



2024 ANNUAL COMPLIANCE REPORT CRC184159 & CRC211511

1 DECEMBER 2024

QUALITY CONTROL SHEET

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CONSENT	
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EXECUTIVE SUMMARY

The Barrhill Chertsey Irrigation Limited (BCI) nitrogen discharge resource consents CRC184159 and CRC211511 commenced on the 14th of October 2021. The consents permit the discharge of nutrients from farming activities for nearly two hundred farms irrigated by BCI and Acton Farmer Irrigation Co-operative (AFIC) shareholders. The consents require the establishment and implementation of an Audited Self-Management Programme (ASM), including audited Farm Environment Plans, catchment nitrogen load limits and reduction targets, Advanced Mitigation achievement targets and a water quality monitoring programme.

This report summarises key outcomes of the BCI ASM programme for the period **1st July 2023 to 30th June 2024**.

BCI's Environmental Management Strategy (EMS) is the key document which sets out the systems and processes needed to effectively implement the Audited Self-Management programme and comply with the discharge consent. Initially developed in 2015, the EMS promotes continuous improvement, compliance with our regulatory obligations and identifies actions needed to improve water quality outcomes within the catchment.

The 2021 EMS was prepared to meet the requirements of the renewed consents in consultation with Te Rūnanga o Arowhenua and certified by Environment Canterbury on 28th November 2022. In November 2024, one third of our EMS documents and how we implement them was externally peer reviewed by WM Environmental (**Appendix E**).

Nitrogen losses from the BCI ASM programme are calculated using The Matrix methodology¹, a catchment nitrogen load calculator formally recognised as “equivalent” to Overseer by Environment Canterbury in April 2020.

To ensure The Matrix continued to be equivalent Overseer for the duration of the consent, we are required to complete a validation exercise every four years, comparing Matrix N loads with the aggregated N loads from a representative sample of scheme farms. We completed this exercise with MHV Water and Ashburton Lyndhurst Irrigation scheme and confirmed The Matrix was within 8.1% of the Overseer N loads and therefore still deemed to be “equivalent” to Overseer.

For the land managed under CRC184159 in the 2023-24 reporting year, the Nitrogen Discharge Allowance (NDA) for Hekeao/Hinds was calculated to be **493.1 T N (v6.5.5)**. For the 2023-24 reporting season, BCI shareholders discharged **455.3 T N, 93%** of the current consented N load limit.

For land consented under Ashburton zoned resource consent (CRC211511) in the 2023-24 reporting year, the NDA was calculated to be **1,715.7 T N**. For the 2023-24 reporting season, BCI and AFIC shareholders discharged **1,613.3 T N, 94%** of the consented N load limit. We have already achieved our 2025 Advanced Mitigation target with 17% of all farms in the catchment audited as Advanced Mitigation, accounting for 24% of the land area.

BCI also invest significantly in an extension programme and work collaboratively with industry to support shareholders with methods to improve their resource use efficiency. Of the 60 BCI and AFIC audit this season, 25% were able to demonstrate achievement of an Advanced Mitigation grade and a further 61% achieved an “A”. Only one farm was graded a “C” and no “D” grades.

BCI's Environmental Monitoring Plan for resource consent CRC211511 was submitted to Environment Canterbury for review on 14th April 2022 and accepted on 28th November 2022. A summary of the data collected to 30th June 2023 has been prepared by Pattle Delamore Partners (PDP) and attached in **Appendix F**. Monitoring for resource consent CRC184159 was already initiated through the MHV Water Limited Environmental Monitoring Plan provided for their discharge consent CRC185857. The Hekeao/Hinds water quality monitoring summary report is included in **Appendix G**.

The Environmental Monitoring Reports note some surface water attributes had been missed in the monitoring programme. The issue has now been identified and the attributes will now be assessed from now on. There were no other issues to report in relation to compliance of resource consents CRC184159 and CRC211511.

¹ Updated to Overseer version 6.5.5, calculated by Dr. Glen Treweek of WSP Limited.

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INTRODUCTION

Barrhill Chertsey Irrigation Limited (BCI) are consented to take up to 17 m³/s of water from the Rakaia River, of which up to 3 m³/s is licensed to Acton Farmers Irrigation Co-Operative (AFIC), east of Rakaia. Only 13.4 m³/s of water was allocated to BCI and AFIC shareholders in the 2023-24 season, with further development of the scheme planned in the future.

Nutrients discharged to groundwater from BCI and AFIC shareholders are permitted through resource consents CRC184159 and CRC211511, granted on 14th October 2021 to manage the effects of farming land use activities within the Ashburton District.

CRC184159 covers over 10,000 ha within the Land and Water Regional Plan's (LWRP) Plan Change 2 (PC2) area, which is located south of the South Branch of the Ashburton River through to the Rangitata River. CRC211511 covers approximately 48,500 ha between the PC2 boundary north to the Rakaia River (LWRP's Plan Change 5 (PC5) area) (Figure 1). All land managed under resource consents CRC184159 and CRC211511 form the "BCI ASM Programme".

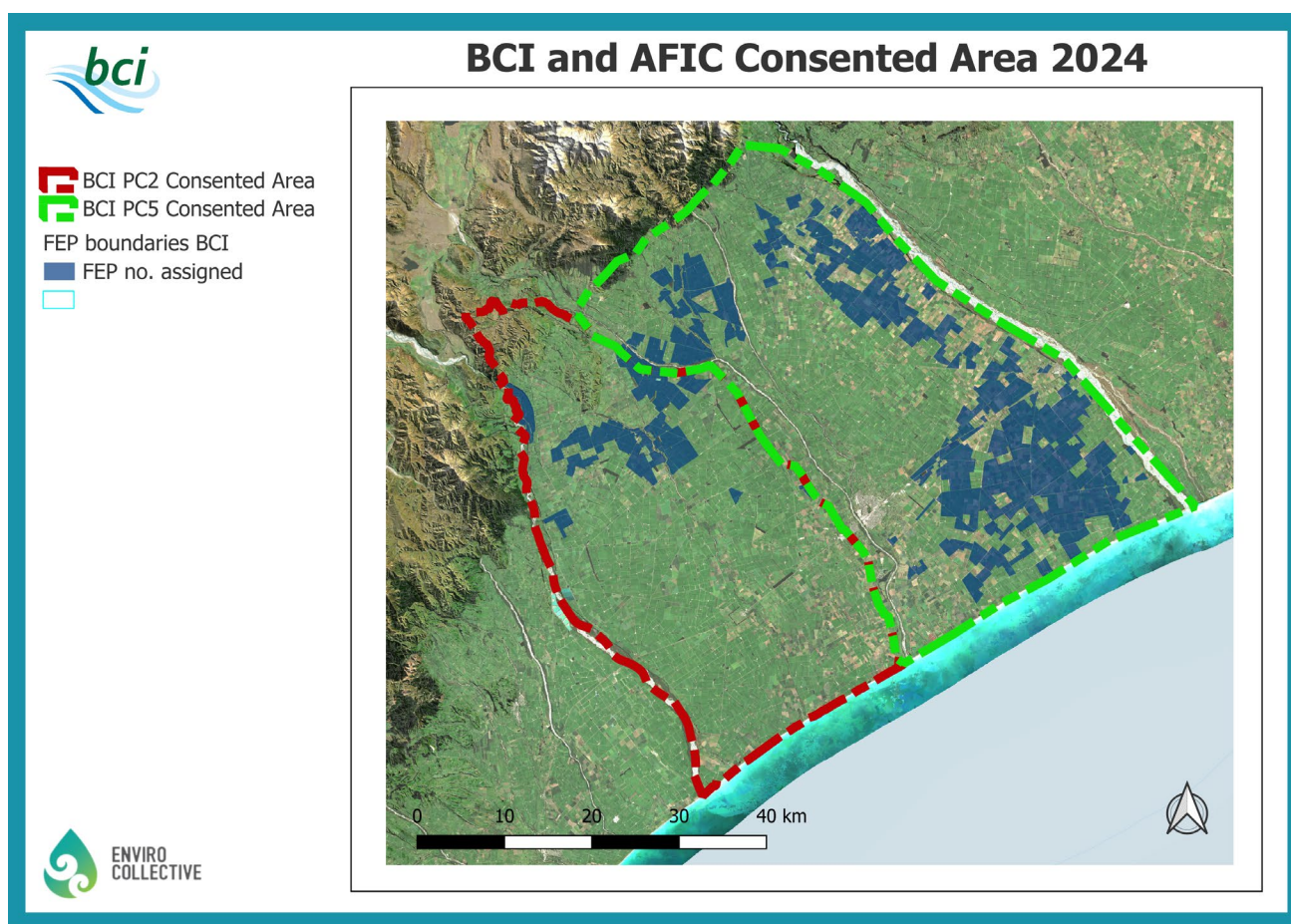


FIGURE 1: 2024 BCI AND AFIC FARM BOUNDARIES

This annual report summarises compliance with resource consents CRC184159 and CRC211511 for the period 1st July 2023 to 30th June 2024.

AUDITED SELF-MANAGEMENT PROGRAMME SUMMARY

The BCI & AFIC Audited Self-Management (ASM) programme was implemented in 2015 following the granting of CRC162882 to discharge nutrients onto and into land from farming activities. The fundamental principle of the ASM programme is to support our farmer shareholders to continually strive for improvements in farming practices to reduce their impact on the Ashburton freshwater catchments.

Resource consent CRC162882 was renewed in October 2021 and replaced with resource consents CRC211511 (Ashburton Zone) and CRC184159 (Hekeao/Hinds Zone).

As a condition of their water supply, all BCI and AFIC shareholders need to implement Farm Environment Plans, complete regular audits, as well as comply with catchment nitrogen load limits. We also complete a surface water and groundwater quality monitoring programme, and provide one on one support to shareholders and their staff, which includes the following:

- Preparation and annual updates of FEPs;
- Workshops (shareholders and staff);
- Resources explaining GMP, Advanced Mitigation and Scheme Policies
- Support to prepare for and follow up FEP Audits;
- Bucket testing; and
- General environmental support or advice to all shareholders and their staff.

Our team are experienced and trained facilitators, supporting farmers to make the best decisions they can to make real improvements to on-farm practice to improve water quality in the catchment.

EXTENSION PROGRAMME

We understand our farmers' needs better than most and we have developed targeted workshops and resources to deliver the information they need, by people they trust, in the location, time and format that suits them. For the year ending 2024, we have delivered the following for our shareholders:

- *"Aiming for Advanced Mitigation"* – Dairy and Arable Field days
- Effective Irrigation Management
- Fertiliser calibration event
- Shed talks
- Resources to support good practice irrigation management and adoption of Advanced Mitigation

Overall, we have had 70 BCI and AFIC farmers and their staff attend our extension events over the past 12 months. We also work collaboratively with other irrigation schemes to enable our shareholders access to additional training events and field days in our region.

CONDITION SUMMARY

CONDITION 1 (CRC184159 & CRC211511)

This consent authorises the discharge onto or into land where contaminants may enter water arising from farming activities on Properties:

- a. listed in Schedule CRC184159A/CRC211511A (as is to be completed by the Consent Holder and provided to the Regional Leader - Monitoring and Compliance, Canterbury Regional Council within one month of the Commencement Date, and as may be amended from time to time in accordance with Condition 8 (CRC184159)/Condition 7 (CRC211511)); and
- b. located within the area shown on Plan CRC184159A/CRC211511A as CRC184159/CRC211511 Nutrient Discharge Area,

and including the expansion of dairy support land and irrigated dairy farm land, the conversion of land to dairy farm land and the undertaking intensive winter grazing.

Advisory note: *Schedule CRC184159A/CRC211511A as provided for in this resource consent at the Commencement Date is a template. It shall be completed and provided in accordance with this Condition 1 and may be updated from time to time in accordance with Condition 7. Any such replacement Schedule CRC184159A/CRC211511A shall apply for the purposes of compliance.*

No comment required.

CONDITION 2 (CRC184159 & CRC211511)

Land Types

Dry Land	Land that is not irrigated but where nitrogen losses are managed under this consent.
Existing Scheme Irrigated Land	Land lawfully supplied with irrigation water supplied by an irrigation scheme or principal water supplier prior to 9 September 2013.
Lawfully Irrigated PC2 Land	Land that was previously not irrigated and which was first supplied with irrigation water by an irrigation scheme or principal water supplier under the authorisation of resource consent(s) CRC121664 or CRC162882 (or replacements and subsequent variations).
Lawfully Intensified (PC5) Land	Land which lawfully increased its nutrient losses above its baseline nitrogen loss rate between 31 December 2013 and 13 February 2016.
Other Irrigated Land	Land that is irrigated from any source and which is not Existing Scheme Irrigated Land or Lawfully Irrigated PC2 Land and which is on a Property that receives irrigation water from the Barrhill Chertsey irrigation scheme.

Advisory note: *All land on a Property managed by the Consent Holder under this resource consent shall fall in one or more of the land types listed. All properties must be fully or partially irrigated with water from the Barrhill Chertsey irrigation scheme.*

Other Definitions

Term	Definition
Advanced Mitigation	The undertaking of farming on a property that is consistent with the Advanced Mitigation targets described in Condition 18 (CRC211511).
Associated Properties	Properties which are not Authorised Properties and which do not receive irrigation water from the Barrhill Chertsey Irrigation Scheme, but which are Properties where the nutrient losses are managed by the Consent Holder.
Authorised Properties	Properties that the Consent Holder has elected to treat as Authorised Properties for the purposes of Condition 9 (CRC184159) and Condition 8 (CRC211511).
Certified Freshwater Farm Plan	A freshwater farm plan certified under section 217G of the Resource Management Act 1991 (as amended from time to time in accordance with section 217E(2) or (3)), or as provided for by the Resource Management (National Environmental Standards for Freshwater) Regulations 2020
CDWPZ Impacted Land	Land that is included in a Community Drinking Water Protection Zone, plus any other land within the same paddock where it not possible to treat such further land on a different management basis for the purposes of Condition 21 (CRC184159 & CRC211511). Advisory note: For example: - it will typically not be possible to provide differential stock grazing within the same paddock; and - it may be possible to provide differential management for a cropping or horticultural operation in the same paddock.
Commencement Date	The date that this resource consent (CRC184159) is given effect to, without limiting any amendment to the reporting requirements as may be agreed in accordance with Condition 32 (CRC184159 & CRC211511).
Community Drinking Water Protection Zone	A Community Drinking Water Protection Zone as identified in Schedule 1 of the Canterbury Land and Water Regional Plan.
Farming activity	All Agricultural and Horticultural land uses (whether irrigated or not) and including but not limited to dairy farming, dairy support, winter grazing, sheep and beef farming, deer, pig and goat farming.
Farm Environment Plan	A Farm Environment Plan in the form set out in Schedules CRC211511C and CRC184159C: - as may be amended following mutual agreement with the Regional Leader - Monitoring and Compliance, Canterbury Regional Council; or - should the use of a <i>Certified Freshwater Farm Plan</i> be required or available on the basis it is certified and available for use then the Consent Holder may, as may be mutually agreed with the Regional Leader - Monitoring and Compliance, Canterbury Regional Council elect to use such a plan (and which will then take the place of Schedules CRC211511C and CRC184159C).
HPZ gmp	The farming practices described in Schedule 24a of the operative Canterbury Land and Water Regional Plan (at the Commencement Date), taking into

Term	Definition
	account: (a) the type of farming activity; and (b) the drainage characteristics of the soils; and (c) the climatic conditions and topography of the Property; and the type of irrigation system used.
Good Management Practice (GMP)	The farming practices which are described in the document titled Industry Agreed Good Management Practices relating to water quality (2015).
Management Plan for Farming Activities	A Management Plan for Farming Activities in the form set out in Schedule CRC211511D: • as may be amended following mutual agreement with the Regional Leader - Monitoring and Compliance, Canterbury Regional Council; or • should the use of a Certified Freshwater Farm Plan be required or available on the basis it is certified and available for use then the Consent Holder may, as maybe mutually agreed with the Regional Leader - Monitoring and Compliance, Canterbury Regional Council elect to use such a plan (and which will then take the place of Schedule CRC211511D).
NES Equivalent Farm	A Property on which: (a) 20 hectares or more is in arable land use; or (b) 5 hectares or more is in horticultural land use; or (c) 20 hectares or more is in pastoral land use; or (d) 20 hectares or more is in a combination of any two or more of the land uses described above; provided that this definition shall not limit the consideration of, as a significant change application, any increase in the area used for dairy farming (being the use of land by milking dairy cows) by more than 10 hectares.
Nutrient Allocation Zone	A nutrient allocation zone within the area shown as CRC184159/CRC211511 Nutrient Discharge Area on Plan CRC184159A/CRC211511A.
Nutrient Discharge Allowance (NDA)	The Nutrient Discharge Allowance as determined by Condition 3 to 6 (CRC211511)/7(CRC184159).
Property	Any contiguous area of land, including land separated by a road or river, 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.
Schedule 24A Plan	A <i>Schedule 24a Plan</i> in the form set out in Schedule CRC184159D: • as may be amended following mutual agreement with the Regional Leader - Monitoring and Compliance, CanterburyRegional Council; or • should the use of a <i>Certified Freshwater Farm Plan</i> be required or available on the basis it is certified and available for use then the Consent Holder may, as may be mutually agreed with the Regional Leader - Monitoring and Compliance, Canterbury Regional Council elect to use such a plan (and which will then take the place of Schedule CRC184159D).

Term	Definition
Sensitive Receptor	Areas of wetland, surface water bodies and riparian areas, sites of cultural significance (as may be further defined in consultation with Te Rūnanga o Arowhenua) and, in the case of any land located within a Community Drinking Water Protection Zone, the Community Drinking Water Supply.
Significant change	In relation to the farming activity on a Property means: (a) an increase in the area irrigated by more than 10 hectares; (b) an increase in the area used for dairy farming (being the use of land by milking dairy cows) (whether irrigated or not) by more than 10 hectares; (c) any increase in the area used for intensive winter grazing (being the grazing of livestock on annual forage crop at any time in the period 1 May to the following 30 September); and (d) any increase in the area on a property of dairy support land (being the farming of non-milking dairy cows, including heifers), as compared to the maximum area used on that Property in any year (being the period of 1 July to 30 June) in the period 1 July 2014 to 30 June 2019.

No comment required.

SCHEDULE OF PROPERTIES

CONDITION 3

Schedule CRC184159A/CRC211511A attached to and forming part of this consent, shall specify the Nutrient Allocation Zone(s) within which each Property is located; and

- a. the load that has been calculated or deemed for each Property in accordance with conditions 4 to 7 (CRC184159) and conditions 4 to 6 (CRC211511); and
- b. a total aggregated NDA for each Nutrient Allocation Zone, being the sum of the assessed nitrogen losses from all Properties provided for in Condition 4 (CRC211511)(a) and (b) and identified in the relevant part of Schedule CRC184159A/CRC211511A.

Advisory Note 1: Where a Property is located within more than one Nutrient Allocation Zone, the load shall be allocated on a pro rata basis against the relevant land area(s).

Advisory Note 2: Where a Property is also able to be managed under CRC211511A/CRC184159 (or any other nutrient discharge consent held by the Consent Holder) or is supplied water by more than one irrigation scheme which also holds a discharge consent, the load shall be allocated on a pro-rata basis proportionally on a contracted flow basis or on such other basis as may be determined in consultation with the Canterbury Regional Council while ensuring all losses are accounted for (and not double counted) as between resource consents or the schemes (as might apply).

Version 24 of Schedules CRC184159A and CRC211511A have been prepared by Dr. Glen Treweek of WSP Limited for all land currently managed under the BCI ASM programme (**APPENDIX B**).

NITROGEN DISCHARGE ALLOWANCE

CONDITION 4 (CRC184159)

The nitrogen losses for each Property listed in Schedule CRC184159A shall:

- a. For Existing Scheme Irrigated Land, Other Irrigated Land and Dry Land, be calculated on the basis of:
 - i. the farming activities which have been identified as occurring on the Property between 1 January 2009 and 31 December 2013; and
 - ii. with nitrogen losses from such land being further limited to HPZ gmp; and
 - iii. with nitrogen losses further reduced:
 - A. from 1 January 2025, by 15%; and
 - B. from 1 January 2030, by 25% provided that the further reductions provided for in Condition 4(a)(iii)(A) and (B) will not be required;
 - C. on any Property where the calculated nitrogen losses for that Property is less than 20 kilograms of nitrogen per hectare per year (kgN/ha/yr) when modelled with OVERSEER® version 6.0; or
 - D. when the nitrate-nitrogen concentration in any monitored river in the Lower Hinds/Hekeao Plains Area is below an annual median of 2.4 milligrams per litre (mg/L) and an annual 95th percentile of 3.5 mg/L, and the annual average nitrate concentration in groundwater in the Hinds/Hekeao Plains Area is at or below 6.9 mg/L.
- b. For Lawfully Irrigated PC2 Land, be a deemed loss rate of 27 kg N/ha/year, when modelled with OVERSEER® version 6.0.3;
- c. For Authorised Properties, be listed in a separate part of Schedule CRC184159A with a nominal value of 'zero', as deemed in accordance with Conditions 9 and 10,

except that where a load is modelled using OVERSEER®, the current version of OVERSEER® shall be used and the inputs shall be updated where relevant to reflect the current OVERSEER® Best Practice Data Input Standards, but they must still describe the same baseline scenario.

Advisory Note 1: Where a Property meets more than one of the above criteria, the nitrogen losses for the Property are calculated on a weighted average of the parcels which form the Property.

Advisory Note 2: Authorised Properties are not subject to any individual nutrient loss limit (and nor do they contribute to or be deducted from the Scheme NDA for the purposes of Conditions 3 to 7). Their inclusion in Schedule CRC184159A is to ensure their inclusion and wider management by the Scheme is clear.

Advisory Note 3: The effect of Condition 4(c) is to ensure the load from Authorised Properties cannot be aggregated with Properties managed under Conditions 4(a) and (b).

Dr. Glen Treweek of WSP Limited has calculated the Nitrogen Discharge Allowance (NDA) for CRC184159 in accordance with the consent (**APPENDIX B**) in version 6.5.5 of Overseer.

The "Lawfully Irrigated PC2 Land" nitrogen loss rate was also updated to v6.5.5 of Overseer as 45 kg N/ha (**APPENDIX C**).

The overall nitrogen load limit for land listed in Schedule CRC184159A is **493.1 T N**.

Consented nitrogen loss reduction targets are not required to be demonstrated until 2025.

CONDITION 4 (CRC211511)

The nitrogen losses for each Property listed in Schedule CRC211511A shall:

- a. For Existing Scheme Irrigated Land, Other Irrigated Land and Dry Land, be calculated on the basis of:
 - i. the farming activities the which have been identified as occurring on the Property between 1 January 2009 and 31 December 2013; and
 - ii. with nitrogen losses from such land being further limited to GMP; and
 - iii. with nitrogen losses further reduced:
 - A. from 1 January 2025, by having 15% of Properties that require a Farm Environment Plan at Advanced Mitigation (representing at least 15% of the total land area of Properties under Condition 4(a)); and
 - B. from 1 January 2030, by having 30% of Properties that require a Farm Environment Plan at Advanced Mitigation (representing at least 30% of the total land area of Properties under Condition 4(a));
- b. For Lawfully Intensified Plan Change 5 Land, be a deemed loss rate of 27 kilograms of nitrogen per hectare per year (kg N/ha/yr), when modelled with OVERSEER® version 6.0.3,
- c. For Authorised Properties, be listed in a separate part of Schedule CRC211511A with a nominal value of 'zero', as deemed in accordance with Conditions 8 and 9;

except that where a load is modelled using OVERSEER®, the current version of OVERSEER® shall be used and the inputs shall be updated where relevant to reflect the current OVERSEER® Best Practice Data Input Standards, but they must still describe the same baseline scenario.

Advisory Note 1: *Where a Property meets more than one of the above criteria, the nitrogen losses for the Property are calculated on a weighted average of the parcels which form the Property.*

Advisory Note 2: *Authorised Properties are not subject to any individual nutrient loss limit (and nor do they contribute to or be deducted from the Scheme NDA for the purposes of Conditions 3 to 6). Their inclusion in Schedule CRC211511A is to ensure the inclusion and wider management by the Scheme is clear.*

Advisory Note 3: *The effect of Condition 4(c) is to ensure the load from Authorised Properties cannot be aggregated with Properties managed under Conditions 4(a) and(b).*

Dr. Glen Treweek of WSP Limited has calculated the Nitrogen Discharge Allowance (NDA) for the Plan Change 5 area in accordance with the consent (**APPENDIX B**) in v6.5.5 of Overseer.

The "Lawfully Intensified PC5 Land" nitrogen loss rate was also updated to v6.5.5 of Overseer as 45 kg N/ha.

The overall nitrogen load limit for land listed in Schedule CRC211511A is **1,715.7 T N**.

Consented Advanced Mitigation targets are not required to be demonstrated until 2025. Auditing against AM Targets commenced in the 2022-23 season, with the whole BCI-AFIC schemes due to have their first assessments completed by the 2024-25 reporting season. A summary of progress to date is detailed in Table 1 below².

We are pleased to advise we have already achieved our 2025 AM target, with approximately a third of shareholder farmers yet to have been assessed against the AM framework.

