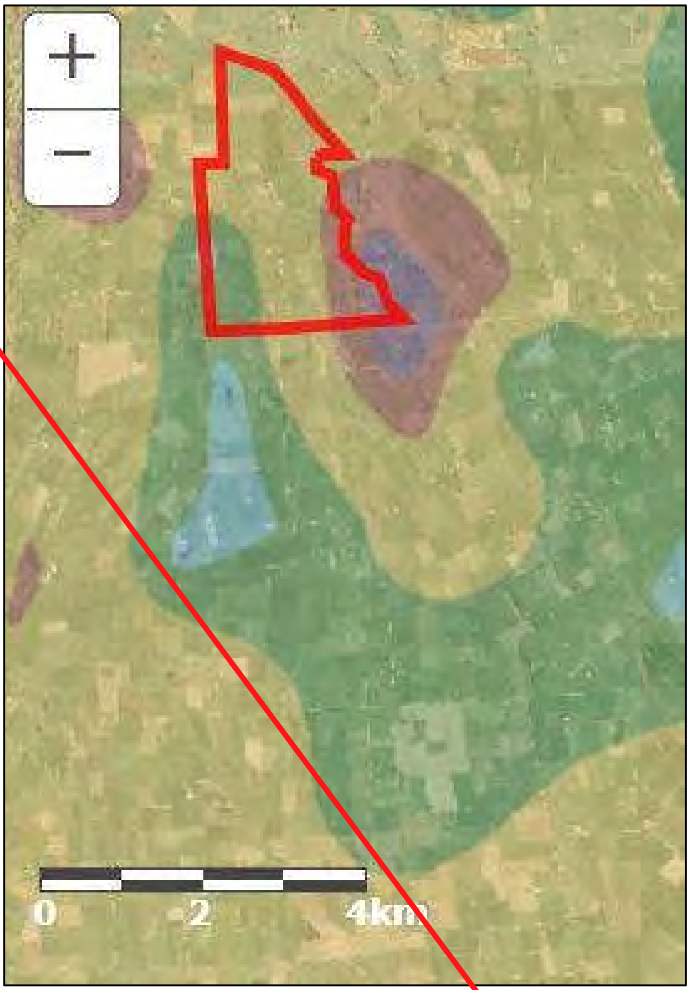
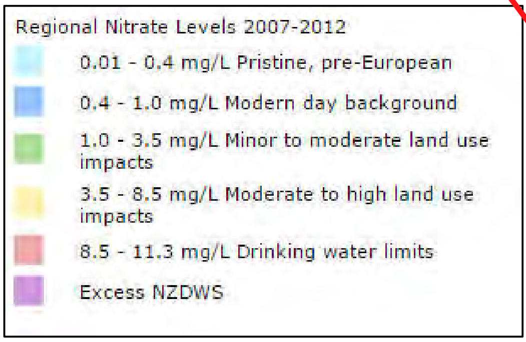


Figure 5.24 Groundwater nitrate levels in the vicinity of the WW1&2 (approximate boundary is outlined in red).



Regional Nitrate Levels 2007-2012

🟦	0.01 - 0.4 mg/L Pristine, pre-European
🟦	0.4 - 1.0 mg/L Modern day background
🟩	1.0 - 3.5 mg/L Minor to moderate land use impacts
🟨	3.5 - 8.5 mg/L Moderate to high land use impacts
🟥	8.5 - 11.3 mg/L Drinking water limits
🟪	Excess NZDWS

Figure 5.25 Key to groundwater nitrate levels

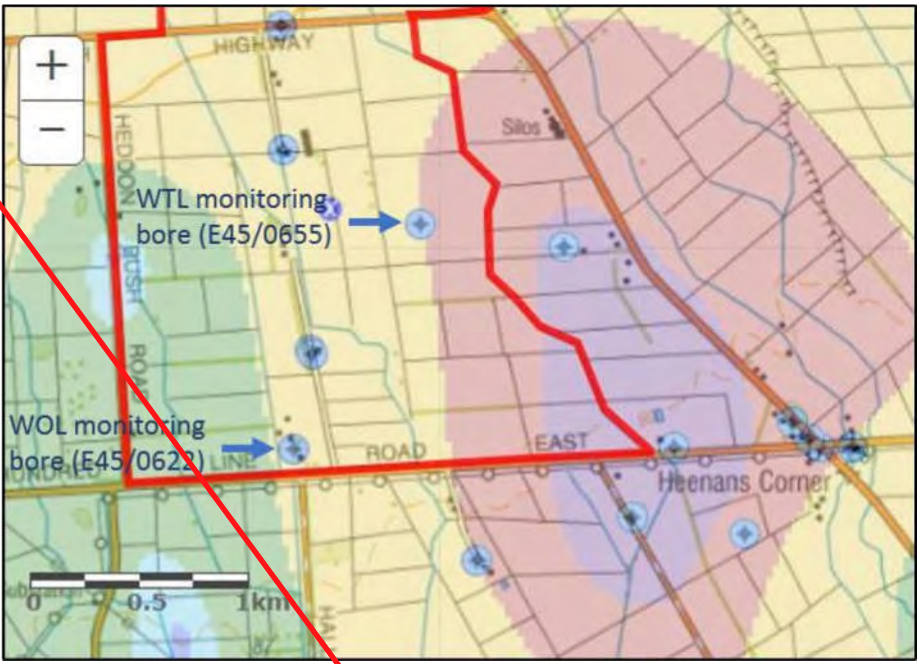


Figure 5.26 Topomap with groundwater nitrate levels showing low levels at the west and the hotspot centred at Heenans Corner to the east. The location of two bores used for monitoring are also shown.

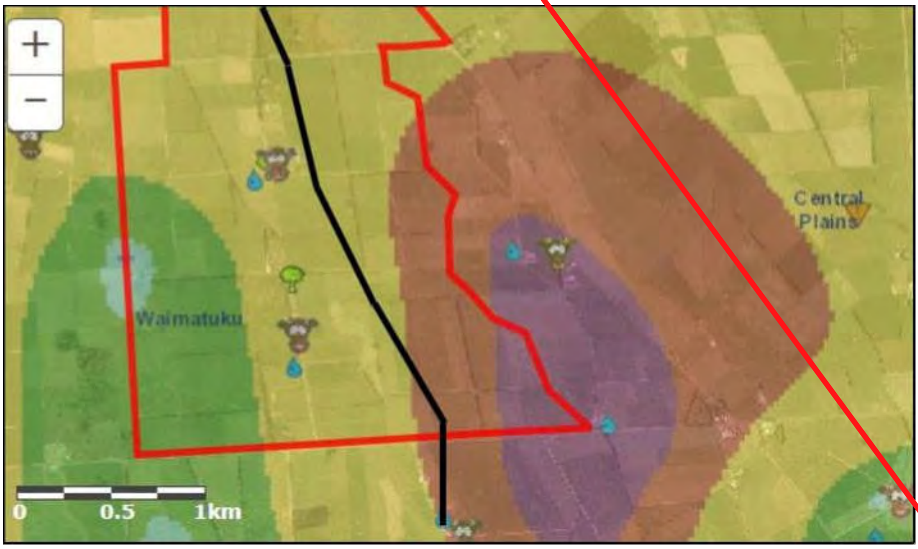


Figure 5.27 Aerial photo with groundwater nitrate levels and groundwater zones (black line indicates boundary between groundwater zones). The nitrate hotspot is in the Central Plains Groundwater Zone.

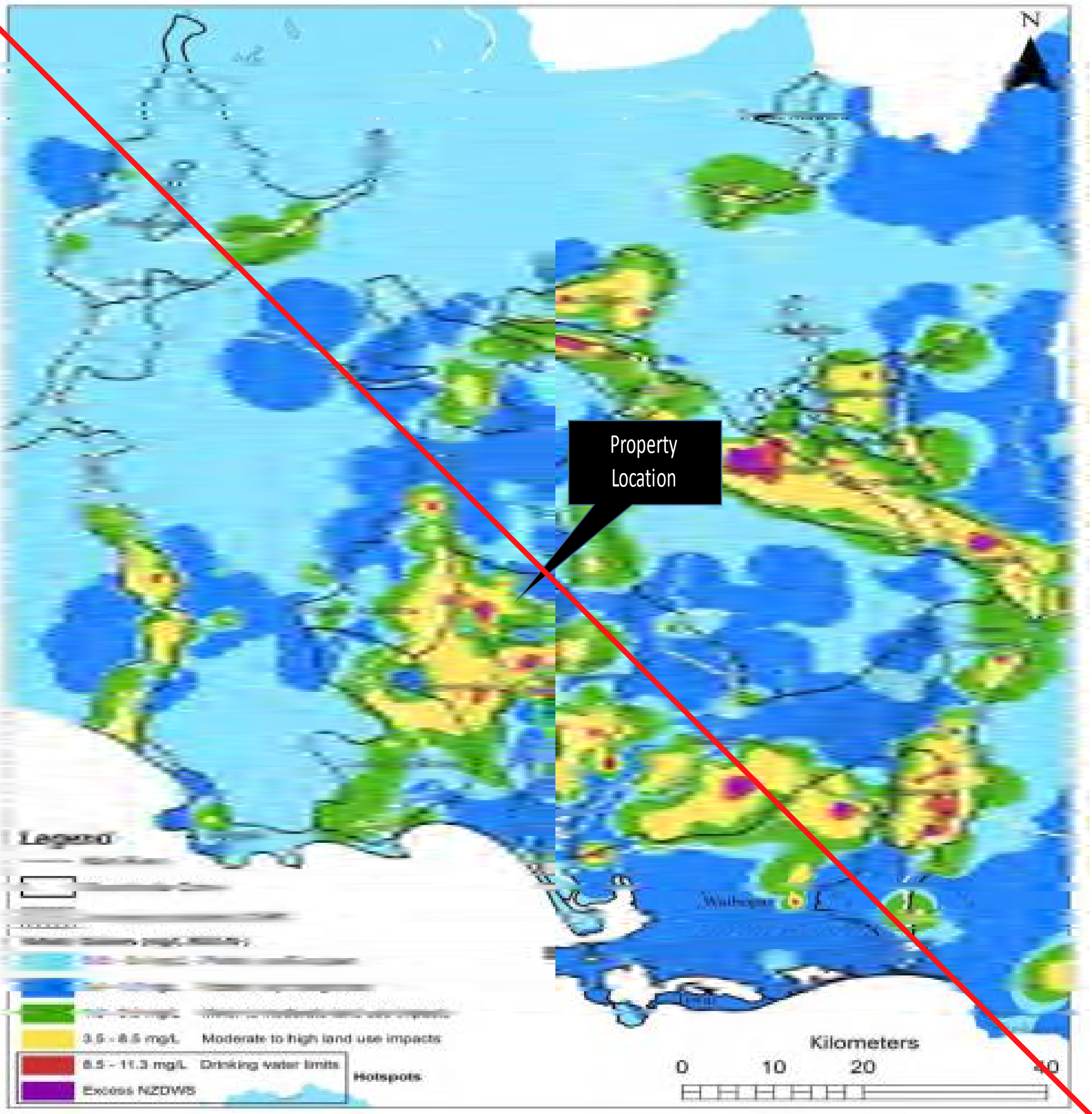


Figure 5.28 Classed NO3-N map for Southland's managed groundwater zones.[16]

---

[16] Rissman (2012). The Extent of Nitrate in Southland Groundwaters. Regional 5 year median (2007-2012). Technical Report.

Figure 5: Spatial distribution of Combined Denitrification Potential (CDNP)(Aquifer Sensitivity) for the *Southern Southland* Region. *Where, blue lines delimit regional groundwater zones. Note the: (i) predominance of low to very low Combined Denitrification Potential aquifers across the major groundwater zones; (ii) occurrence of high to very high CDNP values associated with sections of the Makarewa, Waihopai and Chatton groundwater zones, and; (iii) thin margins of marine-terrestrial aquifers of intermediate CDNP along the Southland coast.*

Figure 5.29 Map showing modelled denitrification potential[17]

Monitoring bores

Two bores located at WW1&2 are monitored by Environment Southland for water quality; one at the south of the WW1 dairy unit (E45/0622)/Waimatuku Groundwater Zone, and one at the south east of the WW2 dairy unit (E45/0665)/Central Plains Groundwater Zone. See figure 5.26 for the location of the bores.

WW1 BORE (E45/0622)

The WW1 bore is mapped on Beacon in the Waimatuku Groundwater Zone. The bore used to monitor WW1's groundwater quality was not drilled as a monitoring bore; it is an old domestic well. It comprises a 90 cm vertical concrete pipe with a hole in the side to let the alkathene through. It is possible for birds or rodents to enter the well along the pipe, fall in and drown, which has happened in the past. Furthermore, the well's top pipe is flush with ground level, and soil in the vicinity has high organic matter content from long grass and woody shrubs in the area. Due to its design and unprotected nature, it is likely to experience frequent localised contamination especially during/following heavy rainfall, as surfacewater can flow down into the wellhead carrying organic material with it. If decaying birds (starlings) or rodents are in the well, these also will cause localised contamination. Given these factors, ***the WW1 bore is unsuitable for use as a monitoring bore,*** and data collected from the well may be unlikely to reflect wider groundwater quality. This is particularly the case for *E.coli* data, which will be more corrupted than nitrate data from localised contamination.