² Note summary excludes Authorised Properties

TABLE 1: SUMMARY OF PROGRESS AGAINST AM TARGET (2024)

	Overall (PC5 only)	2025 Target	AM Achievement		% AM	
			2023	2024	2023	2024
# PC5 Farm Plans	126	19	7	21	5%	17%
PC5 Land Area (ha)	44,733	6,709	3,332	10,890	7%	24.3%

CONDITION 5 (CRC184159)

For the purposes of Condition 4(a)(iii)(D) above, the 6.9 mg/L specified is the groundwater quality determined by the Canterbury Regional Council as the median concentration across the Canterbury Regional Council's quarterly groundwater monitoring bores (screened less than 30 metres below the ground level) being:

- at the Commencement Date of this resource consent, the monitoring bores within the Lower Hinds Plains Area are those referred to in Appendix A in Technical Report R13/93 Hinds Plains water quality modelling for the limit setting process (Technical Report R13/93); and
- any additional or alternative monitoring bore (*New Bore*) that the Canterbury Regional Council determines to use when assessing groundwater in the Hinds/Hekeao Plains Area subject to any transitional arrangements that might be agreed with the Canterbury Regional Council in relation to the use of the New Bore.

Advisory Note: *The Canterbury Regional Council's quarterly groundwater monitoring bores are those referred to or consistent with Policy 13.4.14 and Table 13(i) of the Canterbury Land and Water Regional Plan. If there are any changes to these monitoring bores, the Canterbury Regional Council will inform the Consent Holder and discuss transitional arrangements if the changes may affect compliance with reporting and monitoring obligations under this consent.*

Not applicable as the Environment Canterbury Hekeao/Hinds Plains annual concentration for 2024 is 12.8 mg/L (**APPENDIX A**).

CONDITION 6 (CRC184159)/CONDITION 5 (CRC211511)

The maximum annual amount of nitrogen that is lost to water from the Properties described in Condition 4(a) and (b) (CRC184159 & CRC211511) and listed in Schedule CRC184159A/CRC211511A shall not exceed the combined and aggregated NDA of those Properties.

Advisory Note: *Authorised Properties do not contribute to the load limits described in this Condition 6 (CRC184159)/Condition 5 (CRC211511).*

Dr. Glen Treweek of WSP Limited has calculated the 2024 nitrogen losses for land listed in schedules CRC184159A and CRC211511A in v6.5.5 of Overseer using The Matrix method based on the farm system, irrigation and winter grazing³ area reported for the property for the 2023-24 season (**APPENDIX B**).

In the Plan Change 2 area, the total nitrogen losses were **455.3 T N**, **93%** of the nitrogen discharge allowance for CRC184159.

³ Winter grazing as defined by the Canterbury Land and Water Regional Plan

In the Plan Change 5 area, the total nitrogen losses were **1,613.3 T N**, **94%** of the nitrogen discharge allowance for CRC211511.

CONDITION 7 (CRC184159)/CONDITION 6 (CRC211511)

The NDA as to be determined in accordance with Conditions 4 and 6 (CRC184159)/7 (CRC211511):

1. shall be calculated using the Matrix Method (as approved by the Chief Executive of the Canterbury Regional Council on 29 April 2020) and as included in Schedule CRC184159B/CRC211511B, or any other equivalent method approved by the Chief Executive of Environment Canterbury (together *Matrix Method*), provided that:
 - i. if OVERSEER® is used, the current version of OVERSEER® shall be used and the inputs shall be updated where relevant to reflect the current OVERSEER® Best Practice Data Input Standards, but they must still describe the same baseline scenario; and
 - ii. the nitrogen loss calculation for any dairy farming operation where a building consent and effluent discharge consent was granted for a new or upgraded dairy milking shed in the period 1 January 2009 to 31 December 2013, shall be on the basis that the dairy farming activity is operational.

Dr. Glen Treweek of WSP Limited has calculated the Nitrogen Discharge Allowance (NDA) in accordance with the consents (**APPENDIX C**) in v6.5.5 of Overseer. The update to v6.5.5 required changes to the representative Overseer files to overcome errors. The errors were corrected in accordance with advice provided by Overseer. ECan were advised of the proposed changes on 23rd September 2024, however no response has been received. The changes made to the Matrix representative files to overcome the errors were reviewed by WM Environmental as part of the EMS review (**APPENDIX E**).

Overseer has updated their model tree times since The Matrix was last updated in July 2024, however none of the updates have resulted in changes to the N loss calculations⁴ therefore the Matrix Update in v6.5.5 is comparable to the current version of Overseer (v6.5.8).

2. for land listed within Schedule CRC184159A/CRC211511A at the Commencement Date, may be updated within the 12 months following, provided that:
 - i. the update is consistent with the assessment methodology described for the Matrix Method;
 - ii. information on the changes (including information on the actual land use and irrigation system) is recorded to support each change, including confirmation that the change remains consistent with Condition 4 (CRC184159 & CRC211511);
 - iii. a revised Schedule CRC184159A/CRC211511A including any updates is to be provided to Regional Leader-Monitoring and Compliance, Canterbury Regional Council and any assessments undertaken are provided to the Canterbury Regional Council on request.

A validation process of The Matrix was completed in July 2024 in collaboration with MHV Water and Ashburton Lyndhurst Irrigation Limited (ALIL) to ensure The Matrix remained equivalent to Overseer for the purpose of catchment N load reporting.

The validation project involved collecting recent Overseer nutrient budgets from 96 sample of farms within each scheme which were representative of the land use, soil type and climates.

Nutrient budgets were prepared for all sample farms and checked for robustness against their farm plan, FEP audit reports and long term water usage data provided by the schemes. Where discrepancies were identified, Eva

⁴ See Overseer's Update Release Notes

[v6.5.6](#) (July 2024)

[v6.5.7](#) (September 2024)

[v6.5.8](#) (November 2024)

Harris (CNMA) corrected the nutrient budgets in accordance with our consistency protocols before they were included in the validation project.

Dr. Glen Treweek of WSP Limited calculated The Matrix N losses for the same properties, using the same FEP and audit data used to ensure the nutrient budget was a robust representation of the farming activity on the property.

Nitrogen losses from all nutrient budgets and The Matrix were calculated in v6.5.5 of Overseer.

Overall, 96 farms between MHV Water, ALIL, BCI and AFIC were selected for the assessment, equating to 23,200 ha of farmland between Rangitata and Rakaia Rivers or 16% of the combined command areas of all schemes. The number of farms was consistent with the 95% confidence sample size required by The Matrix validation methodology.

The aggregated Overseer N load for the 96 farms was **981,402 kg N** compared to a Matrix calculation of **1,068,290 kg N**, a difference of 8.1% and within the 10% specified in The Matrix approval to maintain equivalence.

Dr. Glen Treweek has prepared a memo with the full details of the Matrix Validation project (**APPENDIX D**)

CONDITION 8 (CRC184159)/CONDITION 7 (CRC211511)

Properties (or land) may be added or removed from Schedule CRC184159A/CRC211511A, provided:

- a. the Consent Holder provides the updated schedule by 1 December in any year that a change occurs to Schedule CRC184159A, to the Regional Leader - Monitoring and Compliance, Canterbury Regional Council and Te Rūnanga o Arowhenua, including:
 - i. the revision number of the schedule; and
 - ii. an updated consent wide map showing all Properties managed under this consent and the relevant Nutrient Allocation Zone boundary; and
 - iii. an electronic copy of the plan in Condition 8 (CRC184159)/Condition 7 (CRC211511) (a)(ii) above, in a commonly used Geographic Information System (GIS) format; and

Refer to Schedule CRC184159A and Schedule CRC211511A in Glen Treweek's report in **APPENDIX B**.

An electronic GIS copy of the farms managed under resource consents CRC184159 and CRC211511 has been provided with this report.

We note the revised schedules and GIS maps defined the land, farm system and irrigation type by property within the BCI ASM programme as at the commencement date of these consents.

- b. in the case of any Property (or land) joining the Scheme and described in Condition 4(a) and (b) (CRC184159 & CRC211511) and listed in Schedule CRC184159A/CRC211511A, the Consent Holder shall, unless Condition 10(a) (CRC184159) and condition 9(a) (CRC211511) applies, apply to the Matrix Method to the Property's (or land's) nitrogen baseline and make the assessment available to the Canterbury Regional Council on request.

All new land joining the BCI resource consents CRC211511 and CRC184159 have been added to the applicable schedule, utilising information provided by the properties nitrogen baseline. The process undertaken was reviewed by WM Environmental in November 2024 (**APPENDIX E**).

ECan has not requested this information to date.

AUTHORISED PROPERTIES

CONDITION 9 (CRC184159)

Any Property that is:

- a. less than 5 hectares in area; or
- b. greater than 5 hectares, and where the nitrogen losses for the Property are less than 15 kg N/ha/year,

may be treated by the Consent Holder as an Authorised Property for the purposes of this consent.

The BCI ASM Programme does not currently manage any Authorised Properties under resource consent CRC184159.

CONDITION 8 (CRC211511)

Any Property that is:

- a. less than 10 hectares in area; or
- b. greater than 10 hectares, and where:
 - i. the area of the property authorised to be irrigated with irrigation water from any source is:
 - A. less than 50 hectares; and
 - B. for any property where irrigation was occurring as at 13 February 2016, the area of the property authorised to be irrigated has not increased by more than 10 hectares above that which was irrigated as at 13 February 2016; and
 - ii. the area used for winter grazing (as defined in the Canterbury Land & Water Regional Plan at the Commencement Date) is less than:
 - A. 10 hectares, for any property that is less than 100 hectares in area; or
 - B. 10% of the area of the property for any property between 100 hectares and 1000 hectares in area; or
 - C. 100 hectares, for any property that is greater than 1000 hectares in area, may be treated by the Consent Holder as an Authorised Property for the purposes of this consent.

A total of 19 BCI and AFIC shareholder properties managed under CRC211511 are defined as Authorised Properties in accordance with Conditions 8(a) and 8(b). One property on schedule CRC211511 ceased their winter grazing activities altogether in the 2023-24 season and now meets the definition of an authorised property.

Seven Authorised Properties use BCI water for non-farming activities including irrigating sports fields and landscaping areas, dampening horse racing tracks, firefighting purposes and topping up thermal pools. Use of water for these activities are authorised under resource consent CRC205082, which was granted in October 2020.

CONDITION 10 (CRC184159)/CONDITION 9 (CRC211511)

In relation to any Property that the Consent Holder has elected to treat as an Authorised Property in accordance with:

- a. Condition 9(a) (CRC184159)/8(a) (CRC211511):
 - i. any nitrogen losses shall not contribute to or be deducted from the aggregated NDA for the properties listed in Schedule CRC184159A/CRC211511A for the purposes of Conditions 3 to 7 (CRC184159)/6 (CRC211511); and
 - ii. losses from that Property will be listed on Schedule CRC184159A/CRC211511A with a nominal nutrient discharge allowance of '0'.
- b. Condition 9(b) (CRC184159)/8(b) (CRC211511):

- i. the Consent Holder shall require that each such Authorised Property maintain a *Schedule 24a Plan or Certified Freshwater Farm Plan* as required by Condition 18(b) (CRC184159)/17(b) (CRC211511);
- ii. any nitrogen losses shall not contribute to or be deducted from the aggregated NDA for the properties listed in Schedule CRC184159A/CRC211511A for the purposes of Conditions 3 to 7 (CRC184159)/6 (CRC211511); and
- iii. losses from that Property will be listed in Schedule CRC184159A/CRC211511A with an nominal nutrient discharge allowance of '0'.

Advisory note: *This resource consent enables the Consent Holder to supply water to Properties that would otherwise be able to be farmed as or in similar circumstances as permitted farming land use activities outside of the Audited Self-Management (ASM) programme under this resource consent. The nutrient losses from such Properties are authorised by this consent but the Consent Holder may choose to either manage the losses on the basis of being an Authorised Property or in accordance with Conditions 3 to 7 (CRC184159)/6 (CRC211511).*

All BCI and AFIC properties that meet Condition 9(a) and 9(b) of CRC184159 and Condition 8(a) and (8(b) of CRC211511 have a Farm Environment Plan, which meets the requirements for the Schedule 24a Plan or a *Management Plan for Farming Activities*. These properties are registered as a "0" nitrogen loss in schedules CRC184159A and CRC211511A.

ENVIRONMENTAL MANAGEMENT STRATEGY

CONDITION 11 (CRC184159)/CONDITION 10 (CRC211511)

From:

- a. the Commencement Date, the consent shall comply with the Audited Self- Management Programme (ASM), including Environmental Management Strategy (EMS) that was developed in accordance with resource consent CRC162882 and operative immediately prior to the Commencement Date. In complying with this Condition 11(a) (CRC184159)/10(a) (CRC211511), the Consent Holder shall consult with the Regional Leader - Monitoring and Compliance, Canterbury Regional Council to determine how compliance and the transitional regime for any replacement EMS as required by Condition 11(b) (CRC184159)/10(b) (CRC211511) are to be implemented (which shall then form part of the Conditions of this consent); and
- b. Within 12 months of the Commencement Date, the Consent Holder shall update and comply thereafter with the revised EMS that is to be prepared in accordance with Conditions 12 to 14 (CRC184159) and Conditions 11 to 13 (CRC211511).

The BCI Environmental Management Strategy (EMS) prepared to managed compliance with resource consents CRC184159 and CRC211511 was submitted to Environment Canterbury on 13th September 2022. Environment Canterbury certified the BCI EMS on 28th November 2022.

CONDITION 12 (CRC184159)

The EMS required by Condition 11(b) shall:

- a. identify the roles and responsibilities of the persons and entities involved in the management of the Barrhill Chertsey Irrigation environmental programme and the implementation of this resource consent;
- b. implement environmental objectives and targets and methods to ensure:
 - i. this resource consent CRC184159 is complied with;
 - ii. all Properties provided for in Conditions 4(a) and (b) implement HPZ gmp, and in the case of Properties provided for in Condition 4(a), the specified further reductions to achieve nitrogen loss reductions over time; and
 - iii. Properties required to hold a Farm Environment Plan are achieving or working towards the achievement of an 'A' Audit within a reasonable timeframe.
- c. ensure the Consent Holder has robust audit and reporting procedures in place, that meet the Canterbury Regional Councils Farm Environment Plan Audit Manual requirements, to ensure a high level of compliance with *Farm Environment Plans* and *Schedule 24a Plans* (as might apply);
- d. have appropriate procedures in place (through the EMS and each *Farm Environment Plan* and *Schedule 24a Plan*) to ensure the identification of effects on neighbouring sensitive receptors are appropriately avoided, remedied or mitigated;
- e. be consistent with the Environmental Monitoring Plan and associated requirements provided for in Conditions 22 to 29;
- f. require that any Properties wanting to undertake a significant change will first need to obtain the approval of the Consent Holder, with the EMS providing details on how applications for significant change are to be assessed, including procedures to ensure applications for significant change are only approved where:
 - i. in the case of any NES Equivalent Farm, contaminant loads in the catchment and concentrations of contaminants in receiving waterbodies are, as a result of the significant change, no greater than that occurring at 2 September 2020, having regard to:
 - A. any assessed nutrient loss; and

- B. the controls set out in any Farm Environment Plan, Schedule 24a Plan or Certified Freshwater Farm Plan (as might apply);

provided that this Condition 12(f) shall not apply where the significant change application relates to an increase in irrigated area that is not used for dairy farming (being the use of land by milking dairy cows);

Advisory note: *Where a Property can demonstrate a significant change will not result in any increase in nitrogen losses from the Property, it is not expected catchment-scale modelling or assessments will be required.*

- and
 - ii. effects on local sensitive receptors are avoided, remedied or mitigated.
- g. provide reproducible methodology on:
 - i. how the nutrient load limits are calculated, and the rationale for the nutrient load applied; and
 - ii. how nutrients from all land subject to this resource consent will be accounted for, and
- h. provides detail on how the management of Properties joining or leaving the scheme is to occur (including the methodology for allocating nutrients).

CONDITION 11 (CRC211511).

The EMS required by Condition 10(b) shall:

- a. identify the roles of the persons and entities involved in the management of the Barrhill Chertsey Irrigation environmental programme and the implementation of this resource consent;
- b. implement environmental objectives and targets and methods to ensure:
 - i. this resource consent CRC211511 is complied with;
 - ii. all Properties provided for in Conditions 4(a) and (b) implement GMP;
 - iii. Sufficient Properties implement Advanced Mitigation to ensure the requirements of Condition 4(a)(iii) are met; and
 - iv. Properties required to hold a Farm Environment Plan are achieving or working towards the achievement of an A Audit grade within a reasonable timeframe, and to ensure Condition 4(a)(iii) is met, the required number of properties also achieving Advanced Mitigation.
- 3. detail objectives, targets and methods for the achievement of Advanced Mitigation, including the review of any targets and methods to ensure objectives continue to be met;
- 4. ensure the Consent Holder has robust audit and reporting procedures in place, that meet the Canterbury Regional Councils' Farm Environment Plan Audit Manual requirements, to ensure a high level of compliance with Farm Environment Plans and Management Plans for Farming Activities (as might apply);
- 5. have appropriate procedures in place (through the EMS and each Farm Environment Plan and Management Plan for Farming Activities) to ensure the identification of effects on neighbouring sensitive receptors are appropriately avoided, remedied or mitigated;
- 6. be consistent with the Environmental Monitoring Plan and associated requirements provided for in Conditions 22 to 29;
- 7. require that any Properties wanting to undertake a significant change will first need to obtain the approval of the Consent Holder, with the EMS providing details on how applications for significant change are to be assessed, including procedures to ensure applications for significant change are only approved where:
 - i. in the case of any NES Equivalent Farm, contaminant loads in the catchment and concentrations of contaminants in receiving waterbodies are, as a result of the significant change, no greater than that occurring at 2 September 2020, having regard to:
 - A. any assessed nutrient loss; and
 - B. the controls set out in any Farm Environment Plan, Management Plan for Farming Activities or Certified Freshwater Farm Plan (as might apply);

provided that this Condition 11(g) shall not apply where the significant change application relates to an increase in irrigated area that is not used for dairy farming (being the use of land by milking dairy cows).

Advisory note: *Where a Property can demonstrate a significant change will not result in any increase in nitrogen losses from the Property, it is not expected catchment-scale modelling or assessments will be required.*

and

- ii. effects on local sensitive receptors are avoided, remedied or mitigated
- 8. provide reproducible methodology on:
 - i. how the nutrient load limits are calculated, and the rationale for the nutrient load applied;
 - ii. how nutrients from all land subject to this resource consent will be accounted for; and
 - iii. the assessment of how properties are achieving Advanced Mitigation and
- 9. provides detail on how the management of Properties joining or leaving the scheme is to occur (including the methodology for allocating nutrients).

The BCI Environmental Management Strategy (EMS) was submitted to Environment Canterbury on the 13th of September 2022 and certified on 28th November 2022.

Prior to submission for certification, the BCI EMS was peer reviewed by WM Environmental and Te Rūnanga o Arowhenua to ensure all conditions of both resource consents CRC184159 and CRC211511 were met.

CONDITION 13 (CRC184159)

The EMS shall provide for or require:

- a. effects on neighbouring sensitive receptors to be managed through further measures (in addition to Condition 12(b)), including:
 - i. requiring that stock are excluded from waterbodies in accordance with Regional Council rules, any granted resource consent(s) and the Resource Management (Stock Exclusion) Regulations 2020; and
 - ii. requiring the establishment of vegetated riparian strips to minimise nutrient, sediment and microbial pathogen loss to waterbodies.
- b. the management of nutrient losses on Properties (which are not Authorised Properties) through a *Farm Environment Plan* or *Certified Freshwater Farm Plan* (as might apply) and audit process in accordance with the Conditions of this resource consent.
- c. Properties provided for in Conditions 4(a) and (b) shall:
 - i. have their annual nutrient losses assessed in accordance with the Matrix Method identified in Schedule CRC184159B;
 - ii. be subject to an audit procedure in accordance with Condition 19 and 20 (with the EMS being required to specify the steps that will be taken (including consequences to ensure future compliance) where the nitrogen loss reductions in Condition 4(a)(iii)(A) and (B) apply and are not being achieved);
- d. with the Farm Environment Plan audit records for each Property undertaken in accordance with this Condition 13(c) being kept and made available for the Canterbury Regional Council to inspect, upon request; procedures to enable each *Farm Environment Plan* or *Schedule 24a Plan* to be amended to address any changes that might be recommended following the preparation of a Remediation and Response Plan that is prepared in accordance with Condition 26.

- e. the monitoring and data required under this consent and the EMS to be collected and reported to the Canterbury Regional Council in accordance with Condition 30 (with a copy to be provided to Te Rūnanga o Arowhenua); and
- f. within 20 working days of the exit of any Property from Schedule CRC184159A (and the management of nutrient losses by the Consent Holder), the Consent Holder is to advise the Canterbury Regional Council of the authorised land use that is to apply to the departing Property.

CONDITION 12 (CRC211511)

The EMS shall provide for or require:

- a. effects on neighbouring sensitive receptors to be managed through further measures (in addition to Condition 11(b), including:
 - i. requiring that stock are excluded from waterbodies in accordance with Regional Council rules, any granted resource consent(s) and the Resource Management (Stock Exclusion) Regulations 2020; and
 - ii. requiring the establishment of vegetated riparian strips to minimise nutrient, sediment and microbial pathogen loss to waterbodies.
- b. the management of nutrient losses on Properties (which are not Authorised Properties) through a *Farm Environment Plan* or *Certified Freshwater Farm Plan* (as might apply) and audit process in accordance with the Conditions of this resource consent.
- c. a description of how Advanced Mitigation is to be implemented and reported onto ensure the achievement of Condition 4(a)(iii).
- d. Properties provided for in Conditions 4(a) and (b) shall:
 - i. have their annual nutrient losses assessed in accordance with the Matrix Method identified in Schedule CRC211511B; and
 - ii. be subject to an audit procedure in accordance with Condition 19 and 20 (with the EMS being required to specify the steps that will be taken (including consequences to ensure future compliance) for Properties where Condition 4(a)(iii) applies and is not being met);

with the Farm Environment Plan audit records for each Property undertaken in accordance with this Condition 12(d) being kept and made available for the Canterbury Regional Council to inspect, upon request; procedures to enable each Farm Environment Plan or Management Plan for Farming Activities to be amended to address any changes that might be recommended following the preparation of a Remediation and Response Plan that is prepared in accordance with Condition 26.

- e. the monitoring and data required under this consent and the EMS to be collected and reported to the Canterbury Regional Council in accordance with Condition 30 (with a copy to be provided to Te Rūnanga o Arowhenua); and
- f. within 20 working days of the exit of any Property from Schedule CRC211511A (and the management of nutrient losses by the Consent Holder), the Consent Holder is to advise the Canterbury Regional Council of the authorised land use that is to apply to the departing Property.

The BCI Environmental Management Strategy (EMS) was submitted to Environment Canterbury on the 13th of September 2022 and certified on 28th November 2022.

Prior to submission for certification, the BCI EMS was peer reviewed by WM Environmental and Te Rūnanga o Arowhenua to ensure all conditions of both resource consents CRC184159 and CRC211511 were met.

No land has left the BCI or AFIC scheme in the 2023-24 season.

CONDITON 14 (CRC184159)/CONDITION 13 (CRC211511)

When preparing the EMS or seeking amendments to any of the matters listed in Conditions 12 and 13 (CRC184159) and Conditions 11 to 13 (CRC211511), the Consent Holder shall:

- a. engage with the Chair of Te Rūnanga o Arowhenua or their representative to discuss the finalisation of the EMS content listed in Condition 12 (CRC184159 & CRC211511). The purpose of the engagement is to consult with Te Rūnanga o Arowhenua and to enable Te Rūnanga o Arowhenua to participate in and have input into the preparation of the EMS or any amendment to the EMS. Subject to any alternative procedure that might be agreed with Te Rūnanga o Arowhenua and advised to the Regional Leader - Monitoring and Compliance, Canterbury Regional Council, the Consent Holder shall:
 - i. provide drafts of the EMS or amendments to the EMS along with any relevant supporting materials to Te Rūnanga o Arowhenua at least six weeks prior to the documents being submitted to the Canterbury Regional Council for certification;
 - ii. offer to meet with Te Rūnanga o Arowhenua representatives within the six week period referred to in Condition 14(a)(i) (CRC184159)/13(a)(i) (CRC211511), for the purposes of discussing the EMS or amendments to the EMS; and
 - iii. incorporate the comments or changes received from Te Rūnanga o Arowhenua into the EMS or the amended EMS, except that if the Consent Holder determines the comments or changes are not appropriate, it shall undertake further consultation with Te Rūnanga o Arowhenua to see if alternative further changes can be made. If the Consent Holder determines that further changes cannot be made, then it shall prepare a document that records the comments or changes that have not been included and the reasons for not including them;
- b. The updated EMS along with any document to be prepared in accordance with Condition 14(a) (CRC184159)/13(a) (CRC211511) are to be provided to Te Rūnanga o Arowhenua at the time of seeking certification from the Canterbury Regional Council in accordance with Condition 15 (CRC184159)/Condition 14 (CRC211511).

BCI has worked with Te Rūnanga o Arowhenua in the development of the Environmental Management Strategy, who provided confirmation that they were satisfied with the content on the 29th of August 2022, with no requests for amendments.

There have been no updates to the EMS, therefore further consultation has not been required.

CONDITION 15 (CRC184159)/CONDITION 14 (CRC211511)

The EMS or any amendment to the EMS that has been prepared in accordance with Conditions 12 to 14 (CRC184159)/Conditions 11 to 13 (CRC211511) shall be submitted to the Regional Leader - Monitoring and Compliance, Canterbury Regional Council for certification. The Regional Leader – Monitoring and Compliance of the Canterbury Regional Council shall confirm the certification decision within 20 working days. The EMS and any changes shall only be implemented following certification by the Regional Leader - Monitoring and Compliance, Canterbury Regional Council.

There have been no updates to the BCI Environmental Management Strategy since certification on 28th November 2022.

CONDITION 16 (CRC184159)/CONDITION 15 (CRC211511)

- a. Prior to the 1 December:
 - i. immediately after the second anniversary of the Commencement Date of this resource consent; and
 - ii. immediately after the sixth anniversary of the Commencement Date of this resource consent; and

- iii. for each year that is after the second anniversary of the Commencement Date but not provided for by Conditions 16(a)(i) and (ii) (CRC184159)/Conditions 15(a)(i) and (ii) (CRC211511),

(or such other time as may be agreed to by the Regional Leader - Monitoring and Compliance, Canterbury Regional Council), the Consent Holder shall engage a suitably qualified and independent expert to undertake a review of the EMS that shall include:

- iv. for the reviews to be undertaken in accordance with:
 - A. Condition 16(a)(i) and (ii) (CRC184159)/15(a)(i) and (ii) (CRC211511), a full review of the EMS;
 - B. Condition 16(a)(iii) (CRC184159)/15(a)(iii) (CRC211511), a review of at least one third of the EMS (to be rotated annually at each EMS review to ensure the full EMS is reviewed at least once every three years),

for the purpose of identifying and discussing the implementation of the EMS and any improvements that may be able to be made to better achieve the objectives developed in line with Condition 12(b) (CRC184159)/Condition 11(b) (CRC211511); and

- v. for all reviews:
 - A. a review of any changes made to the use of the property irrigation, land use and management standards as applied through the Matrix Method when calculating the scheme nitrogen losses; and
 - B. a review of the process undertaken to update any changes made to the nutrient budget reference files used to calculate scheme nitrogen load limits and losses into the most recent version of OVERSEER®;
 - C. a review of the extent to which Advanced Mitigation is being achieved (CRC211511);
- b. Following the review, the Consent Holder shall provide a copy of the review report to Te Rūnanga o Arowhenua and offer to meet for the purposes of discussing the findings of the review, and any amendments that might be made to the EMS; and
- c. A copy of the review shall be provided to the Regional Leader - Monitoring and Compliance, Canterbury Regional Council as a part of the annual report to be provided under Condition 30.

The first, full review of the EMS was completed in November 2023 by Paul Reese of Matai Consultants. In November this year, only one third of the EMS was assessed by WM Environmental as per section 16(a)(iv)(B). WM Environmental summarises the review as follows:

“In summary, the BCI EMS is comprehensive, the scheme is well on the way to meeting the EMS objectives, processes are being followed as documented, and continuous improvement is evident.

Full details of their review are available in **APPENDIX E**.

CONDITION 17 (CRC184159)/CONDITION 16 (CRC211511)

In the event that a Property is excluded from the ASM programme then the Consent Holder shall notify Te Rūnanga o Arowhenua and the Regional Leader - Monitoring and Compliance, Canterbury Regional Council within 20 working days of the exclusion.

No properties have been excluded for the BCI ASM Programme in the 2023-24 reporting year.

FARM ENVIRONMENT PLANS AND AUDITS

CONDITION 18 (CRC184159)

For all Properties where farming activities are undertaken, and unless Condition 10 (a) applies, the Consent Holder shall ensure that:

- a Properties provided for in Condition 4(a) and (b) maintain a *Farm Environment Plan*; and
- b Properties provided for in Conditions 4(c) and 9(b) maintain a *Schedule 24a Plan*.

BCI and AFIC use the Irrigo Farm Environment Plan Template, which was approved as meeting the requirements of Schedule CRC184159C and Schedule 7 of the Land & Water Regional Plan by Environment Canterbury on the 17th of September 2020. BCI and Acton have also secured a Memorandum of Understanding with Synlait Milk Limited to align our requirements with their Lead with Pride programme.

In 2025, all BCI and AFIC FEPs will be updated to the new Enviro Collective FEP template, which was approved by ECan as meeting Schedule 7 requirements in October 2024.

There are no properties managed under CRC184159 less than five hectares or with a nitrogen loss less than 15 kg/ha/year.

Certified Freshwater Farm Plans are not yet available in Canterbury.

CONDITION 17 (CRC211511)

For all Properties where farming activities are undertaken, and unless Condition 8(a) applies, the Consent Holder shall ensure that:

- a Properties provided for in Condition 4(a) and (b) maintain a *Farm Environment Plan*;
- b Properties provided for in Conditions 4(c) and 8(b) maintain a *Management Plan for Farming Activities*.

All FEP's with more than 50 hectares of irrigation and 10 hectares of winter grazing have been completed on the approved Irrigo Farm Environment Plan template or through Synlait's Lead with Pride Programme, both of which meet the requirements of Schedule CRC211511C.

Authorised Properties that meet 8(b) of CRC211511 have also complete a Farm Environment Plan using the Irrigo template, which meet the requirements of a *Management Plan for Farming Activities*.

In 2025, all BCI and AFIC FEPs will be updated to the new Enviro Collective FEP template, which was approved by ECan as meeting Schedule 7 requirements in October 2024.

Certified Freshwater Farm Plans are not yet available in Canterbury.

CONDITION 18 (CRC211511)

In implementing Condition 17(a), a property shall be deemed to be operating at Advance Mitigation when it is achieving the requirements in Table CRC211511-1 (being targets that are additional to those targets provided for in Schedule CRC211511C or, where relevant, which may be additional to the requirements of a *Certified Freshwater Farm Plan*):

Table CRC211511-1 – Additional requirements for Advanced Mitigation

Irrigation Management

1. To minimise water use and drainage during times of high nitrogen loss risk, irrigation water is applied so that the timing and depth targets crop requirements and optimises capture of rainfall to minimise drainage.
2. The irrigation manager(s) understands the relationship between the irrigation system, soil and climate in order to achieve the Irrigation Management requirement (a)

Nutrient Management

1. To lower soil nitrogen surplus from higher risk land use activities and to reduce leaching of nitrogen fertiliser is applied based on the variability of soils and crop health throughout the season both within paddocks and between paddocks.
2. To improve N fertiliser utilisation, reduce soil nitrogen surplus and lower the risk of nitrogen leaching and increase nitrogen uptake from the soil by optimising pasture and crop growth.

Point Source

1. Point source discharges from critical source areas such as on farm silage, offalpit, rubbish dumps, animal holding areas, soakholes, fuel and agrichemical storage, consumable waste and well head security are managed to prevent as much as practicable contaminants from entering ground or surface waters.

FEP Audits for all BCI and AFIC farms now include an assessment against the Advanced Mitigation targets in the PC2 and PC5 catchments. In the 2023-24 auditing season, 25% of farms audited were able to demonstrate these targets as met.

CONDITION 19 (CRC184159 & CRC211511)

All Farm Environment Plans as required by Condition 18(a) (CRC184159)/Condition 17(a) (CRC211511) shall be audited within the frequency determined by either:

- a. the audit grade received in the previous audit, as provided for in Table CRC184159-1/CRC211511-2 below:

Table CRC184159-1/CRC211511-2

Audit Grade	Audit Frequency	
	<i>No change in management or significant change</i>	<i>Change in management or significant change</i>
Advanced Mitigation	4 years	1 year
A	4 years	1 year
B	2 years	1 year
C	1 year	In the following year
D	6 months	Within 6 months
A "year" is the period from 1 July to the following 30 June.		

provided that the Consent Holder may consult with the Regional Leader - Monitoring and Compliance, Canterbury Regional Council for the purposes of developing an agreed transitional regime for the audit frequencies provided for in Table CRC184159-1/CRC211511-2 (given the 10 September to the following 9 September reporting date being implemented by the Consent Holder at the Commencement Date). Any agreed transitional regime will apply in place of Table CRC184159-1/CRC211511-2;

The 2023-24 FEP Audit season was assessed from 1st of July 2023 to the 30th of June 2024 and no transitional requirements are necessary.

or

- b. in the case of Properties added to Schedule CRC184159A/CRC211511-2, within 1 year of the Property being added to that Schedule; or

There was one new shareholder to BCI for an existing irrigated property added to the BCI ASM programme in 2023-2024 season, audited in May 2024.

- c. in the case of a Property located within a Community Drinking Water Protection Zone where the risk level increased, within one year of the completion of the updated risk assessment; or

No new shareholders have been added to the BCI ASM programme in 2023-2024 season that farm within a community drinking water protection zone nor have there been any changes where the risk level of the farming activity has increased.

- d. where there are exceptional circumstances, and the Consent Holder is able to obtain an approved exemption (in writing) from the Regional Leader - Monitoring and Compliance, Canterbury Regional Council from the frequencies of audits identified in Conditions 19(a) and (b) (CRC184159 & CRC211511). For the purposes of this Condition 'exceptional circumstances' may include any event or action that reasonably prevents an audit being undertaken - including but not limited to any event of *force majeure*, the death or serious illness of a shareholder or shareholder's representative(s) or their dependents, biosecurity or natural hazards or recent Property sales or lease changes; or

The following audit was approved by ECan to be deferred in the 2023-24 reporting year.

FEP Number	Reason for deferral	Updated Audit due date
9024	Property sale	01/03/2025

This property was sold resulting in new management taking over the property from 1st June. The new landowner will be audited by March 2025.

- e. should a *Certified Freshwater Farm Plan* be certified and available for use then the Consent Holder shall comply with the required timings for audits provided for in that plan (and if no audit process is provided for then the Consent Holder shall comply with timeframes for audit set out in the Conditions 19(a) to (d)) (CRC184159 & CRC211511).

Certified Freshwater Farm Plans currently not available in Canterbury.

CONDITION 20 (CRC184159 & CRC211511)

- a. (CRC184159) Farm Environment Plans audits shall be conducted in accordance with the '*Certified Farm Environment Plan Auditor Manual*', May 2020, or such other methodology (including any subsequent version of the '*Certified Farm Environment Plan Auditor Manual*', May 2020) as may be mutually agreed with the Regional Leader-Monitoring and Compliance, Canterbury Regional Council, including the timing and implementation of such other methodology;
- a. (CRC211511) Farm Environment Plans shall be conducted in accordance with (as may apply);
 - i. the '*Certified Farm Environment Plan Auditor Manual*', May 2020, or such other methodology (including any subsequent version of the '*Certified Farm Environment Plan Auditor Manual*', May 2020) as maybe mutually agreed with the Regional Leader - Monitoring and Compliance, Canterbury Regional Council, including the timing and implementation of such other methodology; and
 - ii. any manual or such other methodology that describes the audit and determination of Advanced Mitigation as may be mutually agreed with the Regional Leader - Monitoring and Compliance, Canterbury Regional Council, including the timing and implementation of such methodology.

All Farm Environment Plan audits for the 2023-24 season were conducted in accordance with the '*Certified Farm Environment Plan Auditor Manual*', November 2022.

The Advanced Mitigation Auditor Guidance document was compiled and included in BCI's Environmental Management Strategy which was certified for use on 28th November 2022. All audits from the 2022-23 audit season onwards will be assessed under this framework.

- b. The audit of Certified Freshwater Farm Plan shall be undertaken in accordance with any associated guidance manual, or if no audit process is provided for, or no such guidance material available, the audits shall be undertaken on the basis of applying the '*Certified Farm Environment Plan Auditor Manual*' with any necessary modifications as may be mutually agreed with the Regional Leader - Monitoring and Compliance, Canterbury Regional Council.

Certified Freshwater Farm Plans currently not available in Canterbury.

- c. If requested by the Regional Leader - Monitoring and Compliance, Canterbury Regional Council, the Consent Holder shall facilitate the Canterbury Regional Council undertaking spot checks of any Farm Environment Plan Auditors previously approved by Canterbury Regional Council. This shall include providing copies any audits and the relevant supporting information that are available to the Consent Holder.

Environment Canterbury has not requested any spot checks of audits completed in the 2023-24 audit season.

COMMUNITY DRINKING WATER

CONDITION 21 (CRC184159 & CRC211511)

For any Property falling partly or wholly within a Community Drinking Water Protection Zone, the Consent holder shall ensure:

- a. Discharges from the Property are assessed and managed in discussion with the impacted shareholder(s) and the Community Drinking Water Supplier in accordance with Schedule CRC184159E/CRC211511E, and in a manner that is consistent with the Resource Management (National Environmental Standard for Sources of Human Drinking Water) Regulations 2007, with the assessment completed:
 - i. within three months of the Commencement Date for all properties managed by the Scheme and falling partly or wholly within a Community Drinking Water Protection Zone at that date;
 - ii. at least once every three years for Properties with existing Community Drinking Water Protection Zone risk assessments;
 - iii. within three months of a Property within a Community Drinking Water Protection Zone being added to Schedule CRC184159A/CRC211511A (including a new Community Drinking Water Protection Zone being added to Schedule 1 of the Canterbury Land and Water Regional Plan) that have not been previously assessed in accordance with Schedule CRC184159E/CRC211511E);
 - iv. within three months of the Consent Holder becoming aware of information that may materially impact on any assessment previously undertaken; and
 - v. within three months of any change to the area of an existing Community Drinking Water Supply Protection Zone taking formal effect for the purposes of Schedule 1 of the Canterbury Land and Water Regional Plan;

All BCI shareholding properties which overlap a Community Drinking Water Protection Zone have completed a risk assessment in accordance with Schedules CRC184159E/CRC211511E which was submitted to Environment Canterbury on 17th February 2022. All risk assessments were peer reviewed by Peter Callander of Pattle Delamore Partners Limited and water suppliers consulted prior to submission to Environment Canterbury.

Reviews of the CDWPZ risk assessments have been completed with this year's FEP Updates and will be provided to Environment Canterbury by 21 January 2025 accordance with the three yearly review requirement of Condition 21(a)(ii).

- b. Where a Community Drinking Water Protection Zone Risk Assessment identifies the Property as:
 - i. *'Low Risk'*; there shall be no further management actions required in relation to the farming activities able to occur on the CDWPZ Impacted Land (subject to compliance with this resource consent and permitted activity rules related to Community Drinking Water Protection Zones)
 - ii. *'Medium Risk'*; the farming activities able to occur on the CDWPZ Impacted Land shall be managed to (in addition to compliance with this resource consent and permitted activity rules related to Community Drinking Water Protection Zones):
 - A. avoid the discharge of solid or liquid effluent (including animal based manures) within twenty metres of the Community Drinking Water Protection Zone;
 - B. ensure all irrigation on the CDWPZ Impacted Land in the Community Drinking Water Protection Zone is undertaken using good management practice to minimise drainage to groundwater; and

- C. implement any other site specific recommendations that are consistent with managing Medium Risk activities and that are identified in the Community Drinking Water Protection Zone Risk Assessment;
 - iii. *'High Risk'*; the farming activities able to occur on the CDWPZ Impacted Land shall be managed to (in addition to compliance with this resource consent and permitted activity rules):
 - A. avoid the discharge of solid or liquid effluent (including animal based manures) within 20 metres of the Community Drinking Water Protection Zone;
 - B. avoid any winter grazing (as defined in the Canterbury Land and Water Regional Plan at the Commencement Date) within the CDWPZ Impacted Land;
 - C. ensure all irrigation on the CDWPZ Impacted Land in the Community Drinking Water Protection Zone is undertaken using good management practice to minimise drainage to groundwater;
 - D. ensure there is no increase in stocking rate or fertiliser application on the CDWPZ Impacted Land in the Community Drinking Water Protection Zone; and
 - E. implement any other specific recommendations that are consistent with managing *'Medium'* and/or *'High Risk'* activities and that are identified in the Community Drinking Water Protection Zone Risk Assessment.

CDWPZ Risk assessments were prepared in accordance with this condition and peer reviewed by Peter Callander of Pattle Delamore Partners. Updates were completed by Eva Harris (CNMA) between August-November 2024 and will be provided to ECan in January 2025.

- c. All new Community Drinking Water Protection Zone Risk Assessments prepared after the Commencement Date are to be reviewed by a suitably qualified and experienced individual prior to implementation of the required actions set out in the risk assessment for the Property.

No new Community Drinking Water Protection Zone Risk Assessments have been prepared after commencement date.

- d. Where a Community Drinking Water Protection Zone Risk Assessment review increases the risk status of a Property compared to previous assessments, the assessments are to be provided to the Regional Leader - Monitoring and Compliance, Canterbury Regional Council prior to the implementation of the required actions set out in the risk assessment for the Property.

There were no increases in risk identified in the reviews of the CDWPZ risk assessments. The Dorie School risk assessment was downgraded from "High Risk" to "Medium" as the farmer has isolated the area and now uses the area primarily for lucerne cut and carry with minimal grazing of cattle or calves.

- e. as a part of the Farm Environment Plan, Schedule 24a Plan or Certified Freshwater Farm Plan/Farm Environment Plan, Managed Plan for Farming Activities or Certified Farm Plan (as might apply) for any Property located within the Community Drinking Water Protection Zone, there shall be additional requirements:
 - i. to include an objective that seeks to ensure land located within the Community Drinking Water Protection Zone is managed to prevent deterioration of drinking water from activities occurring on that land; and
 - ii. for the Property Owner to maintain records to demonstrate all agreed minimum actions are being implemented;

The Farm Environment Plan Template and FEP Audit Report templates have been updated to include the above additional targets. Farm Environment Plan and Audit Process documents detailed in the Environmental

Management Strategy specify how these requirements will be documented and assessed to ensure actions specified in the CDWPZ risk assessments are implemented. All four BCI and AFIC shareholders with land located within a CDWPZ have had their farm environment plans updated and engaged in multiple one on one meetings to ensure they understood their responsibilities.

FEP audits from the 2022-23 season will check the actions identified in the risk assessments are being implemented.

- f. without limiting Condition 21(b) (CRC184159 & CRC211511), the Consent Holder shall, as soon as practicable, and in all cases within two working days, notify relevant Community Drinking Water Supplier, and the Regional Leader - Monitoring and Compliance, Canterbury Regional Council, if it becomes aware of an “Event” that may have an adverse effect on the quality of the water in the community supply bore, with an “Event” for the purposes of this consent meaning, but not limited to, an incident within the well protection zones of the relevant community supply bore that may contaminate the water supply from the community supply bore - such as accidental release of pollutants or excessive stock access, combined with the saturation of soil beyond the water retaining capacity (e.g. over-irrigation).

Advisory note: the level of mitigation required should apply based on which ever contaminant has the highest risk rating.

All landowners are aware of their requirements to notify BCI or AFIC and Environment Canterbury if an “Event” occurs. No events were noted for the 2023-24 season.

WATER QUALITY MONITORING

CONDITION 22 (CRC184159 & CRC211511)

Within six months of the Commencement Date, the Consent Holder shall submit to the Regional Leader - Monitoring and Compliance, Canterbury Regional Council, an Environmental Monitoring Plan that satisfies Conditions 23 and 24 (CRC184159 & CRC211511) and which has been prepared by suitably qualified and experienced person(s).

The Environmental Monitoring Plan (EMP) for CRC211511 was prepared by Jeremy Sanson of Pattle Delamore Partners Limited and submitted to Environment Canterbury for review on the 14th of April 2022 following extensive consultation with the Environment Canterbury groundwater science team.

Water quality monitoring in the Hekeao-Hinds catchment is completed in collaboration with MHV Water Ltd. The EMP for CRC184159 was prepared by MHV Water Limited and submitted to Environment Canterbury on 13th October 2021 as part of their own EMP required by their discharge consent CRC185857.

Both EMPs were approved by Environment Canterbury on 28th November 2022.

CONDITION 23 (CRC184159 & CRC211511)

The objectives of the Environmental Monitoring Plan shall be to:

- a. obtain water quality information that may assist in better understanding the effects of nutrient discharges from properties within Schedule CRC184159A/CRC211511A:
 - i. on groundwater nitrate-nitrogen over time; and
 - ii. surface water quality over time; and
- b. require the reporting of any water quality information gathered to the Canterbury Regional Council for the purpose of better informing future water resource management in in the CRC184159/CRC211511 Nutrient Discharge Area;
- c. require the Consent Holder to investigate and respond to changes in water quality attribute state(s) or band(s) (as might apply) for certain contaminants as to be identified based on five years of data in

accordance with Condition 24(b) and 26(b) (CRC184159 & CRC211511) (a 'Deterioration') as specified in Table CRC184159-2/CRC211511-3; and

- d. to require the Consent Holder to prepare a Remediation and Response Plan in consultation with Te Rūnanga o Arowhenua following any identified Deterioration that includes:
 - i. requiring the Consent Holder to manage nutrient losses that are determined to be contributing to any identified Deterioration in a manner that is consistent with improving water quality over time; and
 - ii. reviewing individual Property Farm Environment Plans through the EMS programme where it is determined those farming activities are contributing to any identified Deterioration.

The Environmental Monitoring Plan (EMP) for CRC211511 was prepared by Jeremy Sanson of Pattle Delamore Partners Limited to meet the requirements of this condition and submitted to Environment Canterbury for review on the 14th of April 2022 and certified on 28th November 2022.

The EMP for CRC184159 was prepared by MHV Water Limited and submitted to Environment Canterbury on 13th October 2021 as part of their own EMP required by their discharge consent CRC185857.

CONDITION 24 (CRC184159 & CRC211511)

Catchment Groundwater Monitoring

- a. Subject to Condition 27 (CRC184159 & CRC211511), the Consent Holder shall undertake (either directly or through a catchment group) water quality sampling under the supervision of a suitably qualified person on a minimum of six bores, with all bores being sampled quarterly for nitrate-nitrogen in accordance with the requirements of the *National Environmental Monitoring Standards Water Quality – Part 1 Groundwater* dated March 2019.

Localised surface water monitoring

- b. Subject to Condition 27 (CRC184159 & CRC211511), the Consent Holder shall undertake (either directly or through a catchment group) surface water quality monitoring under the supervision of suitably qualified person in the following waterbodies with the final monitoring site in each waterbody to be determined in consultation with Te Rūnanga o Arowhenua and the Regional Leader - Monitoring and Compliance, Canterbury Regional Council:
 - i. Oakdale Drain (CRC184159);
 - ii. Harris Drain (CRC184159);
 - iii. the Hinds River (CRC184159);
 - iv. Taylors Stream (CRC211511);
 - v. Bowyers Stream (CRC211511);
 - vi. the South braid of the Rakaia River, provided that monitoring under this Condition 24(b)(iii) shall only occur to the extent it is safe and practical to do so (as to be determined through the consultation process provided for by this condition) (CRC211511); and
 - vii. any further or alternative location(s) that may be determined through their view of the Environmental Monitoring Plan that is to be undertaken in accordance with Condition 27 (CRC184159 & CRC211511),

and such surface water monitoring shall include monitoring of the contaminants listed in Table CRC184159-2/CRC211511-3, with:

- A. monitoring to occur at the frequencies included in column 2 of Tables CRC184159-2/CRC211511-3; and
- B. where specified in column 3 of Table CRC184159-2/CRC211511-3, monitoring being undertaken for contaminants to determine a Base Attribute State, calculated for each monitoring site at the commencement of the consent for monitoring sites

where adequate water quality data already exists, or after five years of monitoring (to commence on the provision of the Environmental Monitoring Plan) where no current water quality data exists.

Table CRC184159-2/CRC211511-3

Contaminant	Frequency of sampling	Base Attribute State	Deterioration
Nitrate toxicity NO ₃ - N mg/L	Monthly	Median and 95 th percentile of previous five years of data.	Where the annual (1 July to 30 June) median and/or 95 th percentile NO ₃ - N mg/L are greater than the calculated base attribute state.
Dissolved reactive phosphorous DRP mg/L	Monthly	Median and 95 th percentile of previous five years of data.	Where the annual (1 July to 30 June) median and/or 95 th percentile DRP mg/L are greater than the calculated base attribute state.
Escherichia coli E. coli/100ml	Monthly	The attribute band as calculated in accordance with the Table 9 of the NPSFM 2020 (August 2020) and using five years of data.	Where the attribute band (as per the NPSFM 2020) is worse than the calculated base attribute state (using 5-year rolling data).
Macroinvertebrates (percentage cover)	Annually between December and March (inclusive) (QMCI or MCI using NEMS2020 methodology)	The median attribute band as calculated in accordance with Table 14 of the NPSFM 2020 (August 2020) and using five years of data.	Where the attribute band (as per the NPSFM 2020) is worse than the calculated base attribute state (using annual data)
Deposited fine sediment (percentage cover)	Monthly	The attribute band as calculated in accordance with Table 16 of the NPSFM 2020 (August 2020) and using five years of data.	Where the attribute band (as per the NPSFM 2020) is worse than the calculated base attribute state (using 5-year rolling data).
Periphyton (percentage cover and chlorophyll-a)	Monthly	Not applicable for percentage cover For Chlorophyll-a: the attribute band as calculated using five years of data in accordance with Table 2 of the NPSFM 2020 (August 2020).	Not applicable for percentage cover For Chlorophyll-a: where the attribute band (as per the NPSFM 2020) is worse than the calculated base attribute state (using 5-year rolling data).
Macrophytes (percentage cover)	Monthly	Not applicable	Not applicable

Advisory Note 1: The Base Attribute State(s) are based on the attribute bands and attribute states in Appendix 2A of the National Policy Statement for Freshwater Management 2020 (August 2020).

Advisory Note 2: Where water quality sampling is undertaken as part of a catchment group, members of the group may seek to rely on the same groundwater monitoring bores or surface water monitoring sites as part of their respective consent requirements.

Advisory Note 3: The 'Base Attribute State' (numeric) for nitrate will be calculated as the maximum of annual median and the maximum of annual 95 percentiles from the first 5 years of numeric attribute states calculated from monthly data.

A summary of the water quality monitoring is provided by PDP and MHV Water (**APPENDIX F** and **APPENDIX G**).

On review of the monitoring data provided for the YE2024 season, two attributes were found to be missing from the routine sampling programme; Macrophyte and macroinvertebrate assessments from the surface water monitoring in the PC5 catchment and E. coli in the surface water sampling in the PC2 catchment.

The issues arose from changes in management and a miscommunication with external consultants supporting us with our monitoring programme.