---

[17] Rissman (2011). Regional Mapping of Groundwater Denitrification Potential and Aquifer Sensitivity. Technical Report.

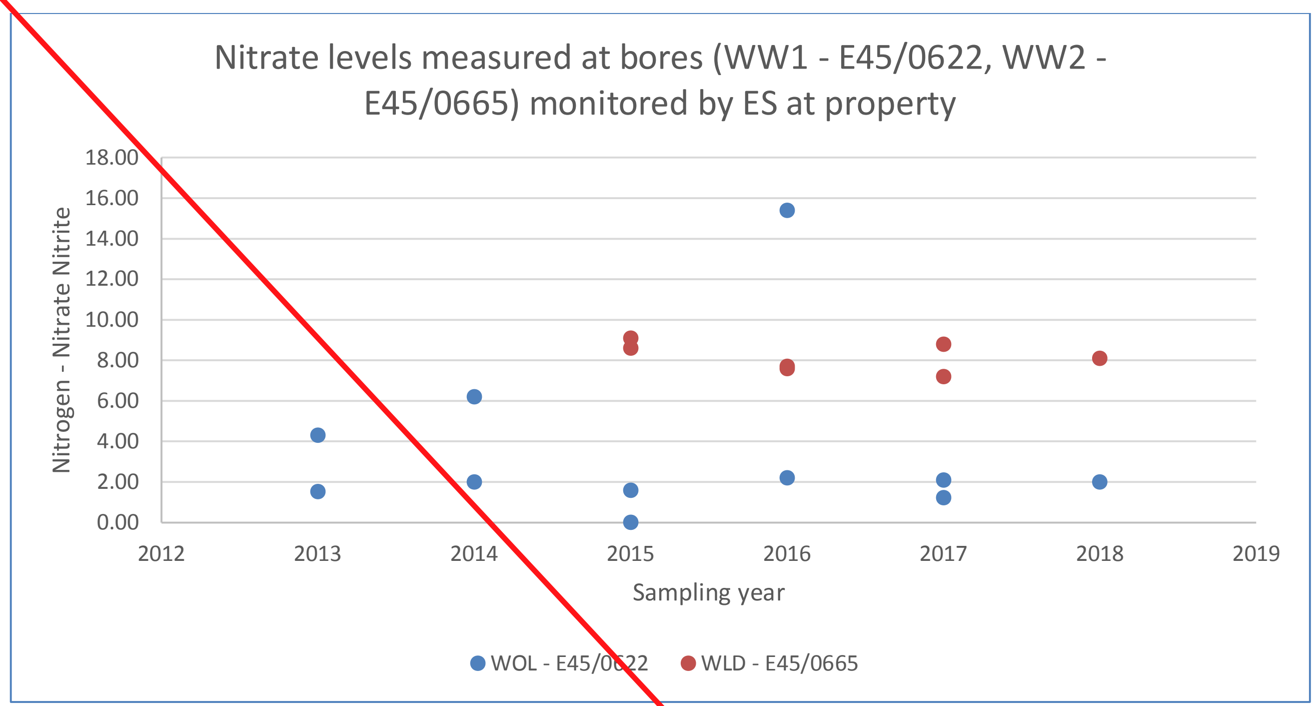
Figure 5.30 WW1 bore (E45/0622) used for groundwater quality monitoring.

WW2 MONITORING BORE (E45/0622)

The WW2 bore was drilled as a monitoring bore and is mapped on Beacon in the Central Plains Groundwater Zone.

NITRATE TRENDS FOR BORES MONITORED AT DAIRY PLATFORM

The WW1 bore (E45/0622) has been sampled by Environment Southland twice per year since 2013 and the WW2 bore (E45/0665) has been sampled by Environment Southland twice per year since 2015 (see figure 5.31 below). Despite the unsuitability of the WW1 well for use as a monitoring bore, it has been included in the following analysis for nitrate. See appendix for raw data.



~~Figure 5.31 Groundwater nitrate concentrations at two bores monitored by Environment Southland WW1&2.~~

~~Except for one outlying result, groundwater nitrate levels at the WW1 bore (E45/0622) are generally low (< 3.5 g/m^3) since 2015. Given its position as an outlier in the dataset, the high 2016 result is likely to have been due to localised contamination of the bore. Bore E45/0622 is a shallow bore (3 m deep) and except for localised contamination issues, should indicate recent land use effects including cumulative effects on upstream groundwater. Groundwater nitrate levels sampled at the bore generally are low and indicate minor to moderate land use effects. Results in 2017/2018 were less than or equal to 2.1 g/m^3.~~

~~Groundwater nitrate levels measured at the WW2 monitoring bore (E45/0665) are more elevated, with a mean value of 8.16 g/m^3 over the sampling period. This reflects a general trend in the area, with higher groundwater nitrate concentrations found progressively towards the east in the Central Plains Groundwater Zone, underlying lighter soils. Longitudinal datasets for a limited number of bores located to the east and north east of WW1&2 on lighter soils show this trend. The WW2 monitoring bore has a depth of 6.5 metres and is found in the Central Plains Groundwater Zone.~~

~~ENVIRONMENT SOUTHLAND MONITORING BORE AT BOYLE ROAD~~

~~An Environment Southland monitoring bore is located on Boyle Road to the south east of WW1&2 and in the Central Plains Groundwater Zone.~~

~~Groundwater is monitored at different depths (3 m, 6 m, 9 m, 12 m, 15 m). Well ID E45/0768 measures water quality at 3 metres depth and well ID E45/0771 measures water quality at 12 metres depth. Longitudinal datasets are available for both well IDs, starting in 2005 until the present (2018).~~

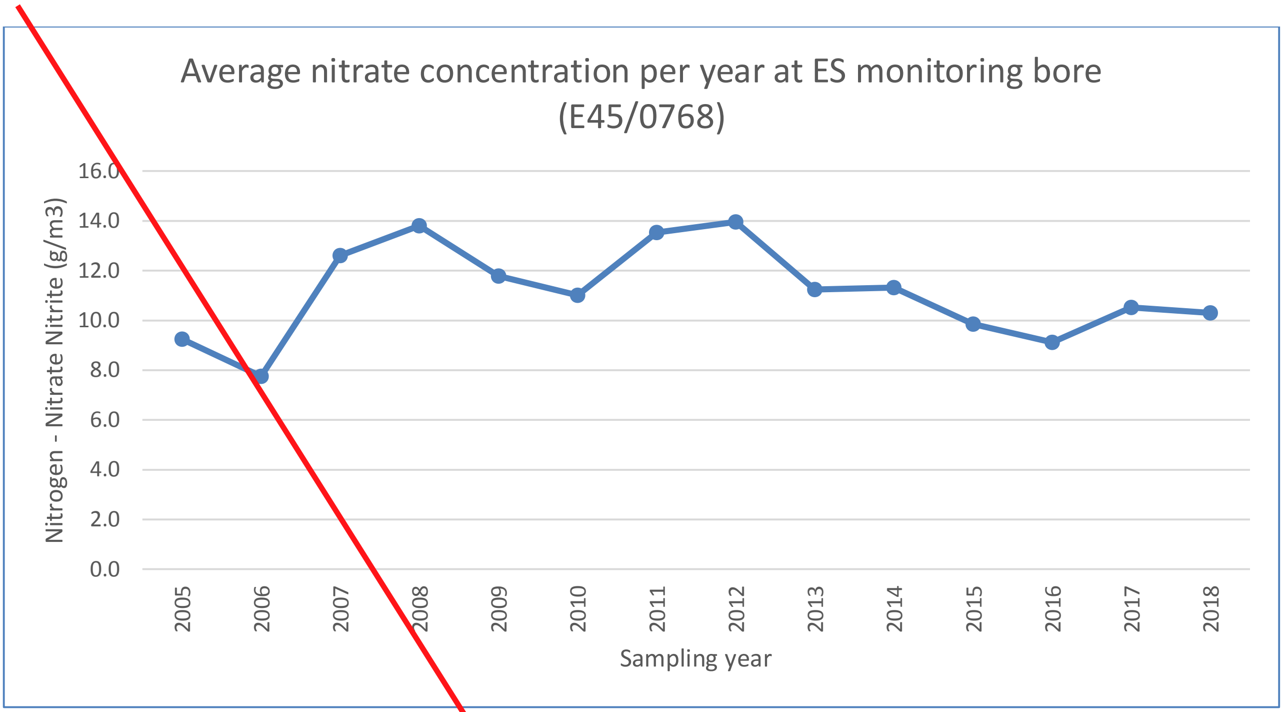


Figure 5.32 Groundwater nitrate concentrations at the ES monitoring bore (E45/0768) at Boyle Road to the south east of WW1&2 and in the Central Plains Groundwater Zone.

Groundwater nitrate levels at the Environment Southland's Boyle Road bore are generally at or above the New Zealand Drinking Waters MAV of 11.3 ppm. As this bore is also a shallow bore (3 metres depth), it is an indicator of recent land use effects and has been included here (rather than the 12-metre depth bore at the same site). Nitrate levels at the bore should be indicative of the cumulative effect of recent land use activities on upstream groundwater, which includes dairy, sheep and beef and cropping activities at numerous properties.

Comparatively groundwater nitrate levels at the two monitoring bores at Ww1&2 are lower than at the Boyle Road bore, with the WW1 data being distinctly lower and likely to reflect a different groundwater stream in the Waimatuku Groundwater Zone. The WW2 data are indicative of moderate to high land use effects in the Central Plains Groundwater Zone but are lower than the shallow bore data from the ES Boyle Road monitoring bore. The WW2 monitoring bore is likely to measure shallow groundwater quality underlying free draining soils at the east side of WW1&2, which is in the Central Plains Groundwater Zone.

Nitrate at registered drinking water supply – Heddon Bush School

Heddon Bush School overlies that Waimatuku Groundwater Zone. The bore for water supply at Heddon Bush School (E45/0718) was drilled in 2017 to a depth of 14.9 metres. It has been tested for nitrate levels since it was drilled although no recent nitrate* testing has been carried out by the school. Heddon Bush School bore testing carried out by Dairy Green Limited in December 2017, January and March 2018, returned nitrate concentrations of 1.8 – 2.0 ppm, which are indicative of minor to moderate land use effects and are well below the NZ Drinking Water Standards MAV for nitrate of 11.3 ppm. See the Appendix for laboratory results from the testing of Heddon Bush School bore by Dairy Green Limited.

*Note: The bore supply at Heddon Bush School is tested for microbial contaminants four times per year.

Groundwater Nitrate – Horner Block

Groundwater nitrate levels in the vicinity of the Horner Block are lower on the east side (1.0 – 3.5 g/m^3) and higher on the west side (3.5 – 8.5 g/m^3) towards the Aparima River (see figure 5.31). This corresponds with the heavier soil types found on the east side and lighter soils found on the west side respectively.

Figure 5.33 Groundwater nitrate levels in the vicinity of the Horner Block (approximate boundary is outlined in red).

Microbial contamination of groundwater

E.coli is widely used as an indicator of faecal contamination of water, including groundwater. *E.coli* is believed remain viable for up to three months in groundwater[18]. Groundwater sampling in the vicinity of WW1&2, including at the WW1, WW2 and ES Boyle Road bores, have generally been negative for *E.coli* (<1 MPN/100 ml). However, at times there have been positive *E.coli* results (1 or >1 MPN/100 ml).

The *E.coli* data from the WW1 bore (E45/0622) are flawed due to localised contamination relating to poor well design; this may have been the case for some other bores in the area also. In these situations, rainfall washes organic material including microbes, close to the bore site down into the well. This causes localised contamination and disappears beyond the zone of reasonable mixing. In the case of the WW1 bore, some decaying birds/rodents in the well may also be responsible for some contamination, which has been observed by the applicants in the past. Since the WW1 bore is likely to suffer frequent localised microbial contamination, *E. coli* data from samples collected at the well

---

[18] Edberg, Rice, Karlin and Allen (2000). *Escherichia coli*: the best biological drinking water indicator for public health protection. Journal of Applied Microbiology 2000, 88, 106S – 116S.

are dubious and unlikely to reflect wider groundwater quality. For this reason, the WW1 bore has been excluded form figure 5.34.

Where positive *E.coli* results are not due to contamination/poor wellhead design, they are an indicator of the presence of faecal microbes in groundwater from drainage events, albeit to a low level and relatively short lived generally.

Figure 5.34 plots *E.coli* results from the WW2 bore from 2015 to 2018. *E.coli* results fluctuate between negative for E.coli (<1 MPN/100 ml) and 548 MPN/100 ml. It is noted that the ES Boyle Road bore was positive for *E.coli* in November 2017 (5 MPN/100 ml) but was negative on other sampling dates.