We have had confirmation E. coli will now be included in routine surface water sampling in the Hekeao-Hinds catchment from now on.

A training day has been scheduled for January 2025 with PDP and the BCI operations team responsible for collecting surface water samples. The training will now include an updated reporting sheet to capture macrophyte assessments.

CONDITION 25 (CRC184159 & CRC211511)

The Consent Holder shall implement the Environmental Monitoring Plan within 12 months of the Commencement Date. Following its implementation, the Consent Holder shall provide a summary within the annual report by 1 December 2022 and then annually thereafter that sets out the results of all sampling undertaken (including both surface water and groundwater monitoring) over the previous 12 month period, including a discussion in the case of surface water on:

- a. the extent to which there has been an identified Deterioration; and
- b. for contaminants where a Deterioration is not defined (being Periphyton and Macrophytes percent covers), the nature of any changes over time, including any unexpected declines.

Pattle Delamore Partners Limited (PDP) have reviewed and analysed the data collected within the reporting period for resource consent CRC211511. The full report is available in **APPENDIX E**.

Justin Legg (MHV Water Limited) has reviewed and analysed the data collected within the reporting period for resource consent CRC184159. The full report is available in **APPENDIX F**.

CONDITION 26 (CRC184159 & CRC211511)

In the event that there is a Deterioration that is identified as a part of the water monitoring required under Condition 24(b) (CRC184159 & CRC211511), the Consent Holder (either directly or through a catchment group) shall, within one month of the Deterioration being identified, engage a suitably qualified and experienced person to prepare a Remediation and Response Plan. The Remediation and Response Plan shall:

- a. discuss the potential causes of the Deterioration, and the extent to which they might be attributable to the activities on farmland under the management of this resource consent;
- b. advise on any changes that might be made to a *Farm Environment Plan* or *Schedule 24a Plan* for the Properties included in Schedule CRC184159A and *Farm Environment Plan* or *Management Plan for Farming Activities* for the Properties included in Schedule CRC211511A, on the basis that any changes will be proportionate to the relative contributions of those Properties to the deterioration;

- c. advise how nutrient discharges may be further managed to ensure improving surface water quality over time;
- d. advise on any further or amended monitoring that may be required to better understand the Deterioration (and the timeframes for that monitoring); and
- e. remain in place and be subject to regular reviews for the duration of any Deterioration, as might be identified through further monitoring.

The Remediation and Response Plan shall be prepared in consultation with Te Rūnanga o Arowhenua and shall be completed within six months of the Deterioration being identified (or such other time as may be agreed to by the Regional Leader - Monitoring and Compliance, Canterbury Regional Council) and the Consent Holder shall implement any recommendations. A copy of the completed Remediation and Response Plan shall be provided to Te Rūnanga o Arowhenua and to the Regional Leader - Monitoring and Compliance, Canterbury Regional Council as a part of the annual reporting required under Condition 30 (CRC184159 & CRC211511).

The Environmental Monitoring Plan was first implemented in November 2022 for the surface water sites. Deteriorating trends can be identified once five years of monitoring data has been collected and base attribute state has been established.

CONDITION 27 (CRC184159 & CRC211511)

The Consent Holder shall undertake a review of the groundwater and surface water monitoring required under Condition 24 (CRC184159 & CRC211511):

- a. within the six month period that begins on the date that is five years after the Commencement Date, being the date which the Base Attribute State has been determined for all listed contaminants in Table CRC184159-2/CRC211511-3; or
- b. at any other time that may be determined by the Consent Holder; or
- c. on making any change to Schedule CRC184159A/CRC211511A that results in increasing the area managed by the scheme on a Property or adjoining Properties for each additional 1,000 hectares (CRC184159)/200 hectares (CRC211511) over that occurring at the Commencement Date, provided that in the case of a review under this Condition 27(c) (CRC184159 & CRC211511), the review shall be limited to the effects of the change and the need to consider further groundwater and/or surface water monitoring sites.

The Environmental Monitoring Plan was first certified by Environment Canterbury on 28th November 2022. The Environmental Management Strategy document *Land Joining and Leaving* details how BCI will account for the total area of new land joining the scheme ASM programme by consent to initiate a review of the EMP if necessary, as summarised in Table 4 below.

TABLE 4: SUMMARY OF NEW LAND CRC184159 AND CRC211511

Reporting Year	PC2 (CRC184159)		PC5 (CRC211511)	
	Total (ha)	Change from 14 th October 2022 (ha)	Total (ha)	Change from 14 th October 2022 (ha)
2023-24	10,064	-64 ha	48,848	+595 ha

PDP have included a review of the monitoring programme under CRC211511 as more than 200 ha of new land has been added to the scheme since the commencement date. They concluded the scale and location of the new land is consistent with existing properties and their use of land will be captured by the existing monitoring network (**APPENDIX F**).

CONDITION 28 (CRC184159 & CRC211511)

If the Consent Holder is required to or elects to undertake such a review under Condition 27(c) (CRC184159 & CRC211511), the Consent Holder will engage a suitably qualified and experienced person to:

- a. Advise on any changes that might be made to add, remove or amend:
 - i. groundwater monitoring bores;
 - ii. surface water monitoring sites;
 - iii. contaminants;
 - iv. how a Deterioration is determined; and
 - v. sampling frequency;
- b. Prepare a Water Monitoring Amendment Report that:
 - i. outlines the reasons for the change(s) proposed; and
 - ii. confirms that the additional, removal or amendment will continue to enable the Consent Holder to meet the objectives set out in Condition 23 (CRC184159 & CRC211511);
 - iii. Consult with the Regional Leader - Monitoring and Compliance, Canterbury Regional Council in the preparation of the Water Quality Monitoring Amendment Report;
 - iv. Provide a copy of the Water Quality Monitoring Amendment Report to the Regional Leader - Monitoring and Compliance, Canterbury Regional Council for certification that any change(s) meet the requirements of this Condition 28 and the objectives outlined in Condition 23.

No changes have been made to the Environmental Monitoring Program as compared with what was submitted to Environment Canterbury on April 14th 2022 and certified 28th November 2022.

CONDITION 29 (CRC184159 & CRC211511)

The Consent Holder shall only implement the change(s) proposed to the monitoring required in Condition 24 if written certification is provided by the Regional Leader – Monitoring and Compliance, Canterbury Regional Council.

No changes have been made to the Environmental Monitoring Program as compared with what was submitted to Environment Canterbury on April 14th 2022 and certified 28th November 2022.

GENERAL REPORTING

CONDITION 30 (CRC184159 & CRC211511)

The Consent Holder shall prepare an annual report describing the results of the ASM programme and the audits that have been conducted each year. The report shall include a summary of the FEP Auditing programme based on the audit reporting requirements in the *Certified Farm Environment Plan Auditor Manual* for the completed year preceding the reporting period, including the following:

- the name of the FEP auditor(s);
- a summary of the audit performance grading, including the predominant farming system on the properties graded;
- the number of Properties receiving each audit grade (including Advanced Mitigation);
- the number of properties which have received repeated fail grades (being 'C' or 'D' grades in relation to a *Farm Environment Plan* or any fail grade as may be determined in consultation with the Regional Leader - Monitoring and Compliance, Canterbury Regional Council in relation to any *Certified Freshwater Farm Plan*) in the past five years including a summary of the reasons and actions taken);

A total of 60 audits were completed between 1st July 2023 to 30th June 2024. Auditors who completed FEP audits for BCI and AFIC last season include:

- Alison van Polanen & Leah Gorman, (EnviroPlan Limited)
- Paul Reese (Matai Consultants)
- Belinda Meares (Irricon Resource Solutions Limited)
- Dave Lucock (The AgriBusiness Group)
- Asure Quality (Synlait's Lead with Pride Programme)

All FEP Auditors are certified by Environment Canterbury and the FEP Audits were completed in accordance with the Environment Canterbury '*Certified Farm Environment Plan Auditor Manual*', May 2020. We note Belinda Meares was a former employee, however she has not provided advisory services to any BCI or AFIC shareholders since 2019.

Table 5 shows the audit grades for the 2023-24 season by land use.

TABLE 5: BCI-AFIC YE2024 FEP AUDIT GRADES BY LAND USE

Land Use	AM	A	B	C	D	Total
Arable	9	23	3	0	0	35
Dairy	2	7	3	1	0	13
Dairy Support	3	6	1	0	0	10
Other	1	1	0	0	0	2
Total	15	37	7	1	0	60

Grades for the 2023-24 season are shown in Figure 2 below. Overall, 25% of farms achieved Advanced Mitigation (AM), 61% "A", 12% "B" and 2% "C" grade. No "D" audit grades were issued this season.

The "C" grade property achieved "A" and "B" Audit grades in the previous 5 years, therefore no property received a repeat fail grade.

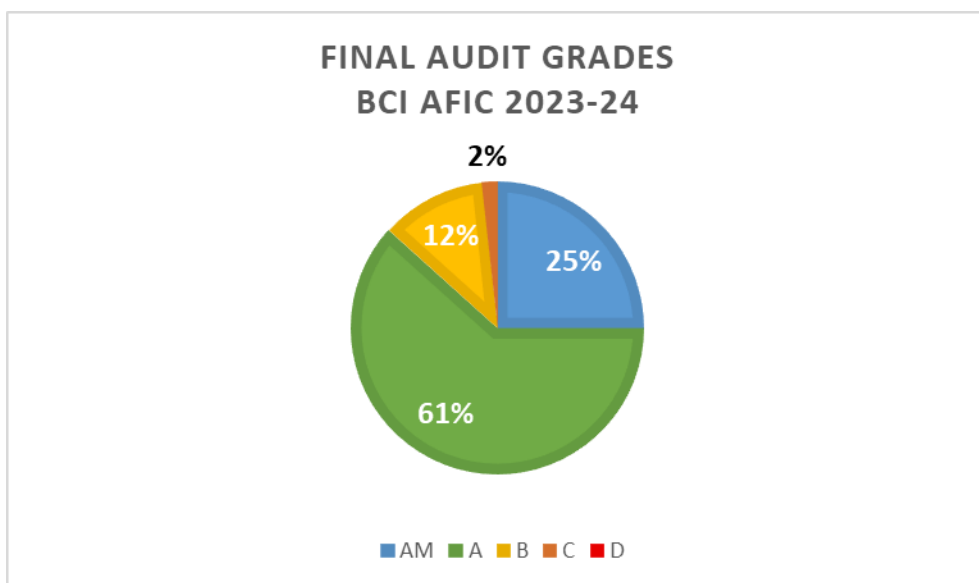


FIGURE 2: BCI-AFIC OVERALL AUDIT RESULTS YE2024

The high proportion of Advanced Mitigation and A audit grades reflects the support BCI and AFIC shareholders receive, including access to training events, resources and one on one time with an experienced environmental advisor. The results this year continue with the trend of BCI and AFIC to achieve higher grades than the Canterbury average (Figure 3).

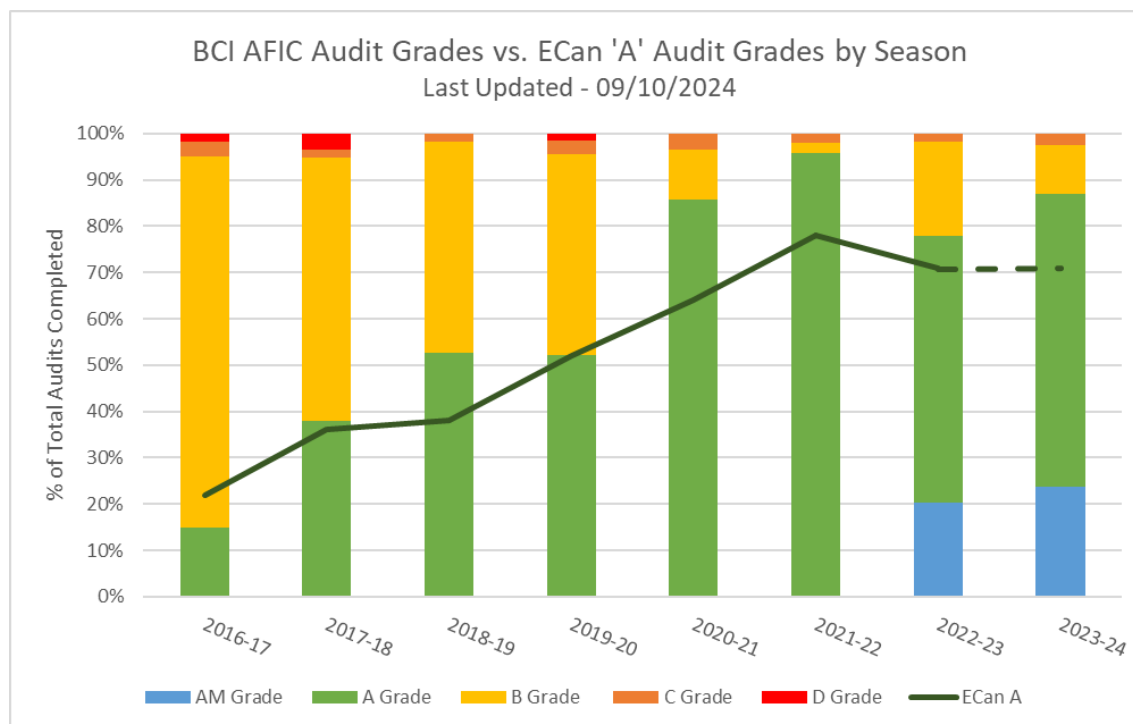


FIGURE 3: BCI-AFIC AUDIT GRADES VS CANTERBURY 2016-2024

- i. the total annual calculated loss of nitrogen from all Properties within the CRC184159/CRC211511 Nutrient Discharge Area over the reported year, in accordance with the method outlined in Schedule CRC184159B/CRC211511B, and including information on:
- ii. the load that has been calculated or deemed for each Property in accordance with Conditions 3 to 7 (CRC184159)/6 (CRC211511);
- iii. the total aggregated NDA for each Nutrient Allocation Zone, being the sum of the assessed nitrogen losses from all Properties provided for in Conditions 4(a) and (b) and identified in the relevant part of Schedules CRC184159A/CRC211511A;
- iv. the implementation of Advanced Mitigation (CRC211511)
- e. predicted changes in average nitrogen concentrations beyond the root zone.

Nitrogen losses by nutrient allocation zone and concentrations for the 2023-24 reporting period were calculated using The Matrix methodology by Dr. Glen Treweek of WSP Limited in Overseer v6.5.5 (**APPENDIX B**). A summary of these results are included in Table 3 and Table 4 below.

TABLE 2: CRC184159 NUTRIENT ALLOCATION ZONE NITROGEN LOSSES (TREWEEK, GROUND SENSE) V6.5.5

	Lower Hinds-Hekeao Plains NAZ	Upper Hinds-Hekeao Plains NAZ	CRC184159 Total
2024 NDA (t N/yr)	493.1	0	493.1
2024 N load (t N/yr)	455.3	0	455.3

TABLE 3: CRC211511 NUTRIENT ALLOCATION ZONE NITROGEN LOSSES (TREWEEK, GROUND SENSE) V6.5.5

	Ashburton - Rakaia NAZ	Ashburton NAZ	Rakaia NAZ	CRC211511 Total
2024 NDA (t N/yr)	1,365.8	345.8	4.0	1,715.7
2024 N load (t N/yr)	1,268.1	340.8	4.4	1,613.3

Nitrogen concentration losses from the BCI ASM programme have been calculated using The Matrix since 2022 and have been summarised in Figure 4 below.

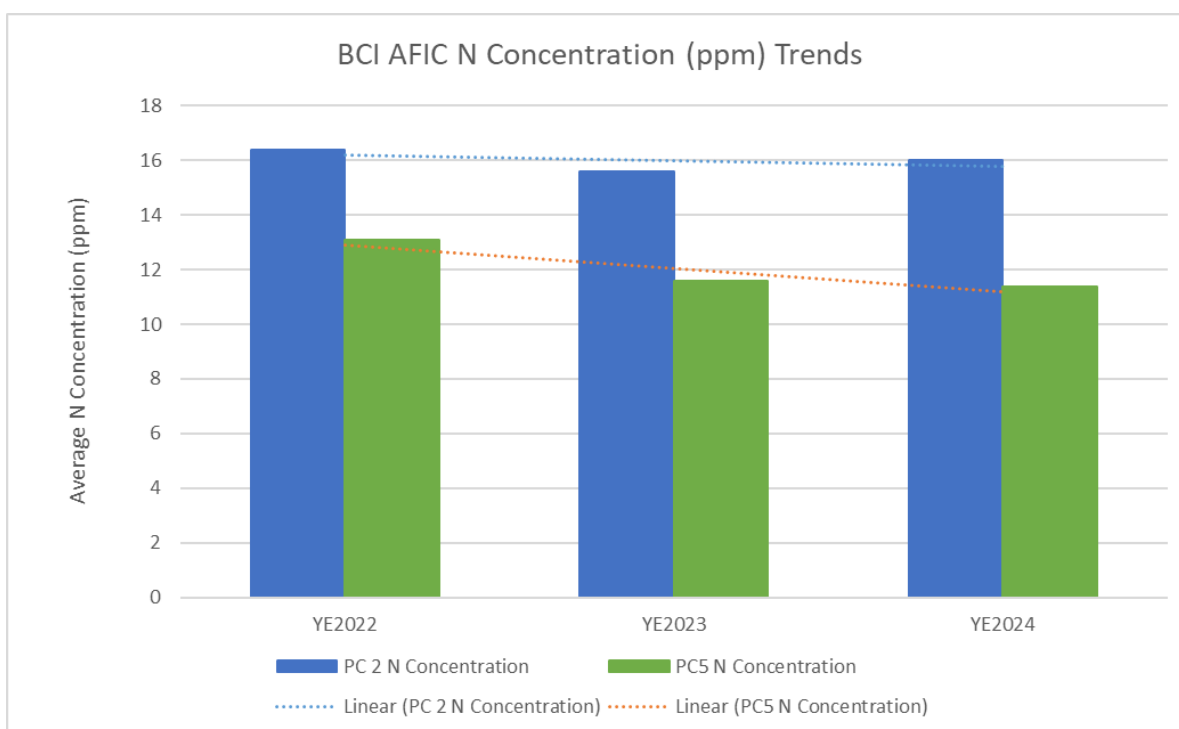


FIGURE 4: N CONCENTRATION TRENDS TO DATE

- f. the reporting on environmental monitoring required in accordance with Condition 24 (CRC184159 & CRC211511);

PDP and MHV Water have prepared summaries of the YE2024 water quality monitoring programme for the Ashburton and Hekeao-Hinds catchments in **APPENDIX F** and **APPENDIX G**.

- g. a summary of any significant change applications considered in accordance with Condition 12 (CRC184159)/11 (CRC211511);

There was one significant change application assessed in the 2023-24 reporting year. Significant Change applications were assessed in accordance with the BCI EMS document *EMSNM-002 Farm Activity Variation Applications*. A summary of all Significant Change applications are detailed in Table 5 below.

TABLE 4: SUMMARY OF SIGNIFICANT CHANGE DECISIONS (2023-24)

Applicant	Status	Change Requested	Assessment
9096	APPROVED	Increase in irrigated area by 163 ha in Chertsey Change in land use from dryland Sheep + Dairy Support to mixed arable + sheep	1. No sensitive receptors on or adjacent to property 2. Applicant already achieved AM audit status 3. Will be managed within a larger farming enterprise 4. New irrigation was efficient 5. Reduction in intensive winter grazing area 6. Whole farming enterprise managed at AM standard ensure no increase in catchment contaminant loads and concentration.

In addition to the above Significant Change application, a further 3 applications for non-significant changes in farm system or new irrigation were assessed and approved in accordance with BCI's Nutrient Management Policy.

- h. the performance of Properties in the scheme in meeting the environmental targets and objectives as specified in the Farm Environment Plans required by Condition 18(a) (CRC184159)/17(a) (CRC211511); and

Level of Confidence grading provided by FEP Auditors in the audits are collated and reported. BCI and AFIC are only given overall grades for the Synlait Lead with Pride grades so are unable to determine the Level of Confidence (LOC) for the Objectives and Targets and are therefore excluded from this analysis.

Figure 5 shows the Level of Confidence analysis for the 2023-24 audit season for BCI and AFIC.

No farm was graded a "Low" Level of Confidence for any target. Irrigation, Nutrient and Soils Objectives was proportionately similar, a significant improvement on previous years where Irrigation was consistently the most common reason for being down-graded in audits.

Key reasons for "B" audit grades in the 2023-24 season were minor and include:

1. Lack of drop tests on effluent ponds
2. Limited objective information to support irrigation scheduling decisions
3. One or more irrigation systems not meeting uniformity standards
4. Fertiliser spreaders no calibrated for uniformity

We anticipate most farms will be able to improve their audit grade at the next audit.

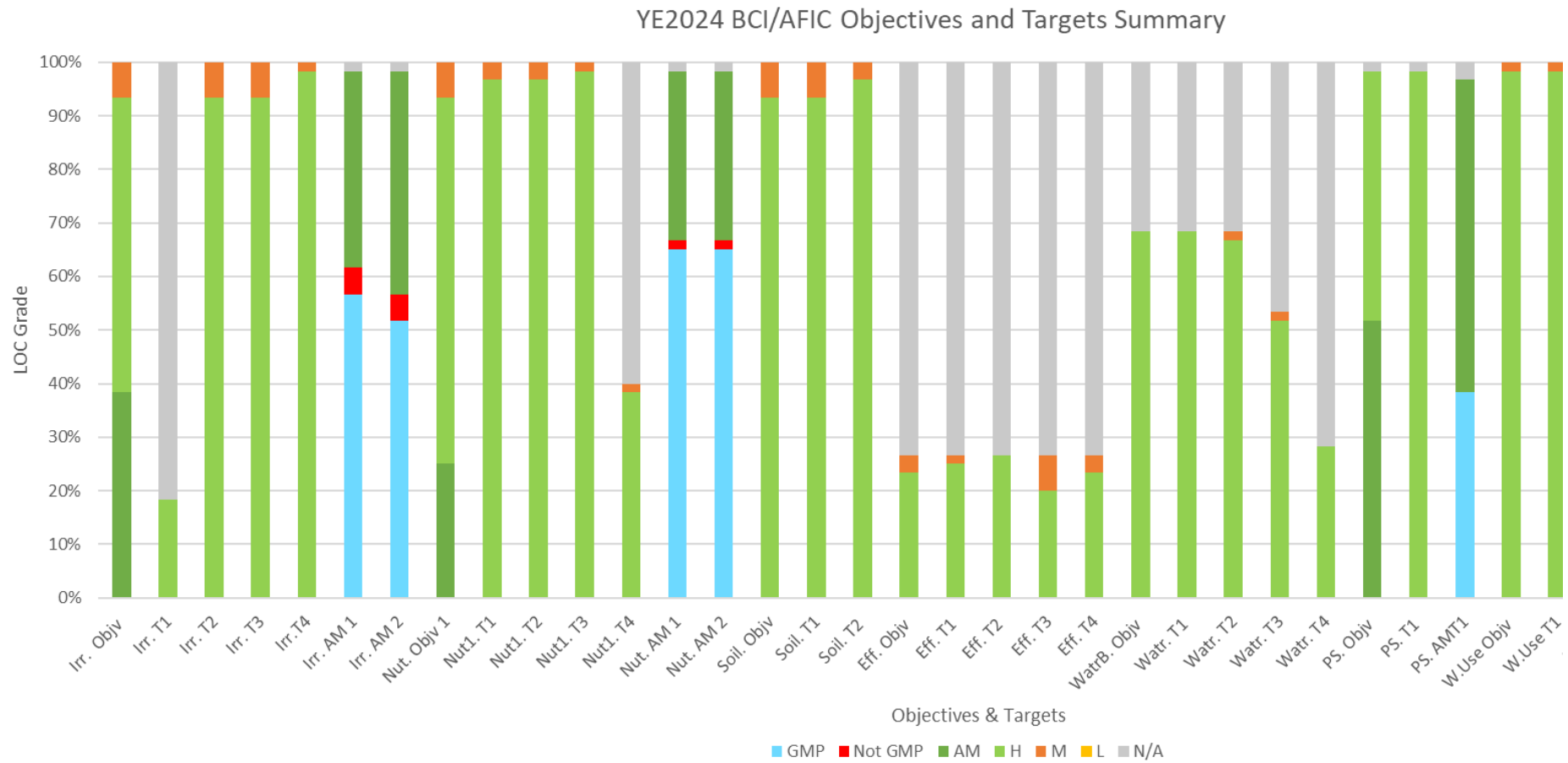


FIGURE 5: BCI-AFIC YE2024 LEVEL OF CONFIDENCE ANALYSIS

- i. results of the review required by Condition 16(CRC184159)/15(CRC211511).

A review of the use of The Matrix and one third of the Environmental Management Strategy was completed in November 2024 by Laura Burgess and Emily McDonald of WM Environmental. The full detail of the review is available in **APPENDIX E**.

CONDITION 31 (CRC184159 & CRC211511)

A copy of the annual report required under Condition 30 (CRC184159 & CRC211511) shall be provided to Te Rūnanga o Arowhenua and the Regional Leader - Monitoring and Compliance, Canterbury Regional Council, by 1 December 2022 and annually thereafter.

The annual report was submitted to Te Rūnanga o Arowhenua and to the Regional Leader – Monitoring and Compliance, Canterbury Regional Council on the 1st of December 2024.

CONDITION 32 (CRC184159 & CRC211511)

The reporting requirements in Condition 31 (CRC184159 & CRC211511) may be altered with the agreement of the Regional Leader - Monitoring and Compliance, Canterbury Regional Council to:

- a. reflect the timing of the consent implementation between this consent and existing consent CRC162882; or
- b. incorporate reporting of both CRC184159 and CRC211511 (or any other nutrient discharge consent held by the Consent Holder) together.

Advisory Note: *The intention of Condition 32(a) is to ensure that the Consent Holder is able to rely on resource consent CRC162882, this consent, or a combination of the two for a transitional period, as might be agreed, for the purposes of ensuring the Consent Holder can avoid unnecessary duplication of reporting requirements and where necessary, complete or dispense with annual reporting requirements where they may be covered by one of more resource consent(s). The intention of Condition 32(b) is to allow the Consent Holder to combine reporting requirements.*

No transitional requirements have been necessary for this past reporting season.

CONDITION 33 (CRC184159)

Within six months of the Commencement Date, the Consent Holder shall ensure that as a part of any water supply agreement between the Consent Holder and any Property provided for in Conditions 4(a) and (b) and where reductions are required in accordance with 4(a)(iii)(A) to (C), the water supply agreement shall specify that the Property owner be required to enter a legally binding obligation running with the land to secure the obligations set out in Condition 4(a)(iii)(A) to (C).

The BCI Water Agreement has been updated and now applies to all Shareholders managed under the BCI ASM programme. The updates to the water agreement establishes a clear legal obligation to Shareholders to ensure consent requirements (including nitrogen loss reductions where applicable) are met. Water agreements relate to specific titles owned by the Shareholder, therefore reduction expectations also apply to the land subject to the Water Agreement.

CONDITION 34 (CRC184159)/CONDITION 33 (CRC211511)

The Canterbury Regional Council may once per year, on any of the last five working days of May or November, serve notice of its intention to review the Conditions of this consent for the purposes of:

- a. dealing with any adverse effect on the environment which may arise from the exercise of the consent; or

- b. addressing the failure of any Remediation and Response Plan to achieve the improvements anticipated in the plan in relation to water quality.

No comment required.

CONDITION 35 (CRC184159)/CONDITION 34 (CRC211511)

The Consent Holder may, in consultation the Regional Leader - Monitoring and Compliance, Canterbury Regional Council combine the obligations in this resource consent with any other resource consent held by the Consent Holder that provides for similar or the same obligations.

Further Advisory Notes:

Addition and removal of Properties to and from the Schedule CRC184159A/CRC211511A is at the sole discretion of the Consent Holder.

The Environmental Management Strategy and this compliance report have been prepared to ensure compliance with both resource consents CRC184159 and CRC211511 are met.

APPENDIX A - ENVIRONMENT CANTERBURY HEKEAO/HINDS PLAINS ANNUAL CONCENTRATION

(2023-24 data sourced from Kurt VanNess, Groundwater Scientist: Environment Canterbury)

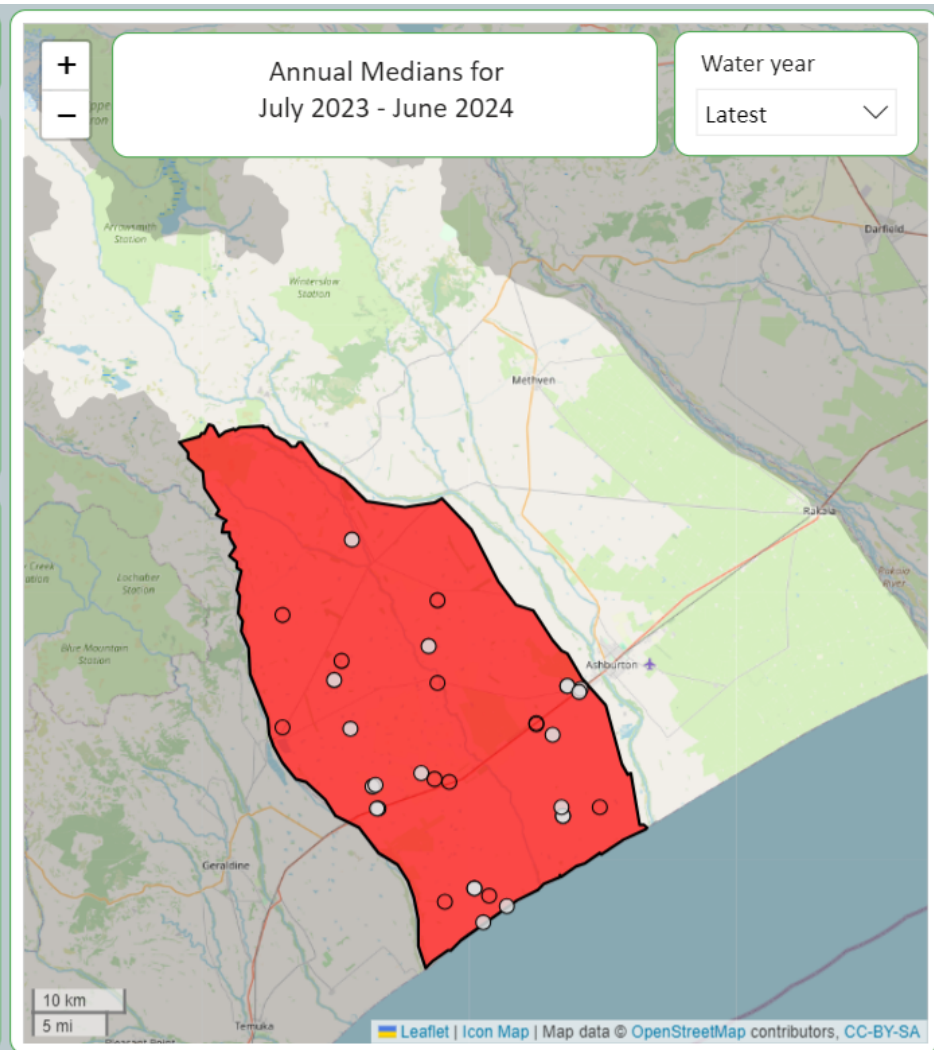
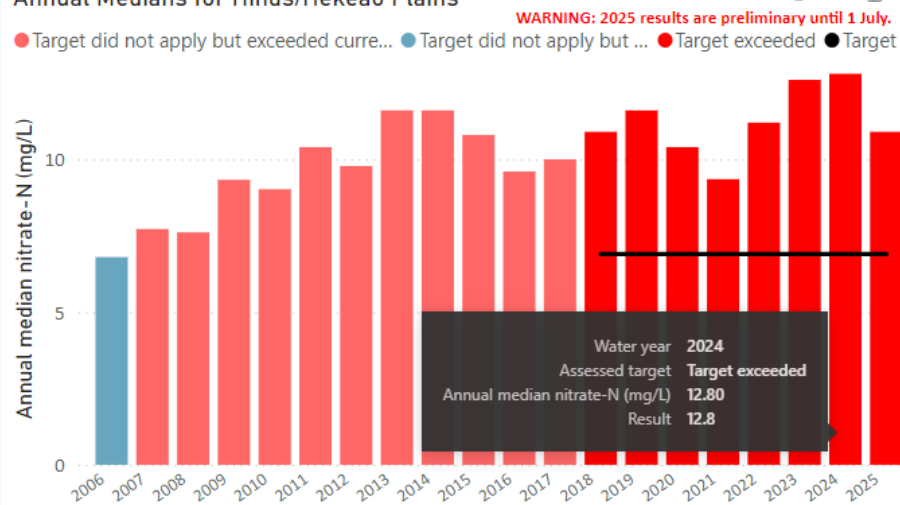
Nitrate-nitrogen annual medians

The Hinds/Hekeao Plains sub-zone can be seen in the map on the right. This area covers a large portion of the Ashburton sub-region. It has a limit for **annual median nitrate-nitrogen concentrations**. This median concentrations is determined using sample results collected from Environment Canterbury's state of the environment groundwater monitoring network. These wells and their nitrate-nitrogen concentrations can be reviewed by interacting with the map.

Method: Since wells could be sampled at different frequencies (typically annually or quarterly), equal weighting is ensured by first determining the annual median for each well before calculating the median for the sub-zone. Only **wells shown in grey** are used for the median, **wells shown as empty circles** are not **quarterly** monitoring wells **screened within 30 metres** of the water table as specified by footnote (1).

The target should be achieved and maintained by 2035.

Annual Medians for Hinds/Hekeao Plains



APPENDIX B – NITROGEN LOAD REPORT 2024 (WSP LIMITED)

Memorandum

To	Eva Harris
Copy	Rex Corlett, Aimee Dawson
From	Glen Treweek
Office	Christchurch
Date	26 November 2024
File/Ref	3-9C747.00
Subject	2024 BCI Compliance NDA

Introduction

Enviro Collective Limited (ECL) have engaged WSP to calculate the Barrhill Chertsey Irrigation Scheme annual Nitrogen Discharge Allowance (NDA) for the 2023-2024 season.

Barrhill Chertsey Irrigation Ltd. (BCI) holds resource consents CRC184159 & CRC211511 to discharge onto or into land contaminants from farming activities. Condition 3 of CRC184159 & CRC211511 require a schedule specifying the permitted nitrogen loss for each farm authorised by CRC184159 & CRC211511. Condition 4, 6 & 7 of CRC184159 & condition 4, 5 & 6 of CRC211511 specify how the Nitrogen Discharge Allowance (NDA) is to be calculated and complied with. The Nitrogen Load was calculated using The Matrix method, in accordance with CRC184159 & CRC211511. The requirements of conditions 4, 6 & 7 of CRC184159 & condition 4, 5 & 6 of CRC211511 are detailed below.

Methodology

Condition 4 of CRC184159 & CRC211511 require methods used to calculate the NDA and Nitrogen Load to be calculated using the current version of Overseer, which, at the time of writing, was v6.5.7. Accordingly, all Nitrogen loss values used in The Matrix method for this assessment were updated to v6.5.7

Nitrogen losses were calculated in accordance with the methodology approved by the Chief Executive of Canterbury Regional Council, in April 2020.

Conditions 9 & 10 of CRC184159 & conditions 8 & 9 of CRC211511 enables BCI to supply irrigation water to Properties that would otherwise be able to be farmed as or in similar circumstances as permitted farming land use activities outside the scheme Audited Self-Management (ASM) programme without any contribution to the nitrogen discharge allowance. These properties are termed Authorised Properties in CRC184159 & CRC211511.

Results

The farmed area presented in Table 1 and Table 2 includes all farmland included in the BCI Audited Self-Management (ASM) Programme, including Authorised Properties. Nitrogen losses from all farmland included in the BCI Audited Self-Management (ASM) Programme are presented in Table 3 and Table 4, but losses from Authorised Properties are allocated a "0" kg N loss in accordance with CRC184159 & CRC211511.

Table 1: Farm area for 2024 in the Hinds-Hekeao Plains (PC2) Nutrient Allocation Zones (NAZ) for Properties included in the BCI Audited Self-Management programme authorised by CRC184159, and Authorised properties.

	Lower Hinds-Hekeao Plains NAZ	Upper Hinds-Hekeao Plains NAZ	BCI Total
	Area (ha)	Area (ha)	Area (ha)
NDA	10,064	0	10,064
Authorised	0	0	0

Table 2: Farm area for 2024 in the Ashburton & Rakaia (PC5) Nutrient Allocation Zones (NAZ) for Properties included in the BCI Audited Self-Management programme authorised by CRC211511 contributing to the BCI NDA, and Authorised properties.

	Ashburton - Rakaia NAZ	Ashburton NAZ	Rakaia NAZ	BCI Total
	Area (ha)	Area (ha)	Area (ha)	Area (ha)
NDA	39,092	8,250	176	47,519
Authorised	1,592	0	37	1,629

Table 3: Calculated Nitrogen Discharge Allowance and Nitrogen Load for the 2024 year for BCI farms in the Hinds-Hekeao Plains (PC2) zones authorised by CRC184159 (Overseer V6.5.7).

	Lower Hinds-Hekeao Plains NAZ	Upper Hinds-Hekeao Plains NAZ	BCI Total
	N load (t N/yr)	N load (t N/yr)	N load (t N/yr)
NDA	493.1	0	493.1
2024	455.3	0	455.3

Table 4: Calculated Nitrogen Discharge Allowance and Nitrogen Load for the 2024 year for BCI farms in the Ashburton & Rakaia (PC5) zones authorised by CRC211511 (Overseer v6.5.7).

	Ashburton - Rakaia NAZ	Ashburton NAZ	Rakaia NAZ	BCI Total
	N load (t N/yr)	N load (t N/yr)	N load (t N/yr)	N load (t N/yr)
NDA	1,365.8	345.8	4.0	1,715.7
2024	1,268.1	340.8	4.4	1,613.3

Condition 30 (e) of CRC184159 & condition 30 (e) (iv) of CRC211511 requires BCI to provide information on the predicted changes in average nitrogen concentrations beyond the root zone. Estimates of root-zone drainage nitrogen concentration for the current year are presented in Table 5 and Table 6.

Table 5: Calculated Nitrogen concentration for the 2024 year for BCI farms in the Hinds-Hekeao Plains (PC2) zones authorised by CRC184159 (Overseer V6.5.7).

	Lower Hinds- Hekeao Plains NAZ	Upper Hinds- Hekeao Plains NAZ	BCI Total
	mg N/L	mg N/L	mg N/L
2022	16.4	-	16.4
2023	15.6	-	15.6
2024	16.0	-	16.2

Table 6: Calculated Nitrogen concentration for the 2024 year for BCI farms in the Ashburton & Rakaia (PC5) zones authorised by CRC211511 (Overseer v6.5.7).

	Ashburton - Rakaia NAZ	Ashburton NAZ	Rakaia NAZ	BCI Total
	mg N/L	mg N/L	mg N/L	mg N/L
2022	12.5	16.2	10.7	13.1
2023	11.5	15.8	9.8	11.6
2024	10.7	14.9	8.9	11.4

Disclaimers and Limitations

This memorandum ('Memo') has been prepared by WSP exclusively for Enviro Collective Ltd ('Client') in relation to calculating a nitrogen discharge allowance for Barrhill Chertsey Irrigation scheme ('Purpose') and in accordance with the Short form Agreement with the Client dated 24.09.2024 (project number 3-9C747.00). The findings in this Memo are based on and are subject to the assumptions specified in the Memo, and the Contract. WSP accepts no liability whatsoever for any reliance on or use of this Memo, in whole or in part, for any use or purpose other than the Purpose or any use or reliance on the Memo by any third party.

In preparing the nitrogen discharge allocation calculation, WSP has relied upon information provided by Enviro Collective Ltd ('Client Data'). Except as otherwise stated in the Memo, WSP has not verified the accuracy or completeness of the Information or the Client Data. WSP will not be liable in relation to incorrect conclusions or findings in the Memo should any Client Data be incorrect, or has been concealed, withheld, misrepresented or otherwise not fully disclosed to WSP.



Schedule CRC184159A v24 – November 2024 (Overseer version 6.5.7)

Farm Identifier	NDA – Lower Hinds-Hekeao Plains Nutrient Allocation Zone (kg N/yr)	NDA – Upper Hinds-Hekeao Plains Nutrient Allocation Zone (kg N/yr)
116	17,439	0
454	8,080	0
348	8,890	0
138	25,812	0
502	4,617	0
866	17,305	0
766	1,762	0
743	16,438	0
957	14,774	0
114	2,861	0
162	20,088	0
399	16,963	0
549	4,278	0
716	13,515	0
630	22,239	0
400	12,466	0
730	7,258	0
687	2,366	0
754	2,884	0
361	16,839	0
547	8,350	0
833	11,383	0
225	2,458	0
49	16,626	0
344	29,438	0
864	17,906	0
70	21,831	0
683	15,377	0
115	19,606	0
358	6,566	0
33	845	0
231	36,341	0
250	16,296	0

Farm Identifier	NDA – Lower Hinds-Hekeao Plains Nutrient Allocation Zone (kg N/yr)	NDA – Upper Hinds-Hekeao Plains Nutrient Allocation Zone (kg N/yr)
295	7,224	0
340	5,256	0
554	6,881	0
823	6,466	0
206	2,242	0
24	9,919	0
314	5,600	0
576	755	0
325	5,279	0
159	3,601	0
Total	493,119	0

Schedule CRC211511A v24 – November 2024 (Overseer version 6.5.7)

Farm Identifier	NDA – Ashburton - Rakaia Nutrient Allocation Zone (kg N/yr)	NDA – Ashburton Nutrient Allocation Zone (kg N/yr)	NDA – Rakaia Nutrient Allocation Zone (kg N/yr)
881	0	0	0
694	11,489	0	0
986	9,317	0	0
77	10,490	0	0
662	21,576	0	0
315	17,271	0	0
686	6,571	0	0
722	6,369	0	0
261	0	0	0
91	9,726	0	0
701	9,796	0	0
105	6,538	0	0
485	0	0	0
939	10,133	0	0
991	20,133	0	0
89	9,070	0	0
562	10,581	0	0
641	9,226	0	0
442	12,806	0	0
558	10,643	0	0
629	9,512	0	0
174	18,846	0	0
514	15,531	0	0
339	18,613	0	0
724	15,340	0	0
130	29,835	0	0
619	23,544	0	0
209	1,789	0	0
428	11,825	0	0
255	9,399	0	0
229	87,020	0	0
996	6,305	0	0
609	9,601	0	0
964	8,854	0	0
505	30,565	0	0
500	25,346	0	0
628	19,820	0	0
974	15,186	0	0
281	10,861	0	0
959	23,975	0	0
154	13,441	0	0

Farm Identifier	NDA – Ashburton - Rakaia Nutrient Allocation Zone (kg N/yr)	NDA – Ashburton Nutrient Allocation Zone (kg N/yr)	NDA – Rakaia Nutrient Allocation Zone (kg N/yr)
984	11,481	0	0
848	10,899	0	0
913	35,952	0	0
393	0	0	0
332	20,468	0	0
402	17,797	0	0
58	0	0	0
356	1,800	0	0
348	0	1,487	0
6	13,716	0	0
134	16,044	0	0
755	0	6,873	0
698	0	11,291	0
863	6,843	0	0
9	10,002	0	0
236	6,062	0	2,811
592	0	9,273	0
846	0	2,942	0
781	2,827	8,029	0
296	0	16,011	0
759	17,429	0	0
8	12,841	0	0
904	0	10,368	0
25	14,422	0	0
577	3,727	0	0
530	11,766	0	0
922	0	0	0
664	0	11,938	0
804	0	25,574	0
757	6,166	0	0
663	4,678	0	0
44	10,689	0	0
28	18,170	0	0
21	8,730	0	0
453	6,980	0	0
247	13,317	0	738
956	10,752	0	0
277	0	0	0
973	0	10,785	0
379	82,949	0	0
708	0	17,437	0
542	8,385	0	0
401	0	3,902	0
85	0	34,439	0
630	0	78	0

Farm Identifier	NDA – Ashburton - Rakaia Nutrient Allocation Zone (kg N/yr)	NDA – Ashburton Nutrient Allocation Zone (kg N/yr)	NDA – Rakaia Nutrient Allocation Zone (kg N/yr)
57	9,025	0	0
156	16,313	0	0
31	11,639	0	0
969	3,350	0	0
503	2,276	0	0
570	0	24,570	0
493	5,914	0	0
501	4,278	0	0
47	0	6,834	0
23	3,868	0	16
512	4,816	0	0
272	0	0	0
334	10,776	0	0
319	0	12,884	0
153	7,251	0	420
432	0	8,043	0
492	0	0	0
859	8,196	0	0
365	9,514	0	0
941	6,567	0	0
374	2,567	0	0
729	5,201	0	0
50	7,395	0	0
417	3,146	0	0
788	45,664	0	0
717	6,173	0	0
15	0	11,809	0
283	0	10,354	0
607	3,200	0	0
611	43,287	0	0
301	0	15,379	0
463	8,265	0	0
246	9,242	0	0
799	10,617	0	0
901	0	10,485	0
353	0	9,787	0
397	13,327	0	0
238	1,828	0	0
491	2,963	0	0
758	1,216	0	0
362	6,956	10,211	0
515	1,734	4,832	0
744	14,338	0	0
692	1,606	0	0
256	0	0	0

Farm Identifier	NDA – Ashburton - Rakaia Nutrient Allocation Zone (kg N/yr)	NDA – Ashburton Nutrient Allocation Zone (kg N/yr)	NDA – Rakaia Nutrient Allocation Zone (kg N/yr)
891	0	0	0
507	0	9,545	0
900	0	12,788	0
824	0	0	0
231	0	1	0
645	0	0	0
448	1,557	0	0
14	0	0	0
929	22,673	0	0
280	9,218	0	0
921	0	0	0
24	0	110	0
513	0	0	0
972	0	0	0
19	7,559	0	0
249	19,784	0	0
436	0	0	0
845	0	0	0
968	960	0	0
1777	4,559	0	0
2586	1,950	0	0
3395	13,544	0	0
4204	9,691	0	0
4205	0	27,781	0
Total	1,365,838	345,841	3,985

APPENDIX C – LAWFULLY INTENSIFIED/IRRIGATED LOAD CALCULATION 2024 (WSP LIMITED)

Barrhill Chertsey Irrigation Ltd

MATRIX UPDATE V6.5.5

Project Number: 3-9C742.03

16 JULY 2024





MATRIX UPDATE V6.5.5

Barrhill Chertsey Irrigation Ltd

WSP Christchurch Office
12 Moorhouse Ave
Christchurch, 8011
New Zealand

REV	DATE	DETAILS	
0	11/07/2024	Draft report	
1	16/07/2024	Final report	

	NAME	DATE	SIGNATURE
Prepared by:	Glen Treweek	10/07/2024	
Reviewed by:	Anne-Maree Jolly	10/07/2024	
Approved by:	Aimee Dawson	16/07/2024	

Disclaimers and Limitations

This report ('**Report**') has been prepared by WSP exclusively for Barrhill Chertsey Irrigation Ltd ('**Client**') in relation to the update of The Matrix nitrogen loss lookup table ('**Purpose**') and in accordance with the Short Form Agreement with the Client dated 31 May 2024. The findings in this Report are based on and are subject to the assumptions specified in the Report. WSP accepts no liability whatsoever for any reliance on or use of this Report, in whole or in part, for any use or purpose other than the Purpose or any use or reliance on the Report by any third party.

In preparing this Report, WSP has relied upon data, surveys, analyses, designs, plans and other information ('**Client Data**') provided by or on behalf of the Client. Except as otherwise stated in this Report, WSP has not verified the accuracy or completeness of the Client Data. To the extent that the statements, opinions, facts, information, conclusions and/or recommendations in this Report are based in whole or part on the Client Data, those conclusions are contingent upon the accuracy and completeness of the Client Data. WSP will not be liable for any incorrect conclusions or findings in the Report should any Client Data be incorrect or have been concealed, withheld, misrepresented, or otherwise not fully disclosed to WSP.

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4	Lawfully Irrigated Land	7
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1 Summary

Barrhill Chertsey Irrigation Ltd (BCI) holds resource consents CRC184159 and CRC211511 to discharge onto or into land contaminants from farming activities.

These resource consents allow the consent holder to calculate aggregated nitrogen losses using The Matrix method.

The nitrogen loss value for Lawfully Irrigated Land when Overseer v6.5.5 is used is **45 kg N/ha/yr**.
The soil water drainage value for Lawfully Irrigated Land when Overseer v6.5.5 is used is **339 mm/yr**.

2 Rationale

The Matrix method uses a combination of farm system, irrigation, soil, and farm management practice information to generate a representative nitrogen loss estimate for the catchment using nitrogen loss values from representative Overseer files.

The Matrix was approved as equivalent to Overseer in April 2020 by the Chief Executive of the Canterbury Regional Council.

The Overseer model is regularly updated, and consents CRC184159 and CRC211511 require the most recent version of Overseer to be used if nitrogen losses are modelled using Overseer. The current version of Overseer as of 5th July 2024, when this work was carried out, was v6.5.5.

3 File Modification

Updates to the OverseerFM model are regularly carried out by Overseer Ltd. In some instances, the updates may mean the model fails to generate a viable analysis, and modifications to the Overseer file are required.

When updating to Overseer v6.5.5, some of the representative files failed to generate a viable analysis. The affected farm analyses showed over-feeding errors for animals on crops for the following files:

- Dairy Support 1 (all variants) (25 analyses)
- Dairy Support 2 (all variants) (24 analyses)
- Sheep & Beef – AM1 – all soil types (4 analyses)

The solution applied to the Sheep and Beef files was adapted from the advice given by Overseer in 2023 (Appendix 1), where the proportion of crop feed fed to sheep was reduced, while maintaining crop yields. The small modification to the Sheep and Beef files resolved the over-feeding error, and the model was able to generate a viable analysis.

Advice from Overseer Ltd was sought to repair the Dairy Support files for version 6.5.5, and a solution was proposed by Alastair Taylor (Appendix 2). The solution for Dairy Support files (all variants) entailed reducing Fodder Beet crop yields in the Reporting Year by the minimum amount required to generate a viable analysis. Fodder Beet yields in Dairy Support 1 files (all variants) were reduced by 0.3-0.8 t DM/ha. While Fodder Beet yields in Dairy Support 2 files (all variants) were reduced by 4 t DM/ha.

4 Lawfully Irrigated Land

Condition 4 (b) of consents CRC184159 and CRC211511 provides an allocation of 27 kg N/ha/yr (when modelled using Overseer v6.03) for lawfully Irrigated Land (Plan Change 2 area) or Lawfully Intensified land (Plan Change 5 area). Overseer v6.0.3 is no longer available and Nitrogen loss values created using this version of Overseer must also be updated using the most recent version of Overseer.

A projected mix of farm systems using three representative Overseer files were originally used to calculate the allowable nitrogen loss value of 27 kg N/ha/yr. The calculation was based on future growth of 60% Dairy Platform, 20% Dairy Support and 20% Arable. Future growth was expected to be 'above Good Management Practice' and was modelled at Advanced Mitigation.