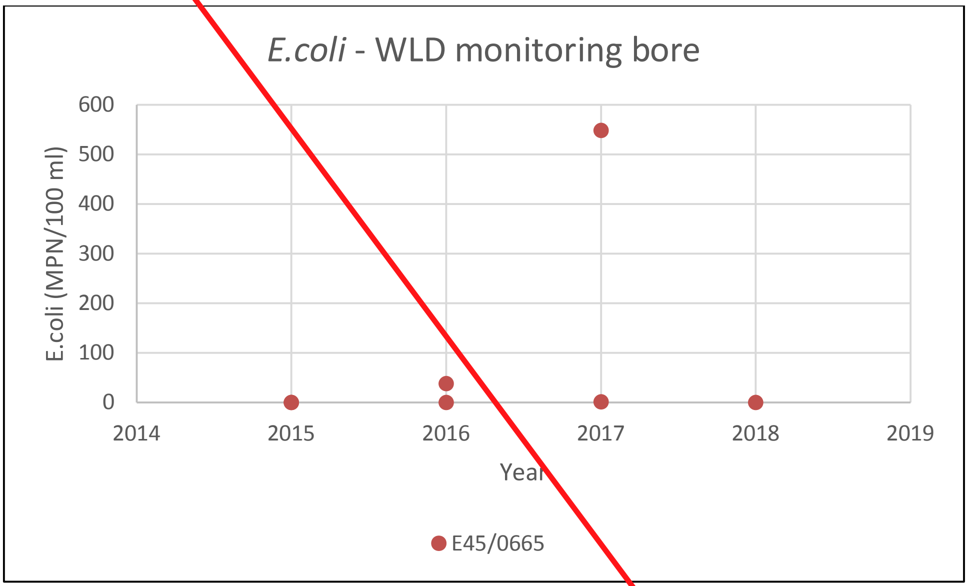


Figure 5.34 *E. coli* sampling at WW2 monitoring bore.

The ES monitoring bore at Boyle Road had some relatively high *E.coli* counts between 2006 and 2008 (e.g. 80 MPN/100 ml in April 2008) as well as many negative results (<1 MPN/100 ml). It was generally negative for *E.coli* in 2009 (< 1 MPN). There was a lack regular *E. coli* testing between 2010 and 2012. Quarterly testing by ES began in 2013, with all tests being negative for *E.coli* (<1 MPN/100 ml) with the exception of March 2014 and December 2017, which had 2 MPN/100 ml and 5 MPN/100 respectively.

No *E.coli* data are available for bores in the vicinity of the Horner Block within the last ten years.

According to school principal, Ms. E Hamilton, the bore at Heddon Bush School (E45/0718) is tested every three months since and has consistently been negative for *E.coli* (counts of <1 MPN/100 ml). Recent test results for the bore are included in the Appendix. Results show no evidence of faecal contamination of the registered drinking water supply at Heddon Bush School.

5.4 Physiographics

Both WW1&2 and Horner Block are identified as being located primarily within the Central Plains and Oxidising physiographic zones. Given the remapping of soil types following a site investigation, it is likely that the area of Oxidising soils is greater than is mapped by Beacon and that the Central Plains area is reduced. The main contaminant pathways for the Central Plains zoned land are artificial drainage and deep drainage. The main contaminant pathway for Oxidising zoned land is deep drainage.

Oxidising

For the Oxidising zone, nitrogen accumulation is expected, particularly during drier months, with excess nitrogen and other contaminants then leaching into underlying aquifers following periods of heavy rainfall over winter and spring. Oxidising soils (Drummond and Glenelg) at the property are free draining so do not have artificial drainage installed.

Central Plains

Central Plain’s zoned land is prone to waterlogging, resulting in the installation of artificial drainage and the potential loss of contaminants (N, P, sediment and microbes) to streams and rivers. It is also believed to have risk of contaminant loss via deep drainage, which relates to swell/crack properties of Braxton type soils. Deep cracks can form in soils during dry summer periods. Subsequent rainfall can transport contaminants via bypass drainage to the underlying aquifer.

Figure 5.35 Physiographic zones (approximate WW1&2 boundary is outlined in red).

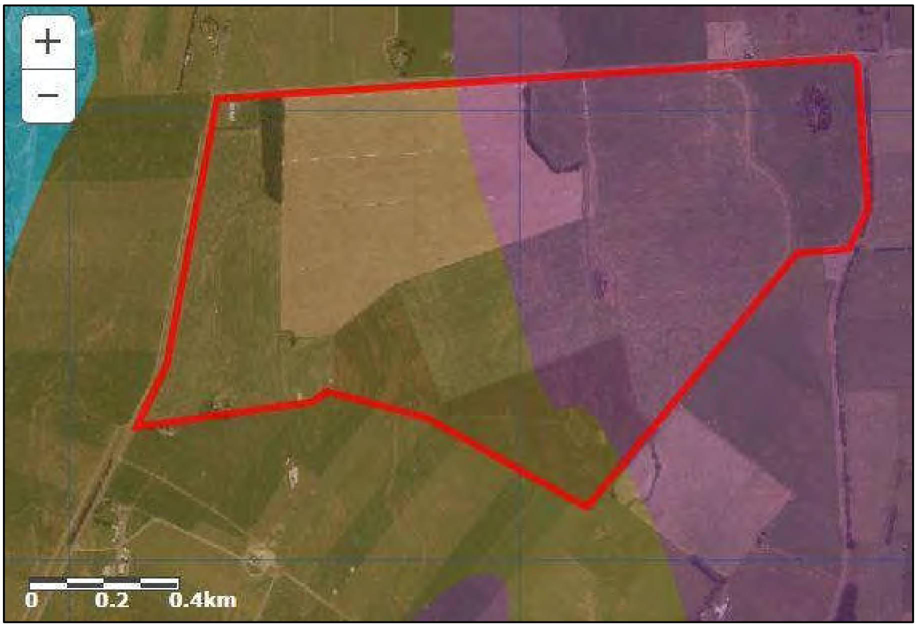


Figure 5.36 Physiographic zones in vicinity of Horner Block.

Figure 5.37 Key to physiographic zones

5.5 Topography

The topography found at the property is very flat. See figures 5.38 and 5.39 below. Slight hollow and low points in the flat terrain are generally underlain by subsurface drainage on the west side of WW1&2.

Figure 5.38 Photograph of flat topography found at WW1&2.

Figure 5.39 Photograph of flat topography found at WW1&2.

6. Proposal Details

6.1 Effluent Discharge

Overview of effluent discharge activity

Table 6.1

Effluent Discharge	
Replacement of consents	Replace 301663 and 20171278-01 with a single discharge permit for WW1&2
New consent	Grant consent for the discharge of agricultural effluent from WW1&2 at the Horner Block. The Horner Block is an effluent receiving area only; it has no effluent storage infrastructure or irrigation infrastructure. It is currently authorised to receive effluent on discharge consents 301663 and 20171278-01.
Duration of consent sought	15 years
Herd size	1,500 cows total: 800 cows at WW2 700 cows at WW1
Supplier number	WW2 unit = 32651 WW1 unit = 32650
Period of discharge	The cowsheds are generally operated from 1 August to 31 May each year, with a limited number of late calving cows milked until mid-June (15th). Effluent irrigation to the discharge areas will be carried out between August and May, and as ground conditions permit for June and July if deemed necessary.
Milking frequency	Twice per day
Winter milking	Not anticipated, seasonal supply only
Feed pad/wintering pad/stand-off pad	There are two wintering barns that will house a total of 1,250 cows.
Other sources of effluent collected in main effluent system	Concrete area at two vat stands Silage pad (WW2)

Feed Pad/Wintering Pad/Stand-off Pads

There are two wintering barns that will house a maximum of 1,250 cows. One barn is located on each dairy unit; each has capacity to house 640 cows but will house a maximum of 625 cows to minimise cow stress. The WW1 barn has recently been upgraded to go from 400 to 640 cow capacity as has its effluent storage infrastructure.

The wintering barns are mainly used in May, June, July, August and September but can be used as stand-off pads at other times during inclement weather. The use of wintering barns as a stand-off pads varies from year to year dependent on weather. Cows are removed from the wintering barn for calving.

The wintering barns have a sealed concrete floor. Effluent from the barns is scraped into a concrete collection channel from where it is pumped to respective storage ponds, which also store effluent from the dairy shed and silage pad (WW2 only) as required. The barns have a small uncovered area, which has been included in the Massey DESC reports.

A rainwater diversion is used on the concrete areas during the off season.

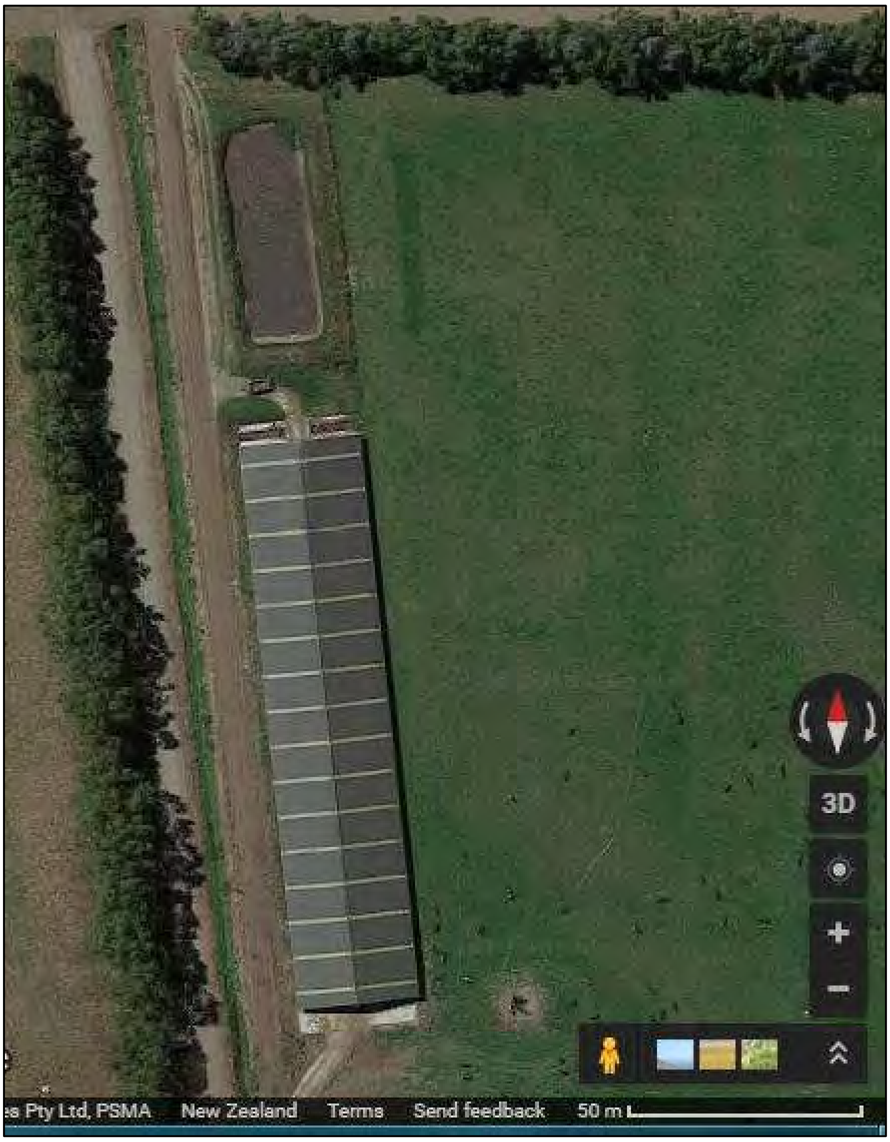


Figure 6.1 Wintering barn and effluent pond – WW1 dairy unit.