The representative Overseer files used were:

- Dairy 1 (D1) on very light soil, Advanced Mitigation (AM1)
- Dairy support 1 (DS1) on very light soil, Advanced Mitigation (AM1)
- Arable 2 (Ar2) on very light soil, Advanced Mitigation (AM1)

Nitrogen losses from the representative files using Overseer v6.0.3 were:

- 60% Dairy @ 26 kg N/ha/yr = 15.6 kg N/ha/yr
- 20% Dairy support @ 33 kg N/ha/yr = 6.6 kg N/ha/yr
- 20% Arable – 23 kg N/ha/yr = 4.6 kg N/ha/yr
 - o Total 26.8 kg N/ha/yr (**27 kg N/ha/yr**)

I took nitrogen losses from the three updated representative Overseer files and re-calculated the equivalent nitrogen loss using Overseer v6.5.5 as follows (Table 1):

- 60% Dairy @ 41.2 kg N/ha/yr = 24.7 kg N/ha/yr
- 20% Dairy support @ 53.9 kg N/ha/yr = 10.8 kg N/ha/yr
- 20% Arable – 46.9 kg N/ha/yr = 9.4 kg N/ha/yr
 - o Total 44.9 kg N/ha/yr (**45 kg N/ha/yr**)

Consents CRC184159 and CRC211511 also require changes in nitrogen concentration to be reported. The soil drainage value necessary for calculating the concentration for Lawful Intensification using the formula above was 339 mm/yr (Table 1).

Table 1: Updated Matrix nitrogen loss and soil water drainage values using Overseer version 6.5.5.

	NITROGEN LOSS (KG N/HA/YR)	SOIL DRAINAGE WATER (MM/YR)
Dairy 1 (D1)	41.2	319
Dairy Support 1 (DS1)	53.9	353
Arable 2 (Ar2)	46.9	384
Total	44.9	339

The updated Matrix values for nitrogen loss and soil water drainage using Overseer v6.5.5 can be found in Appendix 2.

4.1 Mitigations not modelled in Overseer

Original modelling when preparing the projected load of 27 kg N/ha/yr included some mitigations not able be modelled in Overseer, such as mixed pasture sward and short rotation ryegrass. Historically, these mitigations have been modelled by applying a reduction to the N loss from the Dairy 1 representative file of 4.9% to account for the mixed pasture sward, and a reduction 7.5% for the short rotation ryegrass. For consistency, I have applied the same reductions to the Dairy 1 N loss, bringing the whole-farm N loss down from 47 kg N/ha/yr to 41.2 kg N/ha/yr (Table 1).

5 OverseerFM version 6.5.6

The OverseerFM model was updated from v6.5.5 to v6.5.6 immediately after this body of work was completed. However, the update was in relation to maintenance fertiliser modelling and the release notes state that “*there will be **no changes to the N, P, and GHG results***” as a result of the update (Appendix 3). Therefore, while the OverseerFM outputs used in this analysis were taken from Overseer v6.5.5, the nitrogen loss and soil drainage values are correct for v6.5.6.

Appendices

Appendix 1. Recommended solution for ME error in Overseer v6.5.2 (2023)

glen@groundsense.co.nz

From: Alastair Taylor <ataylor@overseer.org.nz>
Sent: Tuesday, 12 September 2023 5:38 PM
To: Glen Treweek
Cc: Eva Harris
Subject: "Irrigo" Matrix - OverseerSci

Hi Glen and Eva

Following up on my call from Eva this afternoon.

We have taken a look at the analysis Sheep & Beef 2 – AM1 – DPD in the farm account in OverseerSci “Sheep & Beef 2 – AM1”

<https://sci.overseer.org.nz/#/app/farm/7fefef78-3fa8-4139-b380-82e381c4b1db/analysis>

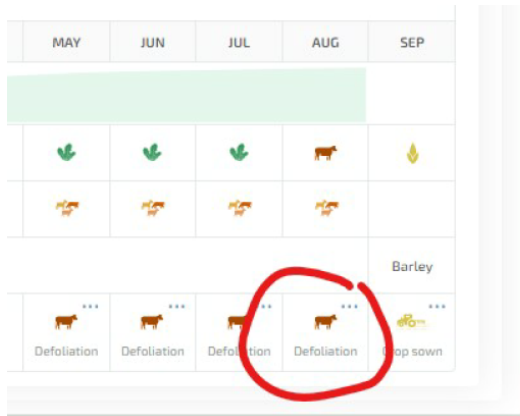
This farm analysis is showing a 164% over-feeding error in the August for the sheep.

In our test environment we have established that there appears to be some dirty data in the file, which appears to be creating one additional defoliation in the data, which is then causing the error.

We have found a simple way to resolve this over-feeding error.

If you look at the analysis “Copy of S&B2 AM1 DPD - Overseer Limited” you will see that I have resolved it by:

- Go to Block BD (Kale > Kale)
- Go to the final defoliation



- You'll see that the percentage of crop eaten by sheep has been changed from 30% to 28%
- If you then go to the animal reports – you will see that the proportion of the diet for sheep in August from crops is now 120% (it's actually 119.9%) but the UI rounds it up. 120% is the maximum possible without creating a feed error

DIET		MJ ME/MONTH	
		JUL	AUG
Crops		301,253 88.8%**	269,529 120%**

- You'll see that this copy of the analysis now generates a result

If you replicate those changes in the other analyses you should see a similar result. I understand you may have to clear this with ECAN first, so we believe this change has been caused by a single additional defoliation which is recorded in the data file – although not displayed in the UI, which meant that the move to Version 6.5.2 caused the modelling to error in accordance with warning note 6 in the release notes.

Hope that helps
Alastair

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Business Development Manager



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OverseerFM Gold Winner 2020

Appendix 2. Recommended solution for ME error in Overseer v6.5.5 (2024)

Treweek, Glen

To: Treweek, Glen
Subject: RE: Sci outputs

From: Alastair Taylor <ataylor@overseer.org.nz>
Sent: Tuesday, July 2, 2024 9:41 AM
To: Treweek, Glen <Glen.Treweek@wsp.com>
Cc: Alexander Hunt-Painter <Alexander@overseer.org.nz>; Jean-Paul Tavernet <jeanpaul@overseer.org.nz>; Eva Harris <eva@envirocollective.co.nz>
Subject: Fwd: Sci outputs

Hi Glen,

See below a response to your question from our lead modeller Jean-Paul Tavernet.

Hopefully it provides you with the information you need.

Regards,
Al

Alastair Taylor
Overseer Limited

Mb: 021 857 627

Hi Glen,

...

The model first calculates the nutritional needs of the animals and then allocates feed, starting with crops, followed by supplements and finally pastures. In your specific case, it seems that the amount of crops provided exceeds the nutritional needs of the animals. Therefore, I recommend either reducing the amount of crops in their diet or increasing the animals' needs (increase initial weight for example).

...

Cheers,
OFM team.



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Appendix 3. Release notes – Overseer v6.5.6



Release notes – Overseer version 6.5.6

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1. Overview

The OverseerFM model release 6.5.6 includes a minor bug fix to the maintenance fertiliser modelling for pastoral blocks. This update does not affect any other model results, so there will be **no changes to the N, P and GHG results**.

In model versions prior to the 6.5.5 version of the model, issues were identified with calculating the nutrient balance for animal product. Specifically, for some farming systems, such as intensive fattening systems or farms with livestock, the model's method of calculating nutrient maintenance recommendations was inaccurate. This issue occurred when livestock herds were gaining weight during the year and their source or fate was recorded as "on-farm" or left unspecified.

In model version 6.5.5 adjustments were made to consider animals only at the block level where maintenance calculation is performed. The fate of animals at the farm level shouldn't have been considered, only at the block level. This adjustment ensured a more accurate calculation of nutrients removed in animal products, providing more reliable maintenance recommendations.

However, while these changes corrected the issues with live weight gain products, they introduced a new issue. The revised method underestimated nutrient removal for other animal products, such as milk or wool. This underestimation led to discrepancies in the overall nutritional balance. This has now been rectified in version 6.5.6 of the model.

2. Overall impact on modelled results

Overall, there is **no impact on N, P or GHG results** from the upgrade to Overseer model version 6.5.6.

Only maintenance fertiliser results for pastoral blocks in farming systems that produce products other than live weight gain are impacted. For example, farming systems involving milk or wool are impacted.

The impact of changes has been tested using the complete database of c.150,000 analyses (c. 130,000 analyses that have results), and a smaller subset of the latest year analyses for all farms modelled in the Overseer database (c.10,100 analyses).

Appendix 4. Matrix nitrogen loss and soil drainage lookup table Overseer v6.5.5

Matrix code	Nitrogen loss v6.5.5 (kg N/yr)	Soil water drainage v6.5.5 (mm/yr)
Ar_BD_DPD_MRB	116	1,717
Ar_BD_L_MRB	117	1,729
Ar_BD_MH_MRB	119	1,719
Ar_BD_VL_MRB	117	1,729
Ar_Piv_DPD_MRB	32	525
Ar_Piv_L_MRB	50	555
Ar_Piv_MH_MRB	40	553
Ar_Piv_VL_MRB	50	555
Ar_RR_DPD_MRB	37	593
Ar_RR_L_MRB	57	683
Ar_RR_MH_MRB	43	585
Ar_RR_VL_MRB	56	683
Ar_Dry_DPD_MRB	18	195
Ar_Dry_L_MRB	30	269
Ar_Dry_MH_MRB	23	238
Ar_Dry_VL_MRB	30	269
Dl_BD_DPD_MRB	132	1,373
Dl_BD_L_MRB	168	1,620
Dl_BD_MH_MRB	143	1,620
Dl_BD_VL_MRB	169	1,620
Dl_Piv_DPD_MRB	69	422
Dl_Piv_L_MRB	104	501
Dl_Piv_MH_MRB	76	501

Matrix code	Nitrogen loss v6.5.5 (kg N/yr)	Soil water drainage v6.5.5 (mm/yr)
D1_Piv_VL_MRB	104	501
D1_RR_DPD_MRB	65	421
D1_RR_L_MRB	104	625
D1_RR_MH_MRB	73	502
D1_RR_VL_MRB	104	625
D1_Dry_DPD_MRB	22	186
D1_Dry_L_MRB	43	246
D1_Dry_MH_MRB	30	222
D1_Dry_VL_MRB	43	246
D2_BD_DPD_MRB	132	1,373
D2_BD_L_MRB	168	1,620
D2_BD_MH_MRB	143	1,620
D2_BD_VL_MRB	169	1,620
D2_Piv_DPD_MRB	60	422
D2_Piv_L_MRB	91	501
D2_Piv_MH_MRB	66	501
D2_Piv_VL_MRB	91	501
D2_RR_DPD_MRB	65	421
D2_RR_L_MRB	104	625
D2_RR_MH_MRB	73	502
D2_RR_VL_MRB	104	625
D2_Dry_DPD_MRB	22	186
D2_Dry_L_MRB	43	246
D2_Dry_MH_MRB	30	222
D2_Dry_VL_MRB	43	246
DS_BD_DPD_MRB	116	1,567
DS_BD_L_MRB	141	1,680

Matrix code	Nitrogen loss v6.5.5 (kg N/yr)	Soil water drainage v6.5.5 (mm/yr)
DS_BD_MH_MRB	128	1,673
DS_BD_VL_MRB	141	1,680
DS_Piv_DPD_MRB	58	498
DS_Piv_L_MRB	86	538
DS_Piv_MH_MRB	70	537
DS_Piv_VL_MRB	86	538
DS_RR_DPD_MRB	62	520
DS_RR_L_MRB	94	666
DS_RR_MH_MRB	72	556
DS_RR_VL_MRB	93	666
DS_Dry_DPD_MRB	22	186
DS_Dry_L_MRB	43	246
DS_Dry_MH_MRB	30	222
DS_Dry_VL_MRB	43	246
WIN_BD_DPD_MRB	163	1,706
WIN_BD_L_MRB	195	1,723
WIN_BD_MH_MRB	179	1,711
WIN_BD_VL_MRB	195	1,723
WIN_Piv_DPD_MRB	85	555
WIN_Piv_L_MRB	124	566
WIN_Piv_MH_MRB	102	564
WIN_Piv_VL_MRB	124	566
WIN_RR_DPD_MRB	92	592
WIN_RR_L_MRB	137	697
WIN_RR_MH_MRB	106	596
WIN_RR_VL_MRB	137	697
WIN_Dry_DPD_MRB	31	217

Matrix code	Nitrogen loss v6.5.5 (kg N/yr)	Soil water drainage v6.5.5 (mm/yr)
WIN_Dry_L_MRB	60	266
WIN_Dry_MH_MRB	42	241
WIN_Dry_VL_MRB	60	266
S&B_BD_DPD_MRB	77	1,427
S&B_BD_L_MRB	93	1,635
S&B_BD_MH_MRB	83	1,633
S&B_BD_VL_MRB	93	1,635
S&B_Piv_DPD_MRB	35	443
S&B_Piv_L_MRB	51	509
S&B_Piv_MH_MRB	40	508
S&B_Piv_VL_MRB	51	509
S&B_RR_DPD_MRB	37	447
S&B_RR_L_MRB	56	634
S&B_RR_MH_MRB	42	512
S&B_RR_VL_MRB	56	634
S&B_Dry_DPD_MRB	14	148
S&B_Dry_L_MRB	27	214
S&B_Dry_MH_MRB	19	192
S&B_Dry_VL_MRB	26	214
Ar_BD_DPD_HPZ_gmp	72	612
Ar_BD_L_HPZ_gmp	124	1,097
Ar_BD_MH_HPZ_gmp	115	909
Ar_BD_VL_HPZ_gmp	124	1,097
Ar_Piv_DPD_HPZ_gmp	28	435
Ar_Piv_L_HPZ_gmp	46	494
Ar_Piv_MH_HPZ_gmp	36	478
Ar_Piv_VL_HPZ_gmp	46	494

Matrix code	Nitrogen loss v6.5.5 (kg N/yr)	Soil water drainage v6.5.5 (mm/yr)
Ar_RR_DPD_HPZ_gmp	39	626
Ar_RR_L_HPZ_gmp	57	638
Ar_RR_MH_HPZ_gmp	45	617
Ar_RR_VL_HPZ_gmp	57	638
Ar_Dry_DPD_HPZ_gmp	18	195
Ar_Dry_L_HPZ_gmp	30	269
Ar_Dry_MH_HPZ_gmp	23	238
Ar_Dry_VL_HPZ_gmp	30	269
D1_BD_DPD_HPZ_gmp	49	435
D1_BD_L_HPZ_gmp	140	971
D1_BD_MH_HPZ_gmp	91	784
D1_BD_VL_HPZ_gmp	140	971
D1_Piv_DPD_HPZ_gmp	33	284
D1_Piv_L_HPZ_gmp	74	410
D1_Piv_MH_HPZ_gmp	48	398
D1_Piv_VL_HPZ_gmp	74	410
D1_RR_DPD_HPZ_gmp	50	448
D1_RR_L_HPZ_gmp	86	532
D1_RR_MH_HPZ_gmp	58	486
D1_RR_VL_HPZ_gmp	86	532
D1_Dry_DPD_HPZ_gmp	22	186
D1_Dry_L_HPZ_gmp	43	246
D1_Dry_MH_HPZ_gmp	30	222
D1_Dry_VL_HPZ_gmp	43	246
D2_BD_DPD_HPZ_gmp	49	435
D2_BD_L_HPZ_gmp	140	971
D2_BD_MH_HPZ_gmp	91	784

Matrix code	Nitrogen loss v6.5.5 (kg N/yr)	Soil water drainage v6.5.5 (mm/yr)
D2_BD_VL_HPZ_gmp	140	971
D2_Piv_DPD_HPZ_gmp	27	304
D2_Piv_L_HPZ_gmp	62	410
D2_Piv_MH_HPZ_gmp	40	398
D2_Piv_VL_HPZ_gmp	62	410
D2_RR_DPD_HPZ_gmp	50	448
D2_RR_L_HPZ_gmp	86	532
D2_RR_MH_HPZ_gmp	58	486
D2_RR_VL_HPZ_gmp	86	532
D2_Dry_DPD_HPZ_gmp	22	186
D2_Dry_L_HPZ_gmp	43	246
D2_Dry_MH_HPZ_gmp	30	222
D2_Dry_VL_HPZ_gmp	43	246
DS_BD_DPD_HPZ_gmp	58	536
DS_BD_L_HPZ_gmp	113	1,031
DS_BD_MH_HPZ_gmp	88	848
DS_BD_VL_HPZ_gmp	113	1,031
DS_Piv_DPD_HPZ_gmp	47	390
DS_Piv_L_HPZ_gmp	79	465
DS_Piv_MH_HPZ_gmp	60	451
DS_Piv_VL_HPZ_gmp	79	465
DS_RR_DPD_HPZ_gmp	62	550
DS_RR_L_HPZ_gmp	94	594
DS_RR_MH_HPZ_gmp	72	547
DS_RR_VL_HPZ_gmp	94	594
DS_Dry_DPD_HPZ_gmp	22	186
DS_Dry_L_HPZ_gmp	43	246

Matrix code	Nitrogen loss v6.5.5 (kg N/yr)	Soil water drainage v6.5.5 (mm/yr)
DS_Dry_MH_HPZ_gmp	30	222
DS_Dry_VL_HPZ_gmp	43	246
WIN_BD_DPD_HPZ_gmp	86	608
WIN_BD_L_HPZ_gmp	162	1,074
WIN_BD_MH_HPZ_gmp	132	894
WIN_BD_VL_HPZ_gmp	162	1,074
WIN_Piv_DPD_HPZ_gmp	71	454
WIN_Piv_L_HPZ_gmp	116	507
WIN_Piv_MH_HPZ_gmp	90	490
WIN_Piv_VL_HPZ_gmp	116	507
WIN_RR_DPD_HPZ_gmp	94	625
WIN_RR_L_HPZ_gmp	139	639
WIN_RR_MH_HPZ_gmp	109	591
WIN_RR_VL_HPZ_gmp	139	639
WIN_Dry_DPD_HPZ_gmp	31	217
WIN_Dry_L_HPZ_gmp	60	266
WIN_Dry_MH_HPZ_gmp	42	241
WIN_Dry_VL_HPZ_gmp	60	266
S&B_BD_DPD_HPZ_gmp	33	462
S&B_BD_L_HPZ_gmp	69	985
S&B_BD_MH_HPZ_gmp	51	799
S&B_BD_VL_HPZ_gmp	69	985
S&B_Piv_DPD_HPZ_gmp	23	326
S&B_Piv_L_HPZ_gmp	41	422
S&B_Piv_MH_HPZ_gmp	30	410
S&B_Piv_VL_HPZ_gmp	41	422
S&B_RR_DPD_HPZ_gmp	33	474

Matrix code	Nitrogen loss v6.5.5 (kg N/yr)	Soil water drainage v6.5.5 (mm/yr)
S&B_RR_L_HPZ_gmp	52	546
S&B_RR_MH_HPZ_gmp	38	498
S&B_RR_VL_HPZ_gmp	52	546
S&B_Dry_DPD_HPZ_gmp	14	148
S&B_Dry_L_HPZ_gmp	27	214
S&B_Dry_MH_HPZ_gmp	19	192
S&B_Dry_VL_HPZ_gmp	26	214
Ar_BD_DPD_AM1	98	1,772
Ar_BD_L_AM1	101	1,784
Ar_BD_MH_AM1	102	1,774
Ar_BD_VL_AM1	102	1,784
Ar_Piv_DPD_AM1	18	296
Ar_Piv_L_AM1	31	350
Ar_Piv_MH_AM1	24	341
Ar_Piv_VL_AM1	31	350
Ar_RR_DPD_AM1	22	325
Ar_RR_L_AM1	38	358
Ar_RR_MH_AM1	29	339
Ar_RR_VL_AM1	38	358
Ar_Dry_DPD_AM1	18	195
Ar_Dry_L_AM1	30	269
Ar_Dry_MH_AM1	23	238
Ar_Dry_VL_AM1	30	269
D1_BD_DPD_AM1	79	1,418
D1_BD_L_AM1	105	1,675
D1_BD_MH_AM1	87	1,674
D1_BD_VL_AM1	105	1,675

Matrix code	Nitrogen loss v6.5.5 (kg N/yr)	Soil water drainage v6.5.5 (mm/yr)
D1_Piv_DPD_AM1	25	258
D1_Piv_L_AM1	44	337
D1_Piv_MH_AM1	29	313
D1_Piv_VL_AM1	44	337
D1_RR_DPD_AM1	20	243
D1_RR_L_AM1	33	328
D1_RR_MH_AM1	23	294
D1_RR_VL_AM1	33	328
D1_Dry_DPD_AM1	20	186
D1_Dry_L_AM1	37	246
D1_Dry_MH_AM1	26	222
D1_Dry_VL_AM1	36	246
D2_BD_DPD_AM1	79	1,418
D2_BD_L_AM1	105	1,675
D2_BD_MH_AM1	87	1,674
D2_BD_VL_AM1	105	1,675
D2_Piv_DPD_AM1	26	258
D2_Piv_L_AM1	45	337
D2_Piv_MH_AM1	30	313
D2_Piv_VL_AM1	45	337
D2_RR_DPD_AM1	20	243
D2_RR_L_AM1	33	328
D2_RR_MH_AM1	23	294
D2_RR_VL_AM1	33	328
D2_Dry_DPD_AM1	20	186
D2_Dry_L_AM1	37	246
D2_Dry_MH_AM1	26	222

Matrix code	Nitrogen loss v6.5.5 (kg N/yr)	Soil water drainage v6.5.5 (mm/yr)
D2_Dry_VL_AM1	36	246
DS_BD_DPD_AM1	99	1,617
DS_BD_L_AM1	120	1,735
DS_BD_MH_AM1	108	1,727
DS_BD_VL_AM1	120	1,735
DS_Piv_DPD_AM1	28	294
DS_Piv_L_AM1	52	352
DS_Piv_MH_AM1	38	334
DS_Piv_VL_AM1	52	352
DS_RR_DPD_AM1	27	288
DS_RR_L_AM1	51	356
DS_RR_MH_AM1	36	325
DS_RR_VL_AM1	51	356
DS_Dry_DPD_AM1	20	186
DS_Dry_L_AM1	37	246
DS_Dry_MH_AM1	26	222
DS_Dry_VL_AM1	36	246
WIN_BD_DPD_AM1	139	1,761
WIN_BD_L_AM1	165	1,778
WIN_BD_MH_AM1	151	1,766
WIN_BD_VL_AM1	166	1,778
WIN_Piv_DPD_AM1	38	320
WIN_Piv_L_AM1	72	363
WIN_Piv_MH_AM1	54	349
WIN_Piv_VL_AM1	72	363
WIN_RR_DPD_AM1	37	319
WIN_RR_L_AM1	73	377

Matrix code	Nitrogen loss v6.5.5 (kg N/yr)	Soil water drainage v6.5.5 (mm/yr)
WIN_RR_MH_AM1	51	347
WIN_RR_VL_AM1	73	377
WIN_Dry_DPD_AM1	27	217
WIN_Dry_L_AM1	50	266
WIN_Dry_MH_AM1	35	241
WIN_Dry_VL_AM1	50	266
S&B_BD_DPD_AM1	62	1,473
S&B_BD_L_AM1	76	1,689
S&B_BD_MH_AM1	67	1,686
S&B_BD_VL_AM1	76	1,689
S&B_Piv_DPD_AM1	17	271
S&B_Piv_L_AM1	28	340
S&B_Piv_MH_AM1	20	316
S&B_Piv_VL_AM1	27	340
S&B_RR_DPD_AM1	16	256
S&B_RR_L_AM1	27	333
S&B_RR_MH_AM1	20	301
S&B_RR_VL_AM1	27	333
S&B_Dry_DPD_AM1	11	147
S&B_Dry_L_AM1	21	214
S&B_Dry_MH_AM1	15	191
S&B_Dry_VL_AM1	20	214
Ar_BD_DPD_Fert_GMP	116	1,717
Ar_BD_L_Fert_GMP	117	1,729
Ar_BD_MH_Fert_GMP	119	1,719
Ar_BD_VL_Fert_GMP	117	1,729
Ar_Piv_DPD_Fert_GMP	31	520

Matrix code	Nitrogen loss v6.5.5 (kg N/yr)	Soil water drainage v6.5.5 (mm/yr)
Ar_Piv_L_Fert_GMP	48	550
Ar_Piv_MH_Fert_GMP	39	547
Ar_Piv_VL_Fert_GMP	48	550
Ar_RR_DPD_Fert_GMP	37	587
Ar_RR_L_Fert_GMP	56	676
Ar_RR_MH_Fert_GMP	43	579
Ar_RR_VL_Fert_GMP	56	676
Ar_Dry_DPD_Fert_GMP	18	195
Ar_Dry_L_Fert_GMP	30	269
Ar_Dry_MH_Fert_GMP	23	238
Ar_Dry_VL_Fert_GMP	30	269
D1_BD_DPD_Fert_GMP	125	1,373
D1_BD_L_Fert_GMP	159	1,620
D1_BD_MH_Fert_GMP	135	1,620
D1_BD_VL_Fert_GMP	160	1,620
D1_Piv_DPD_Fert_GMP	66	422
D1_Piv_L_Fert_GMP	100	501
D1_Piv_MH_Fert_GMP	72	501
D1_Piv_VL_Fert_GMP	100	501
D1_RR_DPD_Fert_GMP	65	421
D1_RR_L_Fert_GMP	105	625
D1_RR_MH_Fert_GMP	74	502
D1_RR_VL_Fert_GMP	105	625
D1_Dry_DPD_Fert_GMP	21	186
D1_Dry_L_Fert_GMP	39	246
D1_Dry_MH_Fert_GMP	27	222
D1_Dry_VL_Fert_GMP	39	246

Matrix code	Nitrogen loss v6.5.5 (kg N/yr)	Soil water drainage v6.5.5 (mm/yr)
D2_BD_DPD_Fert_GMP	125	1,373
D2_BD_L_Fert_GMP	159	1,620
D2_BD_MH_Fert_GMP	135	1,620
D2_BD_VL_Fert_GMP	160	1,620
D2_Piv_DPD_Fert_GMP	61	422
D2_Piv_L_Fert_GMP	93	501
D2_Piv_MH_Fert_GMP	67	501
D2_Piv_VL_Fert_GMP	93	501
D2_RR_DPD_Fert_GMP	65	421
D2_RR_L_Fert_GMP	105	625
D2_RR_MH_Fert_GMP	74	502
D2_RR_VL_Fert_GMP	105	625
D2_Dry_DPD_Fert_GMP	21	186
D2_Dry_L_Fert_GMP	39	246
D2_Dry_MH_Fert_GMP	27	222
D2_Dry_VL_Fert_GMP	39	246
DS_BD_DPD_Fert_GMP	110	1,567
DS_BD_L_Fert_GMP	133	1,680
DS_BD_MH_Fert_GMP	121	1,673
DS_BD_VL_Fert_GMP	133	1,680
DS_Piv_DPD_Fert_GMP	55	498
DS_Piv_L_Fert_GMP	82	538
DS_Piv_MH_Fert_GMP	67	537
DS_Piv_VL_Fert_GMP	81	538
DS_RR_DPD_Fert_GMP	59	520
DS_RR_L_Fert_GMP	89	666
DS_RR_MH_Fert_GMP	68	556

Matrix code	Nitrogen loss v6.5.5 (kg N/yr)	Soil water drainage v6.5.5 (mm/yr)
DS_RR_VL_Fert_GMP	89	666
DS_Dry_DPD_Fert_GMP	21	186
DS_Dry_L_Fert_GMP	39	246
DS_Dry_MH_Fert_GMP	27	222
DS_Dry_VL_Fert_GMP	39	246
WIN_BD_DPD_Fert_GMP	153	1,706
WIN_BD_L_Fert_GMP	182	1,723
WIN_BD_MH_Fert_GMP	167	1,711
WIN_BD_VL_Fert_GMP	182	1,723
WIN_Piv_DPD_Fert_GMP	80	555
WIN_Piv_L_Fert_GMP	117	566
WIN_Piv_MH_Fert_GMP	97	564
WIN_Piv_VL_Fert_GMP	116	566
WIN_RR_DPD_Fert_GMP	86	592
WIN_RR_L_Fert_GMP	129	697
WIN_RR_MH_Fert_GMP	100	596
WIN_RR_VL_Fert_GMP	129	697
WIN_Dry_DPD_Fert_GMP	28	217
WIN_Dry_L_Fert_GMP	54	266
WIN_Dry_MH_Fert_GMP	38	241
WIN_Dry_VL_Fert_GMP	54	266
S&B_BD_DPD_Fert_GMP	77	1,427
S&B_BD_L_Fert_GMP	93	1,635
S&B_BD_MH_Fert_GMP	83	1,633
S&B_BD_VL_Fert_GMP	93	1,635
S&B_Piv_DPD_Fert_GMP	35	443
S&B_Piv_L_Fert_GMP	51	509

Matrix code	Nitrogen loss v6.5.5 (kg N/yr)	Soil water drainage v6.5.5 (mm/yr)
S&B_Piv_MH_Fert_GMP	40	508
S&B_Piv_VL_Fert_GMP	51	509
S&B_RR_DPD_Fert_GMP	37	447
S&B_RR_L_Fert_GMP	56	634
S&B_RR_MH_Fert_GMP	42	512
S&B_RR_VL_Fert_GMP	56	634
S&B_Dry_DPD_Fert_GMP	14	148
S&B_Dry_L_Fert_GMP	27	214
S&B_Dry_MH_Fert_GMP	19	192
S&B_Dry_VL_Fert_GMP	26	214
Ar_BD_DPD_Irr_GMP	112	1,772
Ar_BD_L_Irr_GMP	112	1,784
Ar_BD_MH_Irr_GMP	115	1,774
Ar_BD_VL_Irr_GMP	112	1,784
Ar_Piv_DPD_Irr_GMP	20	248
Ar_Piv_L_Irr_GMP	36	319
Ar_Piv_MH_Irr_GMP	26	285
Ar_Piv_VL_Irr_GMP	35	301
Ar_RR_DPD_Irr_GMP	20	272
Ar_RR_L_Irr_GMP	36	336
Ar_RR_MH_Irr_GMP	26	293
Ar_RR_VL_Irr_GMP	35	328
Ar_Dry_DPD_Irr_GMP	18	195
Ar_Dry_L_Irr_GMP	30	269
Ar_Dry_MH_Irr_GMP	23	238
Ar_Dry_VL_Irr_GMP	30	269
D1_BD_DPD_Irr_GMP	130	1,418

Matrix code	Nitrogen loss v6.5.5 (kg N/yr)	Soil water drainage v6.5.5 (mm/yr)
D1_BD_L_Irr_GMP	171	1,675
D1_BD_MH_Irr_GMP	143	1,674
D1_BD_VL_Irr_GMP	172	1,675
D1_Piv_DPD_Irr_GMP	32	195
D1_Piv_L_Irr_GMP	54	297
D1_Piv_MH_Irr_GMP	35	231
D1_Piv_VL_Irr_GMP	50	265
D1_RR_DPD_Irr_GMP	27	213
D1_RR_L_Irr_GMP	46	299
D1_RR_MH_Irr_GMP	31	274
D1_RR_VL_Irr_GMP	43	284
D1_Dry_DPD_Irr_GMP	22	186
D1_Dry_L_Irr_GMP	43	246
D1_Dry_MH_Irr_GMP	30	222
D1_Dry_VL_Irr_GMP	43	246
D2_BD_DPD_Irr_GMP	130	1,418
D2_BD_L_Irr_GMP	171	1,675
D2_BD_MH_Irr_GMP	143	1,674
D2_BD_VL_Irr_GMP	172	1,675
D2_Piv_DPD_Irr_GMP	25	195
D2_Piv_L_Irr_GMP	44	297
D2_Piv_MH_Irr_GMP	28	231
D2_Piv_VL_Irr_GMP	41	265
D2_RR_DPD_Irr_GMP	27	213
D2_RR_L_Irr_GMP	46	299
D2_RR_MH_Irr_GMP	31	274
D2_RR_VL_Irr_GMP	43	284

Matrix code	Nitrogen loss v6.5.5 (kg N/yr)	Soil water drainage v6.5.5 (mm/yr)
D2_Dry_DPD_Irr_GMP	22	186
D2_Dry_L_Irr_GMP	43	246
D2_Dry_MH_Irr_GMP	30	222
D2_Dry_VL_Irr_GMP	43	246
DS_BD_DPD_Irr_GMP	112	1,617
DS_BD_L_Irr_GMP	137	1,735
DS_BD_MH_Irr_GMP	123	1,727
DS_BD_VL_Irr_GMP	137	1,735
DS_Piv_DPD_Irr_GMP	32	232
DS_Piv_L_Irr_GMP	58	314
DS_Piv_MH_Irr_GMP	40	261
DS_Piv_VL_Irr_GMP	55	292
DS_RR_DPD_Irr_GMP	33	255
DS_RR_L_Irr_GMP	59	323
DS_RR_MH_Irr_GMP	42	291
DS_RR_VL_Irr_GMP	58	311
DS_Dry_DPD_Irr_GMP	22	186
DS_Dry_L_Irr_GMP	43	246
DS_Dry_MH_Irr_GMP	30	222
DS_Dry_VL_Irr_GMP	43	246
WIN_BD_DPD_Irr_GMP	160	1,761
WIN_BD_L_Irr_GMP	191	1,778
WIN_BD_MH_Irr_GMP	175	1,766
WIN_BD_VL_Irr_GMP	191	1,778
WIN_Piv_DPD_Irr_GMP	45	260
WIN_Piv_L_Irr_GMP	83	327
WIN_Piv_MH_Irr_GMP	59	284

Matrix code	Nitrogen loss v6.5.5 (kg N/yr)	Soil water drainage v6.5.5 (mm/yr)
WIN_Piv_VL_Irr_GMP	79	311
WIN_RR_DPD_Irr_GMP	48	286
WIN_RR_L_Irr_GMP	87	340
WIN_RR_MH_Irr_GMP	62	304
WIN_RR_VL_Irr_GMP	87	331
WIN_Dry_DPD_Irr_GMP	31	217
WIN_Dry_L_Irr_GMP	60	266
WIN_Dry_MH_Irr_GMP	42	241
WIN_Dry_VL_Irr_GMP	60	266
S&B_BD_DPD_Irr_GMP	73	1,473
S&B_BD_L_Irr_GMP	89	1,689
S&B_BD_MH_Irr_GMP	79	1,687
S&B_BD_VL_Irr_GMP	89	1,689
S&B_Piv_DPD_Irr_GMP	16	202
S&B_Piv_L_Irr_GMP	30	303
S&B_Piv_MH_Irr_GMP	19	236
S&B_Piv_VL_Irr_GMP	28	273
S&B_RR_DPD_Irr_GMP	17	221
S&B_RR_L_Irr_GMP	30	305
S&B_RR_MH_Irr_GMP	21	275
S&B_RR_VL_Irr_GMP	29	290
S&B_Dry_DPD_Irr_GMP	14	148
S&B_Dry_L_Irr_GMP	27	214
S&B_Dry_MH_Irr_GMP	19	192
S&B_Dry_VL_Irr_GMP	26	214
Ar_BD_DPD_GMP	112	1,772
Ar_BD_L_GMP	112	1,784

Matrix code	Nitrogen loss v6.5.5 (kg N/yr)	Soil water drainage v6.5.5 (mm/yr)
Ar_BD_MH_GMP	115	1,774
Ar_BD_VL_GMP	112	1,784
Ar_Piv_DPD_GMP	20	248
Ar_Piv_L_GMP	36	319
Ar_Piv_MH_GMP	26	285
Ar_Piv_VL_GMP	35	301
Ar_RR_DPD_GMP	20	272
Ar_RR_L_GMP	36	336
Ar_RR_MH_GMP	26	293
Ar_RR_VL_GMP	35	328
Ar_Dry_DPD_GMP	18	195
Ar_Dry_L_GMP	30	269
Ar_Dry_MH_GMP	23	238
Ar_Dry_VL_GMP	30	269
D1_BD_DPD_GMP	123	1,418
D1_BD_L_GMP	161	1,675
D1_BD_MH_GMP	135	1,674
D1_BD_VL_GMP	162	1,675
D1_Piv_DPD_GMP	30	195
D1_Piv_L_GMP	51	297
D1_Piv_MH_GMP	33	231
D1_Piv_VL_GMP	47	265
D1_RR_DPD_GMP	28	213
D1_RR_L_GMP	47	299
D1_RR_MH_GMP	31	274
D1_RR_VL_GMP	45	284
D1_Dry_DPD_GMP	21	186

Matrix code	Nitrogen loss v6.5.5 (kg N/yr)	Soil water drainage v6.5.5 (mm/yr)
D1_Dry_L_GMP	39	246
D1_Dry_MH_GMP	27	222
D1_Dry_VL_GMP	39	246
D2_BD_DPD_GMP	123	1,418
D2_BD_L_GMP	161	1,675
D2_BD_MH_GMP	135	1,674
D2_BD_VL_GMP	162	1,675
D2_Piv_DPD_GMP	27	195
D2_Piv_L_GMP	46	297
D2_Piv_MH_GMP	29	231
D2_Piv_VL_GMP	43	265
D2_RR_DPD_GMP	28	213
D2_RR_L_GMP	47	299
D2_RR_MH_GMP	31	274
D2_RR_VL_GMP	45	284
D2_Dry_DPD_GMP	21	186
D2_Dry_L_GMP	39	246
D2_Dry_MH_GMP	27	222
D2_Dry_VL_GMP	39	246
DS_BD_DPD_GMP	106	1,617
DS_BD_L_GMP	129	1,735
DS_BD_MH_GMP	116	1,727
DS_BD_VL_GMP	129	1,735
DS_Piv_DPD_GMP	30	232
DS_Piv_L_GMP	55	314
DS_Piv_MH_GMP	38	261
DS_Piv_VL_GMP	52	292

Matrix code	Nitrogen loss v6.5.5 (kg N/yr)	Soil water drainage v6.5.5 (mm/yr)
DS_RR_DPD_GMP	31	255
DS_RR_L_GMP	56	323
DS_RR_MH_GMP	40	291
DS_RR_VL_GMP	55	311
DS_Dry_DPD_GMP	21	186
DS_Dry_L_GMP	39	246
DS_Dry_MH_GMP	27	222
DS_Dry_VL_GMP	39	246
WIN_BD_DPD_GMP	149	1,761
WIN_BD_L_GMP	177	1,778
WIN_BD_MH_GMP	163	1,766
WIN_BD_VL_GMP	177	1,778
WIN_Piv_DPD_GMP	42	260
WIN_Piv_L_GMP	79	327
WIN_Piv_MH_GMP	55	284
WIN_Piv_VL_GMP	74	311
WIN_RR_DPD_GMP	45	286
WIN_RR_L_GMP	82	340
WIN_RR_MH_GMP	58	304
WIN_RR_VL_GMP	81	331
WIN_Dry_DPD_GMP	28	217
WIN_Dry_L_GMP	54	266
WIN_Dry_MH_GMP	38	241
WIN_Dry_VL_GMP	54	266
S&B_BD_DPD_GMP	73	1,473
S&B_BD_L_GMP	89	1,689
S&B_BD_MH_GMP	79	1,687

Matrix code	Nitrogen loss v6.5.5 (kg N/yr)	Soil water drainage v6.5.5 (mm/yr)
S&B_BD_VL_GMP	89	1,689
S&B_Piv_DPD_GMP	16	202
S&B_Piv_L_GMP	30	303
S&B_Piv_MH_GMP	19	236
S&B_Piv_VL_GMP	28	273
S&B_RR_DPD_GMP	17	221
S&B_RR_L_GMP	30	305
S&B_RR_MH_GMP	21	275
S&B_RR_VL_GMP	29	290
S&B_Dry_DPD_GMP	14	148
S&B_Dry_L_GMP	27	214
S&B_Dry_MH_GMP	19	192
S&B_Dry_VL_GMP	26	214

APPENDIX D –THE MATRIX CALIBRATION 2024 (WSP LIMITED)



Memorandum

To	Eva Harris, Mel Brooks, Rebecca Whillans
Copy	Rex Corlett, Aimee Dawson, Sarah Everest, Nicole Matheson
From	Glen Treweek
Office	Christchurch
Date	13 November 2024
File/Ref	3-9C742.00
Subject	2024 Matrix calibration

Rationale

Ashburton Lyndhurst Irrigation Ltd. (ALIL) holds (or held) resource consent CRC185469, Barrhill Chertsey Irrigation Ltd. (BCI) holds resource consents CRC184159 and CRC211511, and MHV Water Ltd. (MHV) holds resource consent CRC185857 to discharge onto or into land contaminants from farming activities.

These resource consents allow the consent holders to calculate aggregated nitrogen losses using The Matrix method. The Matrix method uses a combination of farm system, irrigation, soil, and farm management practice information to generate a representative nitrogen loss estimate for catchments (or parts of catchments) using nitrogen loss values from representative Overseer files.

The Matrix was approved as equivalent to Overseer in April 2020 by the Chief Executive of the Canterbury Regional Council. ALIL, BCI, and MHV are required to calibrate The Matrix against Overseer nutrient budgets every 4 years.

ALIL, BCI, and MHV, engaged WSP New Zealand to collate results from calibration exercises carried out by each irrigation scheme.

Methodology & Results

The accepted calibration methodology, as presented by BCI on behalf of the other schemes (ALIL & MHV), is as follows:

Validation

The validation of The Matrix shall be completed once every four (4) years using a randomised sample of properties. The minimum sample size will ensure 95% confidence of a result within 10% of the true value. As of 2020, this would equate to 90 properties.

The properties selected will be representative of farming activities within the Mid Canterbury area. They will each complete a Year-End Overseer nutrient budget, using a suitably qualified professional in accordance with the most recent OverseerFM User Guide, or equivalent document. All nitrogen losses will be aggregated using the same version of Overseer.

A Matrix assessment will be completed for the same sample properties using the most recent land use and irrigation maps and FEP Audit results. The Matrix load will be calculated with the same version of Overseer as the representative sample of nutrient budgets.

An acceptable threshold of aggregated nitrogen losses (calculated as kg N/year) as calculated using The Matrix shall be within +/- 10% of the aggregated nitrogen losses as calculated using OverseerFM.

Each irrigation scheme (ALIL, BCI, and MHV) arranged for representative nutrient budgets to be prepared using Overseer v6.5.5 for a random selection of farms within their command area. Nitrogen losses for the selected farms were also calculated using The Matrix method. Those nitrogen loss values were provided to WSP.

WSP have not verified the information presented by ALIL, BCI, or MHV, however, the schemes have advised that the requirements of the calibration methodology have been satisfied. The total number of farms used in the calibration exercise was 96 (Table 1), which is a sufficient sample size to meet the criteria to ensure 95% confidence.

The farms selected for review covered about 23,000 ha (Table 1), or approximately 15% of the combined schemes' command area. There was a 54 ha difference in the area used for calibration between The Matrix method and nutrient budgets from the Overseer model (Table 1). The difference in area amounted to 0.2% of the total area, and is within the bounds of the methodology of The Matrix and Overseer models.

Table 1: Summary of farm area used by each irrigation scheme during The Matrix calibration in 2024.

	Number of farms	Matrix area (ha)	NB area (ha)	Difference (ha)	Percentage difference
ALIL	25	4,613	4,582	31	0.7%
BCI	35	10,361	10,337	24	0.2%
MHV	36	8,240	8,241	-1	0.0%
Total	96	23,214	23,160	54	0.2%

The total nitrogen loss for the combined total area in Table 1, calculated by The Matrix, was 1,068,290 kg N/yr, and calculated using the Overseer model, was 981,402 kg N/yr. The difference in N loss between the two methods was 86,888 kg N/yr, or 8.1% (Table 2).

The nitrogen loss for the selected farms calculated using The Matrix method was within +/- 10% of the nitrogen loss for those same farms using Overseer (Table 2), therefore The Matrix can continue to be considered equivalent to Overseer for the purposes of complying with resource consents CRC185469, CRC184159, CRC211511, and CRC185857.

Table 2: Summary of Matrix nitrogen loss, Overseer nutrient budget (NB) nitrogen loss, and calibration results for each irrigation scheme in 2024.

	Matrix N loss (kg N/yr)	NB N loss (kg N/yr)	Difference (kg N/yr)	Percentage difference
ALIL	209,437	193,379	16,058	7.7%
BCI	435,339	400,955	34,384	7.9%
MHV	423,514	387,068	36,446	8.6%
Total	1,068,290	981,402	86,888	8.1%

Disclaimers and Limitations

This memorandum ('Memo') has been prepared by WSP exclusively for Ashburton Lyndhurst Irrigation Ltd, Barrhill Chertsey Irrigation Ltd, and MHV Water Ltd ('Client') in relation to calibrating The Matrix as required by resource consents held by the Client ('Purpose') and in accordance with the Short form Agreements with the Client and relevant project change notices (project number 3-9C742). The findings in this Memo are based on and are subject to the assumptions specified in the Memo, and the Contract. WSP accepts no liability whatsoever for any reliance on or use of this Memo, in whole or in part, for any use or purpose other than the Purpose or any use or reliance on the Memo by any third party.

In preparing the nitrogen discharge allocation calculation, WSP has relied upon information provided by Ashburton Lyndhurst Irrigation Ltd, Barrhill Chertsey Irrigation Ltd, and MHV Water Ltd ('Client Data'). Except as otherwise stated in the Memo, WSP has not verified the accuracy or completeness of the Information or the Client Data. WSP will not be liable in relation to incorrect conclusions or findings in the Memo should any Client Data be incorrect, or has been concealed, withheld, misrepresented or otherwise not fully disclosed to WSP.

APPENDIX E – 2023-2024 EMS REVIEW REPORT (WM ENVIRONMENTAL LTD)



Enviro Collective

BCI EMS Audit 2024

21 November 2024

Document Control Register

Document Title:	BCI EMS Audit 2024
Client:	Eva Harris – Principal Environmental Advisor/Director Enviro Collective
Version:	1
Issue Date:	21 November 2024
Document Prepared by:	Emily Macdonald Senior Environmental Consultant
Peer Review Completed by:	Laura Burgess Operations Manager

Report Limitations:

Information utilised in the preparation of this report includes that obtained from Enviro Collective.

This report has been prepared by WM Environmental on the specific instructions of Enviro Collective to use as a basis for BCI EMS Audit. If this report is used for a different purpose or if it is used or relied on by any person other than Enviro Collective, reliance will be solely at their own risk.

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1 Summary

Barrhill Chertsey Irrigation Limited (BCI) hold resource consents CRC184159 and CRC211511, to manage the effects of farming activities. The consents require an Environmental Management Strategy (EMS) and that the EMS is routinely reviewed by a suitably qualified and independent expert.

The 2024 review was made up of an assessment against the implementation of one third of the EMS requirements, an audit to ensure changes to The Matrix inputs is in accordance with the EMS, and the extent to which Advanced Mitigation is being achieved.

For the one third EMS review, the Farm Environment Plan (FEP) policy documents and the non-complying shareholder policy documents were reviewed.

It should be noted that Enviro Collective have considered all 2023 recommendations, and progressed many of them such as updating the FEP template, and have also made various other improvements to the EMS such as developing a new non-complying shareholder flow chart, implementing a new method for tracking non-complying shareholders in sharepoint, and have implemented a new process which has improved FEP auditor adherence to required FEP audit report timeframes. Enviro Collective are also in the process of updating other EMS documents and will defer minor updates to the EMS documentation until larger more substantial updates are needed. As such, the 2024 review aimed not to provide recommendations that are already in the process of being addressed.

It was found that the policy documents reviewed aligned well with the consent conditions and the EMS objectives and only minor improvement recommendations are provided in the below report, mainly to improve clarity of the processes.

2024 examples of implementation of these policies were assessed, such as FEPs, FEP audit reports, non-complying shareholder records, and annual reports. The records reviewed followed the documented processes however there was limited information available to fully assess implementation of the shareholder follow up process, such as dates of the shareholder one-on-ones or dates of FEP updates.

The process for updating property farm systems, irrigation, and management standards GIS layers, and how these changes are pulled through into The Matrix was reviewed and found to be robust, and the data that was checked appeared to align. It is recommended to consider alternative methods for communicating changes to property data, to ensure nothing is missed. At the time of writing this report, WSP consulting (on behalf of Enviro Collective) were in the process of completing internal data spot checks, which will ensure that any potential issues with The Matrix input file update process are identified and resolved.

The updates to the Matrix nutrient budget reference files to the most recent version of OVERSEER® were summarised in a report by WSP consulting. A request for approval from ECan for the file modifications required to generate a viable analysis in OVERSEER® V6.5.5 was completed as required, however ECan had not yet responded to the request. There were no recommendations for improvement to this process.

Advanced Mitigation has already been achieved by 17% of farms, which exceeds the target due in January 2025. 25% of the farms audited in 2024 achieved Advanced Mitigation. This review was completed by Enviro Collective.

In summary, the BCI EMS is comprehensive, the scheme is well on the way to meeting the EMS objectives, processes are being followed as documented, and continuous improvement is evident.

2 Introduction and Purpose

Barrhill Chertsey Irrigation Limited (BCI) are consented to take water from the Rakaia River, of which a portion is leased to the Acton Farmers Irrigation Co-Operative (AFIC). Nutrients discharged to groundwater from BCI and AFIC shareholders are permitted by resource consents CRC184159 and CRC211511, to manage the effects of farming activities.

CRC184159 covers an area within the Land and Water Regional Plan's (LWRP) Plan Change 2 (PC2) area, south of the South Branch of the Ashburton River through to the Rangitata River, and CRC211511 covers an area between the PC2 boundary north to the Rakaia River, which is within the LWRP's Plan Change 5 (PC5) area.

Resource consents CRC184159 and CRC211511 require that an Environmental Management Strategy (EMS) be developed and implemented, with the requirements of the EMS specified by Conditions 12-14 of CRC184159, and 11-13 of CRC211511.

The consents also require that the EMS is routinely reviewed by a suitably qualified and independent expert, with the requirements of the review specified by Condition 16(a) of CRC184159, and 15(a) of CRC211511, and summarised as follows:

1. A review of at least one third of the EMS each year (rotated annually to ensure the full EMS is reviewed at least every three years), with a full review due on the sixth anniversary of the commencement of the Resource consents. The purpose of the review is to identify and discuss implementation of the EMS, and any improvements that may be able to be made to better achieve the objectives;
2. An annual review of any changes made to the use of the property irrigation, land use, and management standards as applied through the Matrix Method when calculating the scheme nitrogen losses;
3. An annual review of the process undertaken to update any changes made to the nutrient budget reference files used to calculate scheme nitrogen load limits and losses into the most recent version of OVERSEER®, and;
4. An annual review of the extent to which Advanced Mitigation is being achieved, for land managed under CRC211511.

The purpose of this report is to document the findings of the annual independent EMS review, which covers points 1-4 above. Point 4 review was completed by Enviro Collective and information is contained in the BCI AFIC End of Auditing Season Report 2023-24.

3 EMS Review

Overview

The purpose of the EMS review is to identify and discuss implementation of the EMS, and any improvements that may be able to be made to better achieve the objectives.