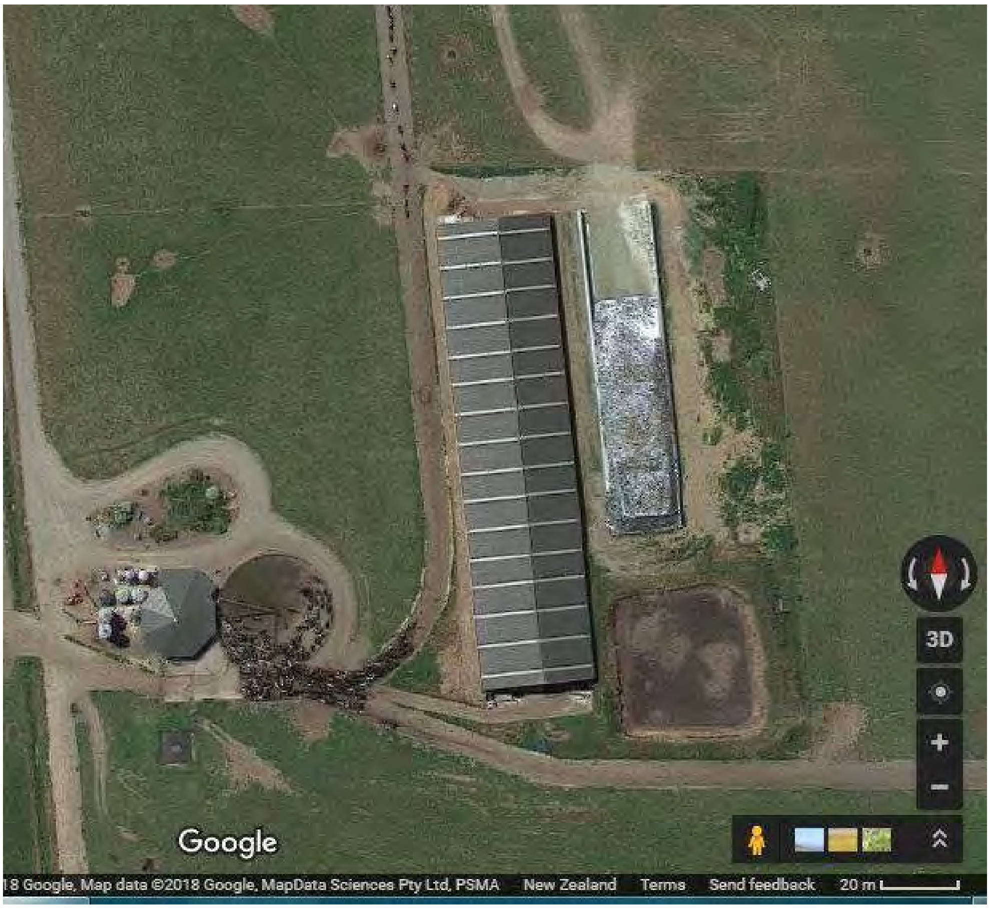


Figure 6.2 Wintering barn, silage pad, dairy shed and effluent pond – WW2 dairy unit

WW2 wintering barn – effluent volume

The total volume of effluent collected has been calculated based on approximately 50 litres per cow per 24-hour day. The volume has been calculated as follows:

May:

$$625\ cows\ x\ 12\ Hours/day\ x\ 50\ l\frac{effluent}{24}Hours\ \ x\ 31\ days = 484\ cubic\ metres$$

June and July:

$$625\ cows\ x\ \ 50\ l\frac{effluent}{day}\ x\ 61\ days = 1{,}906\ cubic\ metres$$

August:

$$370\ cows\ x\ 23\ Hours/day\ x\ 50\ l\frac{effluent}{24}Hours\ \ x\ 31\ days = 550\ cubic\ metres$$

September:

$$75\ cows\ x\ 23\ Hours/day\ x\ 45\ l\frac{effluent}{24}Hours\ \ x\ 30\ days =\ 108\ cubic\ metres$$

Total

$$484\ m3 + 1{,}906\ m3 + 550\ m3 + 108m3\ \ = 3{,}048\ cubic\ metres$$

WW1 wintering barn – effluent volume

The same calculation applies to WW1's wintering barn, which is estimated to be 3,048 m^3.

Wintering barns – total volume of effluent

The volume total of effluent collected from the wintering barns has been calculated as approximately 6,096 m^3/year.

Other sources of effluent

UNDERPASS

An underpass connects WW2 blocks north and south of Wreys Bush Highway, which has a catchment of 200 m^2. The underpass has a concrete sump, from where rainfall and effluent are pumped to a dedicated sprinkler. The underpass has not been included in the Massey DESC report.

> Rainfall site used in Massey DESC: Drummond Marson Road = 1.061 m per year
> 200 m^2 catchment X 1.061 m rainfall = 212 m^3 volume to discharge.

Underpass effluent is very dilute as it is primarily composed of rainwater. It is irrigated using a dedicated low rate sprinkler (at an instantaneous rate of less than 10 mm/hour and less than 10 mm depth per application).

The discharge is to paddocks close to the underpass (low risk soils). Underpass effluent is not discharged to a surface waterway either directly or by overland flow. There is no discharge of underpass effluent when the soil moisture exceeds field capacity.

The discharge of underpass effluent is:

- not within 20 metres of a surface waterway;
- not within 200 metres of a neighbouring dwelling;
- not within 20 metres of a boundary with another landholding; and
- not within 100 metres of a bore.

The maximum loading of N from underpass effluent does not exceed 150 kg N/hectare/year; it is very dilute. Due to its very small volume and highly dilute nature, the nutrient loadings and losses from underpass effluent are negligible compared to that from effluent, slurry and the overall farming activity. The extremely small quantity of nutrients that fall on the underpass and are discharged are accounted for in Overseer, through cow numbers, feed inputs and system losses. Underpasses are not modelled separately in Overseer due to the negligible contribution they make.

Figure 6.3 Aerial photograph of underpass.

SILAGE PAD - WW2

A concrete silage pad is located adjacent to the wintering barn at WW2. Its area is 1,200 m^2. It is constructed on a dry site. The silage pad has concrete walls and a dual drainage system; one for clean rainwater and one for silage leachate. Under the stack and immediately in front of it, the drains are opened into the leachate channel. This takes leachate to a sump from where it is pumped into the effluent storage pond and irrigated appropriately. The sumps in the rest of the pad are open to the farm drainage system so that clean rainwater can be diverted. Rain landing on the silage cover does not mix with leachate and is diverted to the farm drainage.

Only wilted silage is used to minimise the risk of creating leachate. The pad is empty for approximately 3-4 months per year. The silage pad catchment has been included in the Massey DESC report. Given the rainwater diversion in place when the pad is empty, and that rain landing on the cover does not mix with leachate so can be diverted to farm drainage, the silage pad leachate catchment is smaller than 1,200 m^2 for much of the year.

Good management practices for the concrete silage pad at WW2 are:

1. Only wilted silage is stored on the pad to minimise leachate generation;

2. The bunker is filled to the top of the walls with silage and the silage cover hangs over the walls so that rain landing on the silage cover does not mix with leachate.

3. The silage pad is flanked by 1.8 m high sealed concrete walls to prevent leachate escaping;

4. A dual drainage system is operated inside the wall on the low side; one for clean rainwater and one for silage leachate. Only leachate is collected, stored and discharged to land appropriately as follows:
    a. Drains at the front and underneath the stack are opened to the leachate channel. These drain leachate to a sump, from where it is pumped to WW2's effluent storage pond and irrigated appropriately. These areas capture no or minimal rainwater;
    b. The sumps in the rest of the pad are open to the farm drainage system so that clean rainwater can be diverted.

SILAGE PAD - WW1

The silage pad at WW1 meets permitted activity rules both for the use of land and for leachate management. See Section 2 for details. No effluent is collected and pumped to the storage system.

Figure 6.4 Silage pad at WW1

Figure 6.5 Silage pad at WW1

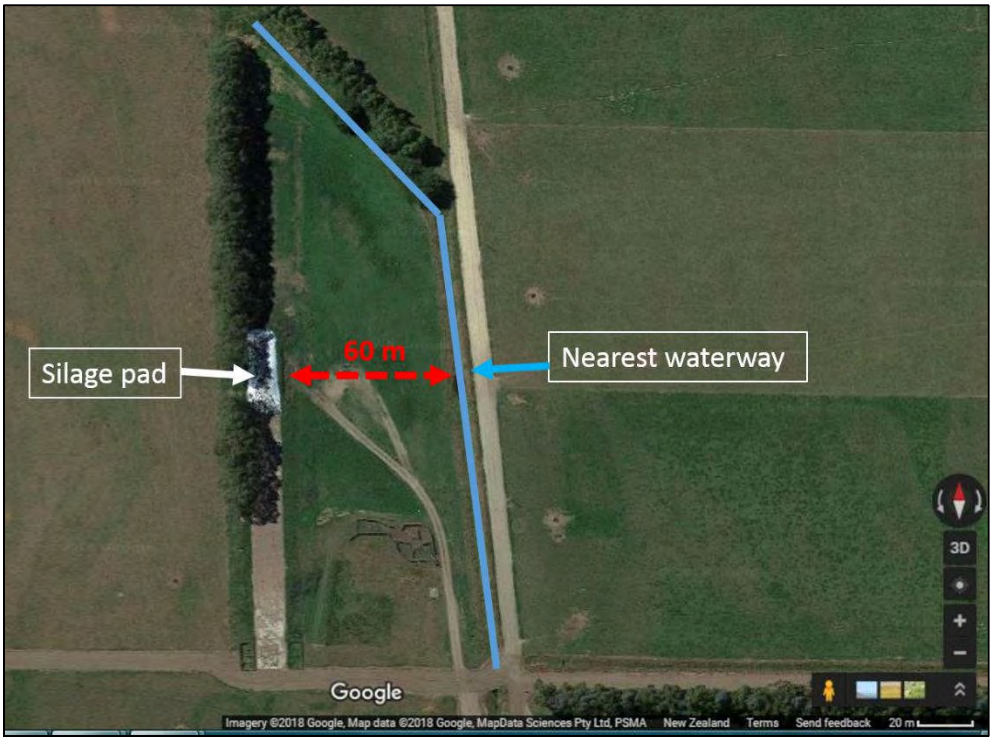


Figure 6.6 Location of the silage pad at WW1.

Effluent collection and storage system

WW1 - DAIRY SHED

The maximum daily dairy shed effluent volume comprises 35 cubic metres of effluent plus any rainfall.

I. Raw effluent from the dairy shed gravity feeds to a pump sump.
II. When soils are below field capacity and have sufficient soil moisture deficit, raw effluent is pumped to a travelling irrigator, from where it is applied to land at low depth.
III. When soils are near or at field capacity, raw effluent is pumped to the buffer storage pond and there is enough storage in the pond so that irrigation is not required.
IV. When soil moisture conditions are suitable for irrigation, raw effluent (slurry) from the pond is applied at low depth to land using a slurry tanker with a trailing shoe or using an umbilical system.
V. An off-season diversion is put in place at the dairy shed.

WW1 - WINTERING BARN

I. The effluent flows by gravity or is scraped to the concrete effluent collection sump, from where it is pumped to WW1 effluent storage pond.
II. The effluent is stored in the pond until soil moisture conditions allow for irrigation to occur.
III. The effluent is pumped from the pond to the slurry tanker with a trailing shoe or umbilical system and irrigated at very low depth to land; and
IV. A rainwater diversion is used in the off season.

WW2 - DAIRY SHED

The maximum daily dairy shed effluent volume comprises 40 cubic metres of effluent plus any rainfall.

I. Raw effluent from the dairy shed gravity feeds to a pump sump.
II. When soils are below field capacity and have sufficient soil moisture deficit, raw effluent is pumped to a travelling irrigator, from where it is applied to land at low depth.
III. When soils are near or at field capacity, raw effluent is pumped to the buffer storage pond and there is enough storage in the pond so that irrigation is not required.
IV. When soil moisture conditions are suitable for irrigation, raw effluent from the pond is applied to land at very low depth using a slurry tanker with a trailing shoe or using an umbilical system.
V. An off-season diversion is put in place at the dairy shed.

WW2 - WINTERING BARN

I. The effluent flows by gravity or is scraped to the effluent sump, from where it is pumped to WW2 effluent storage pond.
II. The effluent is stored in the pond until soil moisture conditions allow for irrigation to occur.
III. The effluent is pumped from the pond to the slurry tanker or umbilical system and irrigated at very low depth to land; and
IV. A rainwater diversion is used in the off season.

WW2 – SILAGE PAD

I. Drains at the front and underneath the stack are opened to the leachate channel. These drain leachate to a sump, from where it is pumped to WW2’s effluent storage pond and irrigated appropriately.

Storage capacity

WW1 – EFFLUENT STORAGE

The pond was upgraded in autumn 2018. As part of its upgrade the storage volume was increased and a synthetic liner (1.5 mm HDPE) was installed, overlying a leak detection system. The pond design was certified by a CPEng as meeting Practice Note 21 standards. The leak detection system terminates at a 400 mm diameter inspection well. The storage capacity of the pond is 4,281 metres cubed. The Massey Dairy Effluent Storage Calculator 90% storage probability volume for WW1 is 3,257 metres cubed, so has sufficient storage for 700 cows plus wintering barn effluent. See Appendix for the Massey DESC report.

WW1 - DESC PARAMETERS

- 700 cows milked at peak
- Milking season is 1 Aug – 15 June
- Yard is diverted from 16 June to 31 Aug
- Yard area – 553 m^2
- Milking shed roof area diverted.
- A maximum capacity of 640 cows wintered on a covered feedpad, which includes an uncovered area of 170 m^2 and is not diverted. The maximum capacity was used although 625 cows will be the maximum number housed in the barn.
- A winter/spring irrigation depth of 2 mm has been used. This reflects the predominant use of the trailing shoe slurry tanker to discharge slurry effluent from the storage pond, which can apply effluent to a depth of 1 mm if required. By applying effluent 20 m^3/hectare the slurry tanker applies slurry effluent to a depth of 2 mm. A low depth travelling irrigator is used to apply dairy shed effluent when there is sufficient soil moisture deficit.
- FDE area is split to reflect Drummond/Glenelg (low risk) and Braxton (high risk) soils at the milking platform and the Horner Block. Conservatively 50 hectares of low risk soils have been entered.

Note: if the dairy shed is upgraded/replaced in the future, additional storage is available in WW1's pond to allow for a larger yard catchment.

WW2 – EFFLUENT STORAGE

The storage capacity of the pond is 3,751 metres cubed. The Massey Dairy Effluent Storage Calculator 90% storage probability volume for WW1 is 3,203 metres cubed, so has sufficient storage for effluent from 800 cows, wintering barn effluent and silage pad leachate. See Appendix for the Massey DESC report.

WW2 - DESC PARAMETERS

- 800 cows milked at peak
- Milking season is 1 Aug – 15 June
- Yard is diverted from 16 June to 31 Aug
- Yard area – 1,126 m^2

- Milking shed roof diverted
- A maximum capacity of 640 cows wintered on a covered feedpad, which includes an uncovered area of 170 m^2 and is not diverted. The maximum capacity was used although 625 cows will be the maximum number housed in the barn.
- A silage pad catchment of 800 m^2 is entered under “Other catchments.”
- A winter/spring irrigation depth of 2 mm has been used. This reflects the predominant use of the trailing shoe slurry tanker to discharge slurry effluent from the storage pond, which can apply effluent to a depth of 1 mm if required. By applying effluent 20 m^3/hectare the slurry tanker applies slurry effluent to a depth of 2 mm. A low depth travelling irrigator is used to apply dairy shed effluent when there is sufficient soil moisture deficit.
- FDE area is split to reflect Drummond/Glenelg (low risk) and Braxton (high risk) soils at the milking platform and the Horner Block. Conservatively 50 hectares of low risk soils have been entered.

WW1 and WW2 - Effluent irrigation

Primary irrigation methods – WW1&2 – low depth travelling irrigator

A low depth travelling irrigator system is used to apply dairy shed effluent to land at a depth of less than 10 mm per application. Two travelling irrigator systems are on farm, with one connected to each dairy shed. Both have been tested as per consent conditions and apply effluent at a depth of < 10 mm per application. See the Appendix for reports from testing each travelling irrigator.

The travelling irrigator systems have a safety system, which automatically switches the system off in the event of an effluent system failure, such as irrigator stoppage or breakdown.

Primary irrigation methods – WW1&2 and Horner Block – low depth slurry tanker with a trailing shoe

A low depth slurry tanker with a trailing shoe is used to apply pond slurry at a maximum depth of 2.5 mm per application. 2.5 mm is the maximum depth proposed as a consent condition.

It can apply slurry to depths as low as 1 mm depending on tractor speed. The applicants own a slurry tanker with a trailing shoe, which has a GPS system. The area and travel speed are monitored using the on-board GPS system. At a travel speed of 8-9 km/hour, the per hectare loading is 20 m^3, which gives a depth of 2 mm. By speeding up the tractor speed, the application depth of lowered further. The capacity of the slurry tanker is 24 metres cubed.

The trailing shoe part of the slurry tanker sits on the ground. It applies slurry at ground level and generates minimal aerosol and odour. It was invented in Europe to reduce adverse odours from the application of slurry/sludge to land, which is standard practice due to the housing of cows in barns over winter. It is regarded as an effective odour minimisation technology and is best practice for slurry/sludge application. Its use will help to avoid adverse odour effects on neighbouring properties.

Contingency method – WW1&2 and Horner Block – umbilical system

An umbilical system is used as a contingency irrigation method, with a maximum depth per application of pond slurry of 3.0 mm.

Future proof – WW1&2 – low rate irrigation

It is proposed to future proof the discharge activity by including low rate irrigation. The applicants may install a low rate system such as pods or a cannon/rain-gun system in the future. Both systems will apply dairy shed effluent at a maximum instantaneous rate of 10 mm/hour and a maximum depth of 10 mm per application.

By including both systems in the permit, the applicants will have flexibility when deciding which system is most suitable, while at the same time being able to assure Environment Southland via consent conditions that the new system will discharge effluent at low rate and low depth.

The system will only be plumbed to land authorised to receive liquid effluent (a.k.a. dairy shed effluent) on the discharge permit/Appendix 1 Discharge Map. If installed, the applicants intend to use a low rate system at times when the soil moisture deficit is too low to safely use the travelling irrigators. E.g. in the shoulders of the season, or in June and August if conditions are suitable and there is sufficient soil moisture deficit to irrigate at depths of 3 – 5 millimetres. The travelling irrigators would still be used over summer/early autumn when the soil moisture deficit is generally greater and irrigation of effluent at depths not exceeding 10 millimetres can be carried out without risk of drainage.

Note: The nutrient budgeting, proposal details and AEE used the high rate travelling irrigator as the primary irrigation system for dairy shed effluent. Low rate systems are regarded as best practice by Environment Southland, and as such will have similar or lesser effects as the high rate travelling irrigator system.

Other conditions – WW1&2

- A minimum return period of 28 days between applications;
- A maximum of 150 kg of N/hectare from agricultural effluent (dairy shed and pond slurry) is applied;
- No effluent is applied to soils showing evidence of cracking;
- A maximum combined depth of application of 25 mm per year for dairy shed effluent to any land area, and
- A minimum land area of 8 hectares/100 cows for the dairy shed effluent.

Other conditions – Horner Block

- A minimum return period of 28 days between applications;
- No effluent is applied to soils showing evidence of cracking; and
- A maximum of 250 kg of N/hectare from agricultural effluent (pond slurry) is applied.

WW1 and WW2 - Contingency measures

The aim is to operate the irrigation systems to always ensure there is buffer storage available. This allows a contingency for wet weather or pump failure.

The umbilical system may be used as a contingency irrigation method. The umbilical system will apply effluent at a maximum depth of application of 3 mm for each individual application.

Should the irrigation pump at either the WW1 or WW2 dairy sheds fail, a replacement pump is available within 12 hours. Alternately a petrol motor-driven or tractor driven pump could be hired. There is adequate storage to allow time for pump replacement.

Nutrient content of effluent

Dairy shed effluent

The nutrient content of dairy shed effluent has not been tested but is expected to be in line with typical dairy shed effluent[19]. An estimate for nutrient content of typical dairy shed effluent based on the above reference is as follows:

- 250 g/m^3 N
- 30 g/m^3 P
- 300 g/m^3 K
- 15 g/m^3 S

Discharging dairy shed effluent at a depth of 10 mm applies 25 kg of N/hectare, and 30 kg of K/hectare. Where the application depth is 9 mm, approximately 22.5 kg of N is applied per hectare.

Table 6.2 N loading from dairy shed effluent

	Dairy Shed
Number of cows	1,500
Nitrogen collected based on 50 L effluent per cow per day	0.013 kg N/cow/day
Daily nitrogen produced	19.5 kg N/day
Maximum days used per year	300
Annual nitrogen produced	5,850 kg N/year
Minimum annual size of discharge area (ha)	220 ha (WW1 + WW2)
Annual nitrogen loading rate	26.6 kg N/ha

Wintering barn effluent

The nutrient concentration of wintering barn effluent is higher than dairy shed effluent due to lack of dilution and the housing of cows in the barns for up 24 hours per day. Slurry effluent in the ponds is predominantly composed of wintering barn effluent, with minor dilution from rain falling on the pond, dairy shed effluent, which is diverted to the ponds when ground conditions are unsuitable for irrigation and silage leachate from WW2's pad.

---

[19] Longhurst, Rajendram, Miller and Dexter (2017). Nutrient content of liquid and solid effluents on NZ dairy cow farms. Science and Policy: nutrient management challenges for the next generation. Occasional Report No. 30.

The nutrient content of pond effluent (slurry) was tested as part of a 2011 AgResearch study[20]. The nutrient content of slurry at the applicant's pond was measured at:

- 3,200 g/m^3 N
- 800 g/m^3 P
- 4,400 g/m^3 K
- 400 g/m^3 S

Applying 15.2 m^3/hectare applies slurry effluent at a depth of 1.5 mm. Discharging slurry effluent at 15.2 m^3/hectare applies:

- 49 kg of N;
- 12 kg of P;
- 69 kg of K; and
- 6 kg of S.

Slurry effluent is applied at the Horner Block and at WW1&2.

Given the use of the Horner Block for grass harvesting, slurry effluent from WW1 and WW2 is applied at very low depth as fertiliser, and grass is harvested and fed to cows at WW1&2 and at other dairy farms. Cows are not grazed at the Horner Block, so a higher slurry loading can be applied without the potential risk of adverse animal health effects due to excessive K levels and without the risk of adverse environmental effects due as described in the AEE.

Nitrogen fertiliser is reduced accordingly at both the Horner Block and WW1&2 to account for the N loading from slurry. Adverse N-related environmental effects are further avoided through the application of pond slurry at very low depths (less than or equal to 2.5 mm per application and typically at 1.5 – 2.0 mm depth per application).

E.g. Slurry effluent applied at 1.5 mm depth by applying 15.2 m^3/hectare, will apply 49 kg of N/hectare. A total of five applications at 1.5 mm depth each will apply a total of 243 kg N/hectare, which is less than the 250 kg N/hectare proposed limit for the Horner Block.

One application of slurry effluent at a similar depth and rate per hectare is also applied at WW1&2 to land that does not receive dairy shed effluent.

Slurry volume

Slurry volume is estimated based on the volume of wintering barn effluent (6,096 m^3), rainwater on the ponds' surface (606 m^3 for WW1, 912 m^3 for WW2) and an allowance for dairy shed effluent diverted to the ponds (2,400 m^3) given the presence of low risk soils and use of very low depth application using the slurry tanker/trailing shoe, which results in a large number of irrigation days available. The area available at the Horner Block (97 ha) and dairy platform (> 180 ha) is sufficiently large to receive the volume of slurry.

---

[20] Houlbrooke, Longhurst, Orchiston & Muirhead (2011). Characterising dairy manures and slurries. AgReseacrh. Envirolink tools report AGRX0901.

Effluent discharge and receiving area

See table 1.1 for details of land areas within the discharge areas at WW1&2 and the Horner Block, which will be authorised on separate permits.

Effluent irrigation to the discharge areas is carried out between August and May, and if ground conditions permit in June and July as necessary. Overall, the effluent receiving area encompasses most of WW1&2 and the part of the Horner support block (c.97 hectares), less Council required buffers around waterways, bores, neighbouring dwellings, boundaries etc.:

- 20 metres from any surface watercourse;
- 100 metres from any potable water abstraction point;
- 20 metres from any property boundary (unless the adjoining landowner's consent is obtained to do otherwise);
- 200 metres from any residential dwelling other than residential dwellings on the property;
- Dairy shed effluent shall not be discharged onto any land area that has been grazed within the previous 5 – 10 days;
- Effluent shall not be discharged to leased land described as Lot 1 DP 451158, Lot 1 DP 13077 and Lot 1 DP 9925;
- Effluent shall not be discharged where the soil has cracked, and
- Effluent shall not be discharged over tiles or mole drains when the soil is at field capacity.

Allowing for the above buffers, a conservative estimate for the size of the effluent discharge area is c.350 hectares at WW1 and WW2, and c.97 hectares at the Horner Block, which gives a total FDE area of 447 hectares. Given the presence of Drummond/Glenelg soils, there are significant areas of low risk soils assuming the use of low depth irrigation.

At an operational level:

- Dairy shed effluent from WW1&2 will continue to be discharged via travelling irrigator at low depth; in the future a low rate irrigation system may be installed;
- Slurry effluent will be discharged at very low depth via slurry tanker (or umbilical system) at the WW1&2. This includes land referred to as the SH96/Marcel Block. A maximum of 150 kg N/ha/year from agricultural effluent will be applied at the dairy platform;
- Slurry effluent will be carted via slurry tanker and discharged at very low depth at the Horner Block. Approximately 97 hectares is available at the Horner Block for this purpose (see figure 6.7). A maximum of 250 kg N/ha/year from slurry will be applied at the Horner Block.
- The slurry effluent areas at the milking platform (WW1 and WW2) and at the Horner Block are sufficiently large to receive both the volume and N loading from the effluent ponds.

- Effluent will not be discharged at times where there is snow on the ground or when rainwater/irrigation water has ponded on the land surface.

- Effluent will also not be discharged when soil conditions are considered unsuitable i.e. when soil temperature is at or below 5 degrees Celsius or when the soil moisture deficit is insufficient. Environment Southland's Beacon website will be consulted as a guide to soil moisture levels.

Figure 6.7 Horner support block with slurry effluent area annotated in purple.

Horner Block – slurry receiving area

The discharge of slurry from WW1&2 at the Horner Block will be authorised on a separate discharge permit. The Horner Block has no effluent storage or permanent irrigation infrastructure. The slurry tanker with the trailing show will be used to discharge pond slurry at the Horner Block, with an umbilical system used as a contingency.

Land use

Land is used as for cut and carry, and to discharge slurry effluent from ponds at WW1&2 and from WW3. No stock is grazed at the block so there is no nutrient loss from urine patches. Cut and carry block are used to grow grass only, typically having 4 cuts per season. Relatively high N inputs are required to achieve this. In this case fertiliser and slurry provide N. Cut and carry blocks are efficient at utilising N and generally have low N loss to water despite relatively high N inputs.

The block (160 ha) will continue to be managed as it has been managed in recent years. A general description of how the block will be managed is as follows:

Cut and carry

- Pasture renewal - the pasture renewal programme is by grass to grass cultivation. Approximately 5% is re-grassed each year.
- Grass (approximately 17 t DM/ha) is harvested and is purchased by dairy farms in the Woldwide Farming Group (including WW1 and WW2 and other farms). Some grass harvested is fed fresh or is stored as silage and fed to cows at wintering barns at WW1 and WW2.

Slurry

Slurry (from WW1&2) receiving area: 97 hectares

N loading: 5 applications of slurry at 15.2 m^3 per hectare per application = 243 kg N/ha from slurry

Woldwide Three: 57.5 hectares (not part of this application)

General fertiliser use

For a detailed fertiliser programme, please see the nutrient budget inputs. N, P, K and S are applied as follows:

- N (207 kg/ha – split applications, little and often)
- P (10 kg/ha)
- K (0)

Fertiliser is applied outside high risk months (i.e. May – July). If ground conditions are suitable and there is minimal risk of drainage, fertiliser can be applied in August.

Downstream users of groundwater

- Farmland is found due south of the HB. Downstream users of groundwater are farms (sheep, dairy and cropping).
- Drummond Township is located ~ 9 km to the south east of the HB so has domestic users of groundwater including Drummond Primary School and Drummond Kindergarten. Both are located at the south of the township.

6.3 Water Take

Groundwater is abstracted from three bores for use at the dairy sheds and to supply stock drinking water. The bores are over 100 metres apart. Two bores supply groundwater to the WW2 unit, one bore supplies groundwater to the WW1 unit. **The maximum volume of groundwater abstracted for 1,500 cows will be 180 meters cubed per day.** This is abstracted as follows:

> **WW1 -**The bore (well ID E45/0071) is located to the west of the dairy shed and supplies water via a submersible pump to three tanks (3 x 30,000 litres) at the dairy shed for stock drinking water and dairy shed use. The abstraction for WW1 is currently managed under Water Permit 301664. **It is proposed to increase the groundwater take to meet the needs of 700 cows milked through the WW1 dairy shed.** The proposed groundwater take at the WW1 unit is 84,000 litres per day.
>
> **WW2** - Two bores (well ID E45/0727 and E45/0083) supply groundwater for dairy use; one is adjacent to Wreys Bush Highway north of the dairy shed, and the other is on the west side of the dairy shed. The two bores supply water via submersible pumps to three tanks (3 x 30,000 litres) at the dairy shed for stock drinking water and dairy shed use. The abstraction for WW2 is currently managed under Water Permit 20171278-02. **The proposed groundwater take at WW2 is the same as the existing take to meet the needs of 800 cows milked through the dairy shed.** The proposed groundwater take at WW2 unit is remaining at 96,000 litres per day.

Groundwater use equates to 120 litres per cow per day and is in line with the Council's standard estimate for water usage (i.e. 70 litres per cow per day for drinking water and 50 litres per cow per day for dairy shed washdown).

Water requirements

Season

During the milking season (twice per day milking), requirements are 70 l/cow/day for drinking water and 50 l/cow/day for dairy shed wash down water:

1,500 cows x 120 l/day = 180,000 litres per day

180,000 litres per day is split between the WW1 (84,000 litres per day) and WW2 (96,000 litres per day) dairy units.

An average lactation length is 280 days.

280 days x 180,000 litres per day = 50,400,000 litres

Off season

Cows remain on-farm over winter when they are housed in two wintering barns. An average lactation length for cows is 280 days, which leaves an average of 85 days when cows are dry. A drinking water allowance for dry cows is 45 l/cow/day. On average 1,280 cows require drinking water in the off season for 85 days:

1,280 cows x 45 l/day x 85 days = 4,896,000 litres for the off season.

Total volume of groundwater required

55,296,000 litres or 55,296 metres cubed

Extraction

Groundwater is abstracted from three bores over 50 metres apart from each other, which ensures that the abstraction rate will be less than 2 L/sec.

Average daily rate of take (WW1)	0.97	litres per second
Average daily rate of take (WW2)	1.11	litres per second
Maximum daily rate of take	2.0	litres per second
Maximum daily volume	180	cubic metres per day
Maximum weekly volume	1,260	cubic metres per week
Maximum monthly volume	5,400	cubic metres per month (30-day month)
Maximum annual volume	55,296	cubic meters

The bores are over 50 metres apart from each other. The bores are not within 700 metres of a neighbouring bore or groundwater take.

The dairy supply bore map references (NZTM2000) are:

-	E45/0083	E1225011	N4889693
-	E45/0727	E1225014	N4890268
-	E45/0071	E1225145	N4888768

Water storage

Three water storage tanks (3 x 30,000 L) are utilised at WW1’s dairy shed to ensure that the rate of take is less than 2 L/sec.

Three water storage tanks (3 x 30,000 L) are utilised at WW2’s dairy shed to ensure that the rate of take is less than 2 L/sec.

6.4 Proposed land-use – dairy farming

WW1&2 Land use activities

Land use

The land is used as a pasture based dairy farm. Calving officially starts on 1 August and cows are typically milked from 1 August to 31 May, with late calving cows milked until 15 June. Cows (Friesan) are milked twice per day.

Stock management

- Up to 1,500 cows (i.e. mixed age cows and replacements) are calved each year. The milking herd peaks in October/November at 1,500. It drops slightly over consecutive months depending on seasonal variation in pasture production; approximately 1,410 cows are milked in March. Cows are dried off in May and June. Approximately 375 cows (25%) are culled by May/June and replaced each year.

- Median calving date is 20 August with approximately 417 heifer calves kept as replacements. R1 calves are on farm for August, September and October. Replacement calf numbers will be reduced by 10% over the following 21 months through deaths/culling, leaving 375 R2 heifers to be wintered, calve and join the milking herd at WW1&2.

  Activities at WRO are explained in detail in the WRO section of the application:
  - In November, weaned R1 calves go to WRO where they remain for approximately 19-21 months. All R1 heifers are IWG at WRO in June/July.
  - Once grown out to R2s, heifers are mated.
  - In-calf R2 heifers are either wintered in barns at WW1&2 (up to 125) or IWG at WRO.
  - The long-term goal is to house all in-calf R2 heifers from WW1&2 in winter barns although that is not part of this proposal.

- Approximately 375 in-calf R2 heifer replacements return to WW1&2, calve in August, September and October when they join the milking herd.
- Approximately 15 bulls are grazed on farm and used as part of the mating programme each year.

Wintering, cropping, grazing and supplements – WW1&2

- Wintering – all MA cows are wintered on farm where they are housed in two wintering barns over June and July. Depending on the season, R2 heifers (c.125) are also wintered in barns. Cows are housed in barns during May, August and September as required also.
- Fodder crop – no fodder crops (brassica or beet) are sown. Animals are not IWG or grazed on fodder crop at any other time.
- Pasture renewal - the pasture renewal programme is by grass to grass cultivation. Approximately 5% of the farm is re-grassed each year.
- Grazing – cows are grazed on pasture throughout the season. The wintering barns are used to stand cows off paddocks during the shoulders of the season and during high risk inclement weather events throughout the season.
- Supplements made – If there is a surplus, silage may be harvested at the dairy farm. There is no dedicated silage block, however, and in general silage is imported.
- Supplements imported – barley, molasses, PKE and grass silage (see nutrient budget inputs)

General fertiliser use

For a detailed fertiliser programme, please see the nutrient budget inputs. N, P, K and S are applied as follows:

Effluent block:

- N (139 kg/ha – split applications, little and often)
- P (25 kg/ha)
- K (0)

Slurry receiving area:

- N (179 kg/ha – split applications, little and often)
- P (22 kg/ha)
- K (0)

Non-effluent blocks:

- N (209 kg/ha – split applications, little and often)
- P (34 kg/ha)
- K (28 kg K/ha)

Fertiliser is applied outside high risk months (i.e. May – July). If ground conditions are suitable and there is minimal risk of drainage, fertiliser is applied in split applications from August to April.

Good Management Practices

Good management practices (GMPs) implemented on farm are also described in the FEMP. A general strategy of good management practice is undertaken to minimise contaminant losses across the whole activity. Details are described in table 6.3 below. Key mitigation measures (distinct from GMPS) are described in table 7.1.

Evidence of sustainable soil and nutrient management is clear in trends in soil testing over many years. See the Appendix for reports from Ravendown supporting good practice management of farm soils and farm fertility.

Table 6.3 General Good Management Practices – WW1&2

Strategy Type	Summary of Management Practices
Operational	Utilising a nutrient management plan; Soil testing is carried out each year to inform on decision making regarding fertiliser application; Trends in soil testing are evaluated and used to inform on decision making regarding soil health, fertiliser and agronomy plans; Surface waterways are fully fenced and with good grass cover, fencing is maintained and stock are excluded from the riparian areas; Wide riparian buffers are maintained; All surface waterways are culverted; Sufficient land area is available for the dairy operation; Young stock is grazed off farm from weaning; All cows are wintered in barns over June and July; Tracks and lanes predominantly sited away from streams; Lane runoff diverted to land; Good management practice of the silage pad is implemented; Restricted grazing of draining pastures in autumn/spring; Specialist machinery is used to harvest grass to minimise the risk of soil compaction; Care in irrigation of FDE, especially when the ground is near or at field capacity; A large land application area is available to ensure N & K returns are not excessive, taking into account the higher strength nature of slurry effluent; Effluent volumes are minimized at source through efficient water use; Appropriate application depths for liquid effluent (a maximum of 10 mm depth per application and less than 50% PAW on Category E soils) and slurry (a maximum of 2.5 mm depth per application across the WW1&2 and the Horner Block) are used;

	Appropriate effluent storage volume to allow for deferred irrigation; All data and maps are kept up to date and all staff are trained and informed of any changes; Programmed maintenance is done in and around FDE, and piping infrastructure around the dairy shed, silage bunkers, cow yards etc.;

Good Management Practices for Key Transport Pathways – WW1&2

See table 6.4 below for a summary of physiographic zones and key transport pathways of contaminants.

Table 6.4 Physiographic zones and key transport pathways

Physiographic Zone	Variant	Key Transport Pathways
Central Plains	n/a	Artificial drainage, deep drainage
Oxidising	n/a	Deep drainage

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

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

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

Recommendations described on Good Practice Management factsheets issues by Environment are implemented where practical. These measures will be reviewed annually with the inclusion of new measures where appropriate. Table 6.5 describes good management practices, which have been implemented on-farm through most recent annual cycle to mitigate the risk of contaminant loss to water (N, P, sediment and microbes).

Reference factsheets: Artificial drainage; Deep drainage; Overland flow

Table 6.5 Good management practices implemented on farm and further explanations.

Transport Pathway	Environmental outcome	Summary of Management Practices
Artificial drainage,	Protect soil structure	Match stock management to land use capability, e.g. avoid grazing cows on more vulnerable soils, especially when wet.

Overland flow	(especially near streams)	Fence off waterways. Stock will not graze riparian strips. Riparian strips are approximately 3 m and well are vegetated; All cows are wintered off paddocks in wintering barns; When appropriate use minimum or no-till cultivation practices such as direct drilling; Re-sow areas of bare or damaged soil as soon as is practical;
Artificial drainage, Overland flow	Reduce P use or loss	Prepare a nutrient budget; Soil test regularly; Maintain Olsen P values at agronomic optimum and no higher; Apply P fertiliser outside of high-risk months in autumn and winter; Manage CSAs close to surface drains appropriately. During and following inclement weather, CSAs close to surface drains will be temporarily fenced off to prevent stock from damaging soils and from adding nutrients to high drainage locations. No effluent will be discharged to the same areas;
Artificial drainage, Deep drainage	Reduce accumulation of surplus N in the soil, particularly during autumn and winter	Maintain sustainable stocking rate (3.1 cows/ha at WW1&2); Reduce inputs of N where possible through optimal fertilizer application on farm, use little and often approach; All MA cows are wintered off paddocks in wintering barns; Optimize timing and amounts of effluent irrigation input applications, accounting for higher strength nature of slurry effluent; Substitute autumn diets with low-N feed when practical; Time N application to meet pasture demand using split applications and when pastures are actively growing (>6 degrees Celsius); Control the duration of grazing pastures; Cut and carry feed where practical;
Artificial Drainage Deep drainage	Avoid preferential flow of effluent through drains or soil cracks	Defer irrigation to effluent storage ponds when soil conditions are unsuitable; Very low depth slurry application is implemented; Low depth dairy shed effluent application is implemented;

		Avoid applying slurry or dairy shed effluent where soils are cracked; A sufficiently large FDE area is available for effluent; Observe buffer zones and placement guidelines; Observe discharge consent conditions;
Overland flow	Manage CSAs; low areas overlying tiles close to outfalls at surface drains	Restrict grazing of pasture CSAs when soils are near saturation; Avoid working pasture CSAs and their margins; Move troughs and gateways away from water flow paths; Reduce runoff from tracks and races;
Deep drainage	Avoid loss of contaminants (nitrate and faecal microbes) to groundwater via deep cracks formed in summer dry periods in Braxton soil types.	Monitor paddocks for deep cracks in summer/autumn. If and where they form, avoid grazing the area and irrigating effluent to the area; Avoid deep crack formation by maintaining good soil structure and good pasture cover;

Specific Mitigation Measures – Expansion

The change to the 1,500-cow system brings in an additional 160 cows. This will occur in conjunction with key mitigation measures to off-set nutrient and contaminant losses potentially generated by additional cows. Overseer predicts that the average annual N loss for WW1&2 will decrease slightly per hectare and that P loss will remain stable per hectare. Some key mitigation measures not recognised by Overseer will further reduce contaminant loss, although these are not recognised by Overseer. P loss can generally be used as a proxy for sediment and microbial loss.

Key mitigation measures are described in table 7.1, along with an assessment of their effectiveness and level of effectiveness.

FURTHER INFORMATION REGARDING MITIGATION MEASURE #6 (FROM TABLE 7.1)

Two lanes lie adjacent to a stream close to the WW1 wintering barn (see figure 6.8). Only one of these lanes (i.e. the east side lane), however, is used for cow traffic to the milking shed. The west side lane is solely used to truck silage in and for truck access to the cattle yards to load and unload stock. Cows do not use the west lane, so it only collects rainwater. Since there is no cow traffic on the west side lane, there is no risk of runoff of contaminants (containing phosphorous or microbes) from dung or urine to the stream.

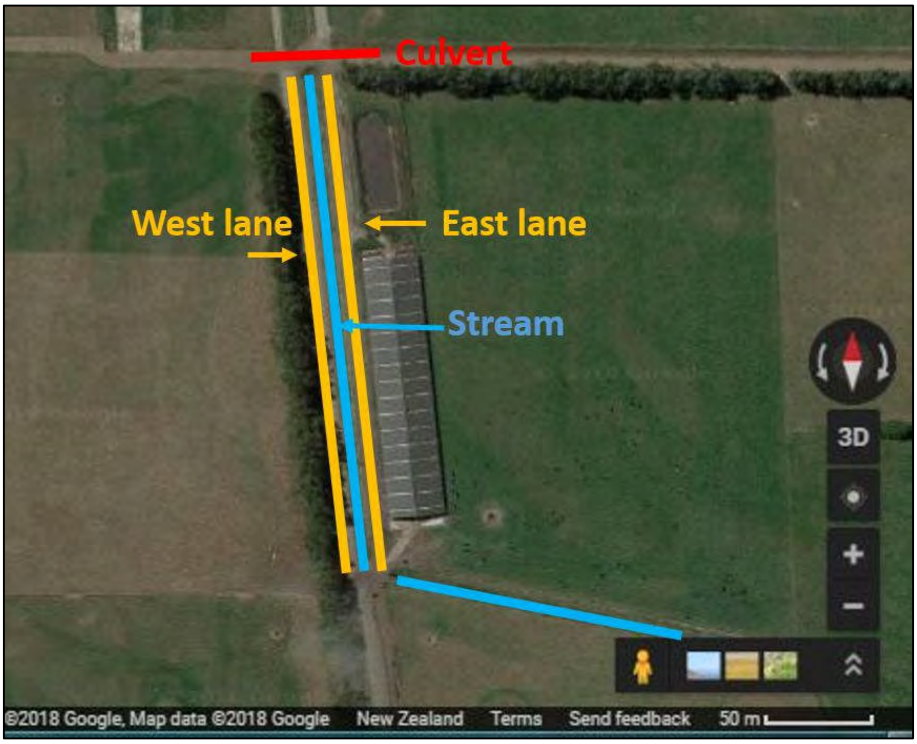


Figure 6.8 Aerial photo of stream flanked by two lanes at WW1, close to wintering barn and north of milking shed.

The east lane has cow traffic, as seen the below figures. The stream is protected by a wide buffer (>3 m) that has a slope of approximately 30 degrees and is vegetated with long grass. In view of an additional 160 cows using the lane, work has recently been carried out to contour the lane to ensure rain falling on the lane drains away from the adjacent stream. This measure will be effective at preventing runoff to the stream, which otherwise could be a greater risk with additional cows. Good grass cover will always be maintained on the stream bank to further protect the stream.

In the below photo, water flowing in the stream appears clear, which is noteworthy as the photos were taken after 40 mm of rainfall in the previous week.

Figure 6.9 Stream flanked by two lanes. Note that photo was taken from the north/facing south.

Figure 6.10 Cows crossing waterway over culvert to walk to the dairy shed on the east lane.

Overseer summary

N LOSS

The key drivers of the small decrease in N loss (kg/ha) despite an additional 160 cows are as summarised follows:

- Removal of summer and winter crop;
- Removal of cows wintered outside on crop or grass;
- Expansion of size and use of wintering barn facilities;
- More efficient use of N fertiliser.

N losses from crop blocks are driven by fertiliser and effluent application, as well as mineralization processes and accumulation of cow excreta associated. The proposed system has no fodder crops/IWG annually. The effect of this is to reduce the average N loss slightly, despite increasing cow numbers by 160.

P LOSS

The key drivers of a stable P loss (kg/ha) despite an additional 160 cows are summarised as follows:

- Decrease in winter crop area;
- Maintaining Olsen P at target level of 30;
- Expansion of size and use of wintering barn facilities.

The key measures that will mitigate P loss also will help to mitigate the loss of sediment and microbial contaminants to water, as they are generally transported to water via artificial drainage and overland flow also.

OTHER MITIGATION MEASURES FOR P LOSS

Other measures that mitigate P, sediment and microbial contaminant loss that are not modelled by Overseer prevent overland flow from critical infrastructure to surface waterways following periods of heavy rainfall. This greatly reduces the propensity of a pathway that transports P (and sediment and microbes) directly to surface waterways. P remains on lanes and/or is returned to adjacent paddocks where it is filtered, attenuated and can be taken up by plants.

These measures include:

- Only a small proportion of lanes run parallel to or close to waterways. This greatly reduces the risk of runoff from tracks and lanes into waterways. Overseer does not recognise the layout of individual farms;
- Herd movement is managed to minimise the time cows spend on lanes and other tracks, especially where there is a risk of runoff to waterways;
- Minimise the number of culvert/bridge crossings of waterways, where run-off from tracks and lanes can reach surface waterways. Any locations where run-off could potentially occur are identified as CSAs and managed to minimise the risk of runoff occurring. Track shaping and cutting is carried out to direct surface drainage at such locations to paddocks and away from waterways. If necessary, nib boarding is put in place. Runoff is filtered through pasture before draining to waterways.

Review

A review of good management practices and mitigation measures will be carried out annually. Practices undertaken in the previous 1 June to 31 May period will be reviewed and practices will be implemented over the following 1 June to 31 May as appropriate.

Nutrient budgets

Seven nutrient budgets (NBs) have been prepared:

- Four pre-expansion nutrient budgets have been prepared based on actual figures for 2013/14, 2014/15, 2015/16 and 2016/17 years. A high level of evidence has been provided to support inputs used for all year end nutrient budgets.
- One nutrient budget has been prepared to for the proposed 1,500 cow system at WW1&2.
- Two nutrient budgets for the Horner Block (one current and one proposed).
    - Environment Southland have since been advised via a legal opinion that the Horner Block is not required to be on the land use consent for farming; as such nutrient budgets are not needed. Since nutrient budgets were already prepared for the Horner Block, they will be used as a useful information source.
- One nutrient budget has been prepared for WRO based on the 2017/18 year.

Cain Duncan (CNMA) from Farm Source Sustainable Dairying carried out all Overseer work. Soil nutrient test data, the latest version of the Overseer model (ver. 6.3.1) and Overseer Best Practice Data Input Standards were used. Associated XML files have been submitted electronically.

Table 6.6 Overseer files

Number	Year	XML file name
1	2013/2014	Ovr-Woldwide 1,2 & 96 13_14 (2).xml
2	2014/2015	Ovr-Woldwide 1,2 & 96 14_15 (2).xml
3	2015/2016	Ovr-Woldwide 1,2 & 96 15_16 (2).xml
4	2016/2017	Ovr-Woldwide 1,2 & 96 16_17 (2).xml
5	Proposed WW1&2	Ovr-Woldwide 1&2 Proposed (Mitigations & Slurry) (2).xml
6	Current use - Horner Block	Ovr-Horner Block -Current (3).xml
7	Proposed use - Horner Block	Ovr-Horner Block - Proposed (3).xml
8	2017/18 – WRO	Ovr-Woldwide Runoff (Merrivale & Merriburn).xml

Mr. Duncan also prepared an in-depth nutrient budget analysis report for WW1&2 and the Horner Block, which is submitted with this application. Rather than duplicate material, please refer to the appended nutrient budget analysis report for assumptions and a summary of inputs for each nutrient budget:

- Assumptions: Sections 5, 6 and 7
- Inputs: Section 9, 12

Nutrient budgets 1 – 5 from the above table contain the same land areas: former WW1 milking platform, former WW2 milking platform, Marcel Block and SH96 block.

Where the nutrient budget report by Mr. Duncan states that the land area is being increased by bringing in support land, this refers to the SH96 and Marcel Blocks, which were consented for dairy farming as part of WW2's land use consent for farming granted in 2017. Mr. Duncan has also prepared detailed maps and a summary for each individual nutrient budget as part of the report.

The WRO nutrient budget is described in a separate report prepared by Mr. Duncan. Outputs from the WRO nutrient budget are detailed in the WRO section of the application.

Nutrient Losses as Modelled by Overseer – WW1&2

PRE-EXPANSION

Table 6.7 Modelled nutrient losses for pre-expansion year end nutrient budgets (source: Nutrient Budget Analysis Report).

	13/14	14/15	15/16	16/17	Average
Total N Loss (kg)	19055	23016	19112	20723	20477
N Loss/ha (kg)	40 (15)	46	38	41	41
N Concentration in Drainage (ppm)	7.3 - 12.9 (Pastoral) 16.4 - 27.1 (Crops) 5.9 – 12.5 (Silage/WGYS)	9.9 – 15.7 (Pastoral) 13.5 - 17.6 (Crops) 5.9 – 9.5 (Silage/WGYS)	7.3 – 14.3 (Pastoral) 13.1 - 18.8 (Crops) 4.0 – 9.8 (Silage/WGYS)	8.5 – 15.3 (Pastoral) 18.0 - 23.8 (Crops) 2.9 – 7.5 (Silage)	
Total P Loss (kg)	345	374	362	357	360
P Loss/ha (kg)	0.7 (0.2)	0.7	0.7	0.7	0.7
Pasture Grown Kg/DM/ha/yr (Dairy Platforms)	15,003	15,483	15,089	15,909	15,371

PROPOSED

Table 6.8 Modelled nutrient losses for post-expansion nutrient budget (Source: nutrient budget analysis report).

	Proposed Dairy Unit
Total N Loss (kg)	20,262
N Loss/ha (kg)	40
N Concentration in Drainage (ppm)	Pastoral – 7.8 to 17.2 ppm

Total P Loss (kg)	357
P loss/ha (kg)	0.7
Pasture Grown Kg/DM/ha/yr	15,544

Discussion – nutrient losses at WW1&2

N LOSS

The pre-expansion average annual N loss based on four years of supported data and analysis is 20,477 kg/year. The proposed 1,500 cow dairy farm is predicted by Overseer to have an average N loss of 20,262 kg/year. Overseer predicts an average reduction in N loss of 215 kg/year with the change to the proposed system. The N loss per hectare value for the proposed 1,500 cow farm (40 kg/year) is predicted to reduce slightly relative to the pre-expansion land use (41 kg/year).

This decrease is mainly driven by the removal of forage brassica and beet winter and summer crops, and their associated IWG or summer grazing, the removal of pasture grazing in winter, greater use of the wintering barns and more efficient fertiliser use. Soil aggregates are broken up and mixed when cultivated for cropping. This results in a high rate of N mineralisation through accelerated microbial decomposition of soil organic matter and subsequent rapid nitrification, which produces large quantities of nitrate. Dung and urine are deposited in relatively high volumes on winter crop ground, further driving losses of N. This is especially seen during late winter and early spring, when the ground lies fallow. Greater use of the wintering barn facilities allows the collection and storage of nutrients in dung and urine, some of which were previously deposited on winter crop and grass paddocks as they were grazed. Because of significant changes in management practices, the proposed 1,500 cow system is predicted to have slightly less average annual N loss than the pre-expansion system despite an increase of 160 cows.

Pasture production is similar for both the pre-expansion system (15,371 kg DM/ha/year) and the proposed 1,500 cow farm (15,544 kg DM/ha/year).

P LOSS

The pre-expansion average annual P loss is based on four years of supported data and analysis is 360 kg/year. The proposed 1,500 cow dairy farm is predicted to have an average P loss of 357 kg/year, which is essentially no change. The per hectare P loss value for the proposed 1,500 cow farm (0.7 kg/year) is predicted to remain as for the pre-expansion land use (0.7 kg/year). For both the pre-expansion and proposed system, the risk of P loss from effluent is classed by Overseer as low for all blocks. The risk of P loss from soil and fertiliser is classed as low for all soil type blocks.

The key drivers of the stable predicted P loss are the removal of forage brassica and beet winter and summer crops, and their associated grazing, the maintenance of Olsen P at a target of 30, and the expansion in size and use of the wintering barns.

As already explained, effective measures to mitigate P loss that are not detected by Overseer will also be implemented on farm.

Nutrient loss – Horner Block

The current nutrient budget represents a conservative approach to modelling the existing nitrogen and phosphorus losses on the HB.

Under both current and proposed land use, the Horner Block has very low nutrient losses. The current use is predicted to have an annual average N loss of 20 kg/hectare; the proposed has N loss of 19 kg/hectare. The current use is predicted to have an average P loss of 0.1 kg/hectare; the proposed has P loss of 0.1 kg/hectare.

Discussion – effects of losses

Please see Section 7 (AEE) for a discussion on the effects of predicted nutrient losses.

7. Assessment of Environmental Effects/Mitigations

An assessment of effects in accordance with Schedule 4 of the RMA is provided in this section. The assessment has been prepared in three sections covering the discharge activity, water take and land use/farming activity respectively, since each will be authorised on its own consent; discharge permits, water permit and land use consent for farming respectively.

The discharge activity will be authorised on two permits, one each for WW1&2 and the Horner Block respectively.

The discharge activity is part of the overall farming activity, so information provided in section 7.1 is also relevant to the AEE for the farming activity (section 7.3).

7.1 Effluent discharge activity

Odour

Adverse effects from odour can occur due to the discharge of agricultural effluent (liquid and slurry) where it may be encountered beyond the boundary of the site. The applicants have proposed the continued use of very low depth and low depth application technology, which coupled with the proposed effluent discharge buffers means there is little risk of adverse effects from odour and spray drift on surrounding land owners and occupiers. They irrigate according to wind direction and risk, which helps to avoid adverse odour effects.

Slurry is applied a very low depth using the slurry tanker with the trailing shoe. The trailing shoe part of the slurry tanker sits on the ground. It applies sludge at ground level and generates minimal aerosol and odour. It was invented in Europe to reduce adverse odours from the application of slurry/sludge to land, which is standard practice due to the housing of cows in barns over winter. It is regarded to be an effective odour minimisation technology and is best practice for slurry application. Its use will help to avoid adverse odour effects on neighbouring properties.

Risks to surfacewaters from effluent discharge

Adverse effects on surface water can occur from the discharge of farm dairy effluent where contaminants present in effluent such as nutrients N and P, organic matter and microbes reach receiving surface waters such as streams, rivers and estuaries. Effects such as nutrient enrichment of surface waters *are cumulative*, and can lead to algal blooms including slime, and promote nuisance aquatic plant growth. The collection of plants and animals that inhabit receiving waters are adversely affected by nuisance plant growth, as well as in-stream values such as biodiversity and ecosystem services. Values associated with surfacewater streams and coastal waters are many and relate to the landscape, biodiversity, history and people living in the catchment. These values include maintaining the health of water bodies both in-stream and coastal, protecting biodiversity and ecosystems, protecting recreational activities such as fishing, walking and boating; protecting human and animal health, maintaining sustainable farming practices and the socioeconomic well-being of people through preserving values that relate to inshore fishing, farming and tourism. Iwi/cultural values include the principles of protection or kaitiakitanga of the mauri of the water and mana of the land, while minimising adverse effects on taonga and mahinga kai.

WW1&2 receiving surface waters predominantly lie in the Waimatuku Stream catchment, Waimatuku Estuary and coastal waters, as well as New River Estuary catchment. Horner Block receiving waters also lie in the Waimatuku Stream and Waimatuku Estuary, as well as in the Aparima River, Jacobs River Estuary and coastal waters. These are considered sensitive environments due to the accumulation of nutrients, sediment and microbes. Receiving waters show evidence of land use impacts, with elevated levels of nutrients, sediment and algal blooms at times. The Waimatuku Stream catchment shows higher levels of nutrients than the Aparima River or Oreti River catchments.

Artificial drainage is a contaminant pathway, particularly subsurface drainage channels installed in silty clay Braxton soil types. Artificial drainage transports contaminants via bypass drainage to receiving surfacewaters during and following periods of heavy rainfall. Parts of the discharge area with Braxton soils types at both WW1&2 and the Horner Block are high risk for effluent discharge and require appropriate management of effluent discharge to mitigate the risk of contaminant loss to surfacewaters. Braxton soils are found in the Waimatuku catchment. Shallow groundwater in the Waimatuku catchment is understood to discharge to the local stream network and can potentially contribute cumulatively to adverse effects on surfacewaters.

Risks to Drummond Peat Swamp and Bayswater Bog are described and effects are assessed in section 5.

Risks to groundwater from effluent discharge

Adverse effects on groundwater can occur from the discharge of agricultural effluent where contaminants present in effluent such as nutrients N (nitrate) and microbes (pathogens such as campylobacter) reach receiving groundwaters via leaching/deep drainage pathways. A major risk of elevated nitrate levels in groundwater is to users (consumers) of groundwater as nitrate becomes toxic to living organisms such as humans, animals and fish at high levels. The New Zealand Drinking Water Standard maximum allowable value for nitrate is 11.3 ppm. Another risk is to consumers of groundwater is waterborne gastroenteritis through the ingestion of groundwater contaminated with pathogens such as campylobacter. This was demonstrated in Havelock North in 2016, when over 5,000 people became ill with camplyobacteriosis. Adverse effects on other users of groundwater such as other farms, small industries, schools or settlements/domestic users are possible and need to be avoided. Particularly, any risk from the discharge activity to the drinking water supply at Heddon Bush School 2.3 km south of the property needs to be avoided. *E.coli* is widely used as an indicator of faecal microbial contamination of water, including groundwater.

WW1&2 predominantly overlies the Waimatuku Groundwater Zone. The eastern part of WW1&2 overlies the Central Plains Groundwater Zone. The eastern part of the Horner Block overlies the Waimatuku Groundwater Zone and the western part overlies the Upper Aparima Groundwater Zone. Heddon Bush School also overlies the Waimatuku Groundwater Zone. Although Drummond and Glenlg soil types have risk of contaminant loss via deep drainage to underlying aquifers, they are low risk for effluent discharge due to their physical properties (and drainage properties), and due to the nature of the discharge activity (low depth and very low depth).

Braxton soil types have swell/crack characteristics that can allow contaminants in effluent to be washed down to the underlying groundwater resource via deep cracks that can form during prolonged dry summer conditions. Parts of the discharge area with Braxton soils types at both WW1&2 and the Horner Block are high risk for effluent discharge and require appropriate management of effluent discharge to mitigate the risk of contaminant loss to groundwater if and where deep cracks are formed. A site investigation by Environment Southland in January 2018 did not find evidence of deep cracks on Braxton type soils, however, leading to a conclusion Braxton soil types may not form deep cracks and are therefore less likely to provide a pathway for contaminants in effluent to reach groundwater.

Mitigation of adverse effects due to effluent discharge

Adverse effects, *including cumulative effects*, due to the discharge of agricultural effluent (liquid effluent and slurry) are either avoided, remedied or mitigated at WW1&2 and Horner Block through the implementation of good effluent management practice and mitigation measures. Contaminants present is effluent (N, P, microbes) are held in the root zone, adsorbed by plants or are filtered/adsorbed by soil particles. The below section refers to the mitigation of adverse effects due to effluent discharge at both WW1&2 and the Horner Block.

Due to its nature and scale, there will be little or no effect on receiving ground and surface waters *including cumulatively*, from the effluent discharge activity in this instance. The discharge system meets industry best practice standards for farm dairy effluent discharge by using buffer storage and low depth application. The use of best practice effluent application should avoid adverse effects on the environment. This principle is well documented in various scientific reports prepared for Environment Southland during the process of setting policies and rules around effluent discharge to land. A 2009 report[21] provides context and background to the principle that best practice effluent application should not cause adverse effects on water quality. The graph below is taken from the report to illustrate that nutrient loss from FDE application is minor if undertaken using best practice. In this example, less than 1% of nutrients applied in effluent reached drainage water on tile and mole drained soil. These soils are considered high risk relative to some of the soils available for effluent discharge at WW1&2 and Horner Block, that drain via matrix flow.

---

[21] Houlbrooke & Monaghan (2009). The influence of soil drainage characteristics on contaminant leakage risk associated with the land application of farm dairy effluent. Report prepared for Environment Southland.

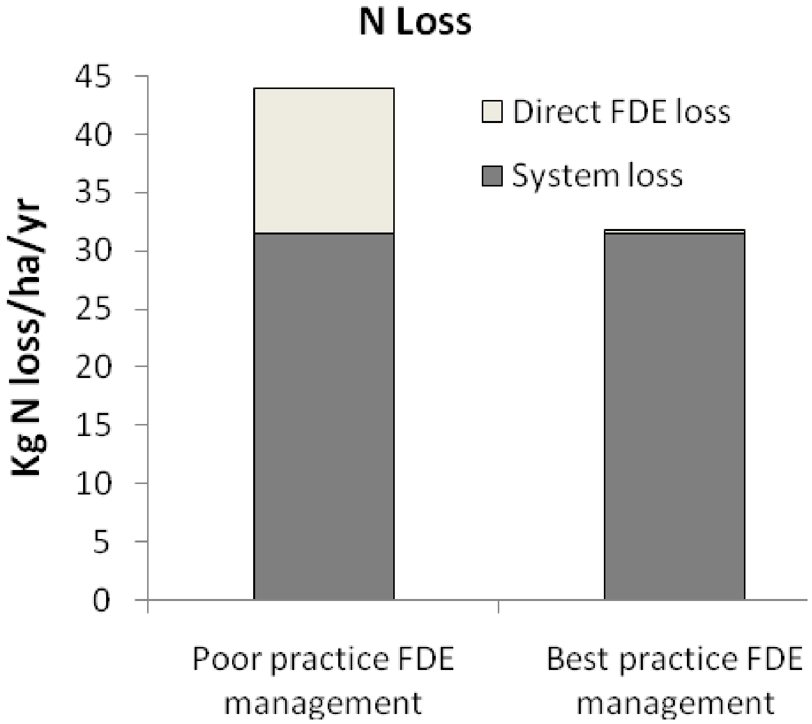


Figure 7.1. Houlbrooke and Monaghan (2009)

The applicants intend to apply effluent in accordance with best practice at all times to avoid adverse or *cumulative effects* on the receiving environment. The authors explain that if effluent is applied to soil when a soil moisture deficit exists then the effluent preferentially remains in the soil's root zone as plant available water or is adsorbed onto soil particles. The soluble nutrients in the effluent can then be taken up by the plant and used in nutrient cycling. Microbes can be filtered and held by soil particles until they are no longer viable. The applicants use the closest Environment Southland soil moisture monitoring site, which is available on the ES website, to determine whether a suitable soil moisture deficit exists for each of the irrigation systems. Effluent application, including both liquid effluent and slurry, is deferred if soil moisture levels are too high to safely and correctly apply effluent. Effluent is only applied when there is a ground moisture deficit and when effluent application will not induce drainage.

Deferred irrigation

The dairy platform currently has a total storage capacity of 8,032 m^3 in two effluent storage ponds, which provides for deferred irrigation for effluent from the dairy sheds, wintering barns and silage leachate according to the Massey Dairy Effluent Storage Calculator. 6,460 m^3 is the 90% probability volume according to the Massey DESC. The ability to defer irrigation during marginal times means that effluent will only be applied when a soil moisture deficit occurs. By deferring irrigation when ground conditions are unsuitable, losses to drainage water should be considerably less than the 1.1% of the total nutrients applied in the effluent experienced in the above-mentioned trial. When soils are near or at field capacity and there is risk of contaminant loss via artificial drainage (or overland flow when soils are saturated) to receiving surfacewaters, or risk of contaminant loss via cracks in Braxton soil types to groundwater, irrigation is deferred by storing effluent in the two storage ponds. The risk of contaminant loss from effluent discharge via artificial drainage, overland flow or deep drainage is in this way mitigated.