The EMS was reviewed as a whole in 2023, which was the second anniversary of the commencement of Resource Consents CRC184159 and CRC211511. The 2024 review requires a review of one third of the EMS. We have considered one third of the EMS to be one third of the EMS documents, including supporting documents. Table 1 provides a plan for the EMS review cycle for 2024, and the coming years.

Table 1: EMS review cycle overview

Year	Consent requirement	General topics for review	Documents included in the review
2023	2 nd Anniversary – whole EMS	Whole EMS – all topics	Whole EMS – all documents that make up the overall EMS
2024	One third of the EMS	- Farm Environment Plans - Non-complying Shareholders	- EMSFEP-001 Farm Environment Plan (FEP) Process - EMSFEP-002 FEP Audit Process - EMSFEP-003 FEP Audit Follow up - EMSPOL-002 Non-Complying Shareholder Policy
2025	One third of the EMS	- Nutrient Management - Farm Activity Variation Applications - Land joining or leaving the scheme - The Matrix	- EMSPOL-001 Nutrient Management Policy - EMSNM-002 Farm Activity Variation Application Process - EMSNM-003 Properties joining or leaving the scheme - EMSNM-004 Matrix – Nutrient Accounting
2026	One third of the EMS	- Advanced Mitigation - Environmental Monitoring - Sensitive Receptors - Environmental Management Strategy	- EMSNM-005 Advanced Mitigation - EMP Environmental Monitoring Plan - EMSSR-001 Sensitive Receptors – Community Drinking Water Protection Zones - EMSSR-002 Sensitive Receptors - Environmental Management Strategy document
2027	6 th Anniversary – whole EMS	Whole EMS – all topics	Whole EMS – all documents that make up the overall EMS

Review Process

To achieve the purpose of the review, each process or document that makes up the EMS was assessed to determine:

- The extent to which the process or document meets the consent requirements
- The extent to which the process or document facilitates the achievement of the EMS objectives
- The extent to which the documented process is being followed in practice

- Any recommendations for improvement to the process, documentation, or adherence to these in practice, to better achieve the EMS objectives

Findings

The extent to which the EMS meets the consent requirements

Document	Relevant Consent Conditions (summarised)	Discussion	Recommendations for Improvement to the document
EMSFEP-001 Farm Environment Plan (FEP) Process	CRC184159 12(b) & CRC211511 11(b) - Implement environmental objectives and targets for all applicable Properties to ensure: i. resource consents CRC184159 and CRC211511 are complied with; ii. Properties implement GMP or HPZ gmp, as may apply iii. the specified further reductions to achieve nitrogen loss reductions over time or sufficient properties implement Advanced Mitigation; and iv. Properties required to hold a Farm Environment Plan are achieving or working towards the achievement of an 'A' Audit or Advanced Mitigation within a reasonable timeframe. CRC184159 12(d) & CRC211511 11(e) - Effects on neighbouring sensitive receptors are identified in the FEP, and avoided, remedied or mitigated. CRC184159 13(b) & CRC211511 12(b) - The EMS shall provide for or require the management of nutrient loss on applicable Properties through a Farm Environment Plan or Certified Freshwater Farm Plan (as might apply) and audit process in accordance with the conditions of this resource consent. CRC184159 18(a) & CRC211511 17(a)	Section 2 Purpose lists the applicable consent conditions that the FEP must comply with. Guidance is provided on which type of property require an FEP, such as Authorised Properties and Approved Environmental Programmes, and how to identify an "independently managed operating unit". Reference is made to EIPFEP-002 Risk Assessment. Document is currently under review. Section 5.7 describes management of sensitive receptors, including Community Drinking Water Protection Zones (CDWPZ). Reference is made to EIPFEP – 003 FEP Mapping. Document is currently under review. There is limited information provided on how the FEP will support the environmental objectives and targets, or how it will be used to manage nutrient	Include more specific information on how the FEP will support achievement of the environmental objectives. Include links to other related documents such as EMSNM-005 Advanced Mitigation, EMSSR-001 Sensitive Receptors – Community Drinking Water Protection Zones, EMSSR-002 Sensitive Receptors, and EMSFEP-002 FEP Audit Process. Specify who is permitted to develop the FEP (i.e. fill in the template) and if they require particular expertise or training. Also specify if the FEP requires approval.

Document	Relevant Consent Conditions (summarised)	Discussion	Recommendations for Improvement to the document
	- An FEP must be maintained for all applicable properties where farming activities are undertaken. CRC211511 18 - In implementing Condition 17(a), a property shall be deemed to be operating at Advanced Mitigation when it is achieving the requirements in Table CRC211511-1. CRC184159 21(e) & CRC211511 21(e) - As a part of the Farm Environment Plan (or other applicable plan), for any Property located within the CDWPZ, there shall be additional requirements: i. to include an objective that seeks to ensure land located within the CDWPZ is managed to prevent deterioration of drinking water from activities occurring on that land; and ii. for the Property Owner to maintain records to demonstrate all agreed minimum actions are being implemented;	loss, other than reference to the FEP template. There is nothing specific about who can develop the FEP, only about who should be involved in the FEP updates.	
EMSFEP-002 FEP Audit Process	CRC184159 12(c) & CRC211511 11(d) - Robust audit and reporting procedures in place, that meet the CRC FEP Audit Manual requirements, to ensure a high level of compliance with FEPs and Schedule 24a Plans (as might apply). CRC184159 13(d) - FEP audit records must be kept and made available for CRC to inspect on request	The FEP Audit Process document Section 2 lists the applicable Resource Consent conditions that the FEP audits must comply with. Section 3.1 lists all the requirements of the FEP auditor, including that they must be ECan certified, and understand BCI policies, objectives, and EMS.	Include in the FEP Audit Frequency flow chart, all the conditions where a change to the frequency of audit may be required (e.g. where the risk level of a property in a CDWPZ zone increases, or where an approved exemption may be granted). Fix the Figure 2 reference in Section 3.7, currently showing an error.

Document	Relevant Consent Conditions (summarised)	Discussion	Recommendations for Improvement to the document
	- Procedures must be in place to enable FEPs to be amended to address recommendations following a Remediation and Response Plan. CRC211511 12(d) - Properties (as per 4(a) and (b)) shall be audited and the EMS must specify the steps that should be taken where properties are not meeting Advanced Mitigation targets (including consequences to ensure future compliance). - FEP audit records must be kept and made available for CRC to inspect on request, and procedures must be in place to enable FEPs to be amended to address recommendations following a Remediation and Response Plan. CRC184159 19 & CRC211511 19 - All FEPs shall be audited within the frequency described in the table in (a) or alternative frequency where conditions b, c, d or e are met. CRC184159 20 & CRC211511 20 - FEP audits shall be conducted in accordance with the 'Certified Farm Environment Plan Auditor Manual', May 2020, or such other methodology as approved by CRC. - The consent holder shall facilitate CRC undertaking spot checks of any FEP auditors, by providing audit reports and supporting documents.	The flow chart and description in Section 3.2 explains how it is identified if a property requires an FEP audit during the season. Section 3.4 lists the conditions where an approved exemption may be obtained from CRC. Both of these sections combined meet the requirements of Condition 19. It may be useful to extend the flow chart to include all conditions where an FEP would be required (such as a CDWPZ risk change), rather than only based on the previous grade, or a "Change in Management or Farm System". Section 3.7 has an error where the Figure 2 reference should be provided within the paragraph. Section 3.7 and 3.8 provide reference to the 'Certified Farm Environment Plan Auditor Manual', May 2020, as required the consent. Section 3.8 – there is no definition provided for abbreviation "LOC" within the procedure. Section 4.2 describes the requirement for all audit documents to be made available to CRC on request, which	Provide definition for abbreviation "LOC" in Section 3.8.

Document	Relevant Consent Conditions (summarised)	Discussion	Recommendations for Improvement to the document
		meets the various related consent conditions.	
EMSFE-003 FEP Audit Follow up	CRC184159 12(c) & CRC211511 11(d) - Robust audit and reporting procedures in place, that meet the CRC FEP Audit Manual requirements, to ensure a high level of compliance with FEPs and Schedule 24a Plans (as might apply). CRC183159 13(c) & CRC211511 12(d) - Properties provided for in Conditions 4(a) and (b) shall: ii. be subject to an audit procedure in accordance with Condition 19 and 20 (with the EMS being required to specify the steps that will be taken, including consequences to ensure future compliance, for Properties where condition 4(a)(iii) applies and is not being met). - FEP audit records must be kept and made available for CRC to inspect on request, and procedures must be in place to enable FEPs to be amended to address recommendations following a Remediation and Response Plan.	The document details the process taken when the FEP audit grade does not meet the EMS requirements. A flow chart is provided to describe the frequency for tracking action plans as an outcome of an FEP audit, depending on the grade received, however the process for amending FEPs to address recommendations following an audit is not clear.	More clearly describe in Section 5 of the document how the recommendations and improvement actions are incorporated into the FEPs, and when it will be completed.
EMSPOL-002 Non-Complying Shareholder Policy	CRC184159 12(c) & CRC211511 11(d) Robust audit and reporting procedures in place, that meet the CRC FEP Audit Manual requirements, to ensure a high level of	The Non-Complying Shareholder Policy describes the process followed for different levels of breach, from verbal warning (Level 1) to surrender of shares (Level 7). There is minimal guidance	When it has been completed, include in the policy (or provide a link to) the flow chart for providing guidance on determining the appropriate

Document	Relevant Consent Conditions (summarised)	Discussion	Recommendations for Improvement to the document
	compliance with FEPs and Schedule 24a Plans (as might apply). CRC184159 13(c) & CRC211511 12(d) Properties (as per 4(a) and (b)) shall be audited and the EMS must specify the steps that should be taken (including consequences to ensure future compliance) where properties are not meeting N loss reductions (CRC184159) or Advanced Mitigation targets (CRC211511).	provided in the Policy about how to determine the level of breach based on what the breach was, other than staging that repeated minor breaches may raise the level of the breach. Enviro Collective are in the process of developing a new flow chart for BCI to provide additional guidance on the non-complying shareholder policy.	consequence based on the type of non-compliance.

The extent to which the EMS facilitates the achievement of the EMS objectives

Document	EMS Objectives	Discussion	Recommendations for Improvement
EMSFEP-001 Farm Environment Plan (FEP) Process	Objectives of the EMS: - Resource Consents CRC184159 and CRC211511 are complied with - Properties implement HPZ gmp or GMP - Properties achieve nitrogen loss or Advanced Mitigation targets - Properties required to hold a Farm Environment Plan are achieving or working towards the achievement of an A audit or Advanced Mitigation. Objectives of the implementation of the EMS: - Improve long term water quality trends in the catchment	The FEP process, FEP Audit process, and FEP Audit Follow up process all generally facilitate the achievement of the EMS objectives, and the objectives of the implementation of the EMS. There could be more emphasis within the documents to connect the FEPs and FEP audits with the achievement the objectives of the implementation of the EMS, such as how they contribute to improving long term water quality trends or mitigate adverse impacts on sensitive receptors. This may further engage Shareholders in the process if	Consider how the FEP processes can further facilitate continuous improvement by engaging Shareholders.
EMSFEP-002 FEP Audit Process			
EMSFEP-003 FEP Audit Follow up			

Document	EMS Objectives	Discussion	Recommendations for Improvement
	2. All BCI Shareholders are actively engaged with the cycle of continuous improvement to achieve Advanced Mitigation 3. Shareholders are supported to ensure farming activities are actively managed to avoid, remedy, or mitigate adverse impacts on sensitive environments and receptors.	they can fully understand the connection.	
EMSPOL-002 Non-Complying Shareholder Policy		There is minimal guidance provided in the Policy about how the level of breach is determined. This could reduce engagement with Shareholders (especially non-complying Shareholders) as the consequences of not meeting compliance or required targets are not clear. Enviro Collective are in the process of developing a new flow chart for BCI to provide additional guidance on the non-complying shareholder policy.	When it has been completed, communicate with the Shareholders the flow chart for providing guidance on determining the appropriate consequence based on the type of non-compliance. This increase in transparency may promote engagement with the Shareholders.

The extent to which the EMS is being followed in practice

Documents	Documents and Records reviewed	Discussion	Recommendations for Improvement
• EMSFEP-001 FEP Process • EMSFEP-002 FEP Audit Process • EMSFEP-003 FEP Audit Follow up • EMSPOL-002 Non-Complying Shareholder Policy	• AFIC FEP Register 2024 • BCI FEP Register 2024 • 2023-24 BCI AFIC Audits List • FEPs and FEP Audit Reports for 8025, 9060, 9047, 8013 and 9021 • Updated FEP template and examples 9004 Bradley Fields FEP 2024 and 9110 Valetta Pastures FEP 2024 • Non-Complying shareholder follow up 2024 list • Non-complying Shareholder Follow up documents for 9141 • AFIC Board report May 2024 • BCI AFIC End of Auditing Season Report 2023-24 • CRC211511 CRC184159 BCI Limited Annual Compliance Report 2023	FEP examples and updated template The updated FEP template improves on the previous template and it is planned that all FEPs will be moved into the new template at their next annual update cycle. Examples of improvements noted are: • Management of greenhouse gases and sensitive receptors have been more clearly included within the new FEP template. The GHG section is optional, and the sensitive receptor section is only required if there are sensitive receptors on the property. • Includes the version number, issue date, review date and season. • Other recommendations as suggested in the 2023 EMS review. FEP Audit reports • ECan requires that draft audit reports are issued within 10 working days of the audit, and the BCI EMS requires the final report within 10 working days of the draft report. The required timeframes were not met for FEP audit reports 8025 and 9047. • To rectify this issue, a new process has been implemented by Enviro Collective for tracking audit dates and report due dates, and the timeframes and process has been written into FEP auditor contracts. Since the new process has been in place, there have been no incidents of late FEP audit reports.	Provide the record showing dates of shareholder one-on-ones so that the FEP follow up process can be more fully reviewed.

Documents	Documents and Records reviewed	Discussion	Recommendations for Improvement
		<i>Non-compliant shareholder follow up</i> • There is a new sharepoint for tracking non-compliant shareholder follow up. • The highest level of breach recorded for the season was Level 1 – verbal. • All of the shareholders where follow up is still required will be completed at the next one on one, which is also when the FEP is updated with the shareholder to incorporate recommendations from the FEP audit. • A new non-compliance flow chart is being developed to provide more transparency to shareholders about what to expect when there has been a breach. • Enviro Collective are working with BCI to clarify roles and responsibilities across both organisations to improve communication. • It was difficult to fully review this process due to the limited information available regarding shareholder follow up. <i>Reporting</i> • All three reports were completed as required (AFIC Board report May 2024, BCI AFIC End of Auditing Season Report 2023-24, and CRC211511 CRC184159 BCI Limited Annual Compliance Report 2023) and all contained the required information as listed in the BCI EMS Section 5 Reporting.	

4 The Matrix Review

Overview

The aim of The Matrix review is to ensure changes or updates to The Matrix are in accordance with the reproducible methodology detailed in the EMS and supporting documentation, with regards to:

1. Changes to Farm system, irrigation, and management standards GIS layers used to calculate nitrogen losses
2. Updates to reference nutrient budget files used to calculate nitrogen load limits and losses into the most recent version of OVERSEER®

Review Process

For point 1 above, the process for updating The Matrix when changes to farm systems, irrigation, or management standards were made to individual properties was demonstrated. Examples of changes were viewed as part of the review, as well as an example of a FAVA Matrix assessment.

For point 2 above, Glen Treweek from WSP consulting firm provided a report from July 2024 detailing the updates made to the reference nutrient budget files when updated to OVERSEER® version 6.5.5. This document and the approval process were reviewed.

Findings

Review	Documents and records reviewed	Discussion	Recommendations for Improvement
Changes to Farm system, irrigation, and management standards GIS layers used to calculate nitrogen losses.	- GIS layers for #9096 Hewson farm, which was an approved FAVA in 2023. - The Matrix spreadsheet and attribute data inputs. #9096 Hewson FAVA Matrix calculation summary V1	The process for updating The Matrix when changes to individual property farm systems, irrigation or management standards are made was demonstrated. The EMSNM – 004 Matrix document does not specifically describe the process for doing this. In summary, after a FAVA approval, FEP update, or other property change, details of any changes required to individual property files are emailed to the person responsible for updating The Matrix files. Following the email, the GIS layers for that property are updated. The Matrix pulls through the new attribute data using vlook up calculations	Consider alternative methods for communicating required updates to The Matrix property attribute data, to reduce risk of changes being missed.

Review	Documents and records reviewed	Discussion	Recommendations for Improvement
		within the spreadsheet. There is a potential risk that property updates may be missed when relying on someone sending an email, however Enviro Collective confirmed that the process has been working well to date. At the time of writing this report, WSP consulting on behalf of Enviro Collective were in the process of completing data spot checks, to ensure that the data had been correctly transferred from the property file to the GIS layer, to provide accurate data in The Matrix. This internal check provides assurance that if there are any issues with the Matrix update process, that they will be identified and addressed. Hewson Farms applied for a significant change through the FAVA process. As part of the FAVA approval process, the effects of the FAVA on BCI scheme nitrogen load were assessed. The document provides a summary of The Matrix calculation and shows that the N loss criteria has been met. The document is evidence that the FAVA approval process has been followed. The Nitrogen loss value in the FAVA summary was checked against The Matrix and found to match.	
Updates to reference nutrient budget files used to calculate nitrogen load limits and losses into the	- BCI Matrix Update V6.5.5 – 16 July 2024. The document contains a summary of the following: - rationale for updating The Matrix;	When updating to OVERSEER® V6.5.5, three representative files failed to generate a viable analysis, and advice was sought from Overseer Ltd for options to modify the files to resolve the issues. The recommendations from Overseer	N/A

Review	Documents and records reviewed	Discussion	Recommendations for Improvement
most recent version of OVERSEER®.	- file modifications required to update to OVERSEER® V6.5.5; - calculations for updating Nitrogen loss values; - mitigations not modelled in OVERSEER®; and - OVERSEER® V6.5.6 changes; The appendix contains correspondence with Overseer Ltd, Overseer V6.5.6 release notes, and a lookup table of The Matrix nitrogen loss and soil drainage figures for OVERSEER® V6.5.5. 2. Email from Enviro Collective to ECan requesting approval: - for the file modifications required to generate a viable analysis through Overseer; and - that the Matrix update to V6.5.5 still represents nitrogen losses in V6.5.7.	Ltd were provided in the Appendix. As per EMSNM-004 Matrix Section 9, approval for these changes was requested from ECan in September 2024 however at the time of writing this report, ECan had not responded to the request. The calculations for updating the Nitrogen loss rates for Lawfully Irrigated Land were provided in the BCI Matrix Update document and these calculations followed the EMSNM-004 Section 10 process as required. The equivalent Nitrogen loss rate was calculated to be 45 kgN/ha/yr.	

APPENDIX F – CRC211511 ENVIRONMENTAL MONITORING PLAN 2023-2024 REPORT (PATTLE DELAMORE PARTNERS LIMITED)

Annual Monitoring Report for Barrhill Chertsey Irrigation Limited: July 2023 – June 2024

✦ Prepared for

Barrhill Chertsey Irrigation Limited

✦ November 2024



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Quality Control Sheet

TITLE Annual Monitoring Report for Barrhill Chertsey Irrigation Limited: July 2023 – June 2024

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Limitations:

This report has been prepared on the basis of information provided by Barrhill Chertsey Irrigation Limited. PDP has not independently verified the provided information and has relied upon it being accurate and sufficient for use by PDP in preparing the report. PDP accepts no responsibility for errors or omissions in, or the currency or sufficiency of, the provided information.

This report has been prepared by PDP on the specific instructions of Barrhill Chertsey Irrigation Limited for the limited purposes described in the report. PDP accepts no liability if the report is used for a different purpose or if it is used or relied on by any other person. Any such use or reliance will be solely at their own risk.

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- Appendix A: Groundwater Figures
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1.0 Introduction

Barrhill Chertsey Irrigation Ltd (BCIL) were granted consent CRC211511 on 14 October 2021 to discharge nutrients to land from farming between the Rakaia and Ashburton Rivers. Consent CRC211511 requires BCIL to hold and adhere to an Environmental Monitoring Plan, that outlines how groundwater and surface water quality will be monitored for the duration of the consent. This report has been prepared by Pattle Delamore Partners Limited (PDP) to fulfil the reporting requirements of consent CRC211511.

2.0 Consent Requirements

The environmental monitoring requirements are listed in conditions 22 to 29 of CRC211511 and the annual reporting requirements are listed in condition 25, as outlined below:

The Consent Holder shall implement the Environmental Monitoring Programme within 12 months of the Commencement Date. Following its implementation, the Consent Holder shall provide a summary within the annual report by 1 December 2022 and then annually thereafter that sets out the results of all sampling undertaken (including both surface water and groundwater monitoring) over the previous 12-month period, including a discussion in the case of surface water on:

- a. the extent to which there has been an identified Deterioration; and*
- b. for contaminants where a Deterioration is not defined (being Periphyton and Macrophytes percent covers), the nature of any changes over time, including any unexpected declines.*

3.0 Groundwater Quality

BCIL is required by consent CRC211511 to undertake quarterly water quality sampling from 18 bores. The location of the 18 monitoring bores is shown in Figure A1 (Appendix A).

On 17 August 2022, Neeraj Pratap from PDP provided groundwater quality sampling training to the following BCIL staff: Helen Stanger; Richard Bowman; Nick Houghton; Joe Cuthers; Michael Collins; and Isabelle Lynch.

Neeraj has a Bachelor of Engineering with Honours degree from the University of Canterbury and has been employed by PDP as an Environmental Engineering since January 2018. Neeraj is well trained in groundwater quality sampling and has undertaken groundwater quality sampling in Canterbury for a number of years, including for other irrigation schemes.

The training involved: measuring water levels and calculating the required purging volume; calibrating a water quality field meter; purging a bore until a

minimum of three well volumes have been removed and field parameters (pH, conductivity and temperature) have stabilised; recording adequate field notes and chain of custody documentation; sterilising sampling point for *E. coli* sampling; collecting samples (including wearing new nitrile gloves for each sample container at each bore); packing and storing samples; and arranging transport to the testing laboratory within required time frames.

3.1 Nitrate-N Results

A summary of the nitrate-N data from the monitoring bores is listed in Table 1 below. Note that bores L37/0010 and L37/1595 were chosen as replacement monitoring bores (for L37/0114 and L37/0254), starting May 2023, as agreed with ECan groundwater scientist Mark Trewartha (email dated 16 June 2023).

Table 1: Summary nitrate-N data for BCIL monitoring bores					
Well	Depth (m)	Nitrate-N (mg/L)			Sample Count
		Min	Median	Max	
BX21/0001	168	9.0	9.5	9.8	8
BY22/0067	36	12.3	13.6	19.5	26
K36/0033	8	1.6	7.4	14.0	104
K36/0088	17	0.08	3.7	6.8	63
K36/0145	7	2.3	3.2	4.3	8
K36/0172	10	1.6	3.9	10.3	47
K36/0244	12	<0.002	<0.002	0.08	39
L36/1242	83	2.4	12.7	17.5	67
L36/2414	115	5.8	8.1	11.3	36
L37/0010	74	3.5	3.9	12.4	7
L37/0016	72	10.8	11.3	12.0	8
L37/0020	68	5.8	7.8	24.0	71
L37/0197	41	7.2	9.7	11.8	61
L37/0297	25	15.0	22.0	26.0	59
L37/0556	44	5.3	7.0	16.2	28
L37/0867	30	0.2	9.9	14.9	71
L37/1566	21	6.6	13.5	16.7	14
L37/1595	95	7.5	8.1	9.7	6
Notes: 1. Red text indicates that the maximum acceptable value (MAV) for nitrate-nitrogen in the Water Services (Drinking Water Standards for New Zealand) Regulations 2022 of 11.3 mg/L has been exceeded. 2. Table displays data for entire available monitoring record in each bore.					

Figures A2 and A3 (Appendix A) classifies all bores according to their median and maximum nitrate-N concentrations, respectively, while Figure A4 (Appendix A) classifies all bores according to their long-term trend. In addition, Appendix A contains time series plots showing nitrate-N concentrations for all bores (Figures A5-A8).

Figure A3 shows that 11 of the 18 bores (61%) have exceeded the maximum acceptable value (MAV) for nitrate-nitrogen as set out in the Water Services (Drinking Water Standards for New Zealand) Regulations 2022, which is 11.3 mg/L. These exceedances have occurred in bores with depths between 8 and 83 m. One further bore, L36/2414 (115 m deep) recorded a concentration of 11.3 mg/L during October 2023. The locations of the exceedances are generally south of State Highway 1, with the exception of K36/0033 and L36/1242.

The groundwater monitoring results indicate that nitrate concentrations are generally higher towards the coast, which is typical of most Canterbury plains aquifers.

3.2 Trend Analysis

Long-term nitrate-nitrogen trends were determined for all monitoring bores with at least ten samples using NIWA's Time Trends version 11.1 software.

The Mann-Kendall test with no seasonality was used and a positive (i.e. increasing) or negative (i.e. decreasing) trend was assumed if the statistical test met all of the following criteria:

- ∴ $P < 0.05$ (i.e. 95%)
- ∴ Median annual slope $> \pm 0.03$
- ∴ 95% confidence limits on slope both either positive or negative.

The results of the trend analysis are listed in Table 2 below.

Well	Sample size	P	Median annual slope	Percent annual change	95% confidence limits on slope	Long-term Trend
BX21/0001	8	-	-	-	-	Insufficient data
BY22/0067	26	0.757	-0.029	-0.212	-0.317 to 0.233	Stable
K36/0033	104	0.000	-0.149	-2.016	-0.207 to -0.076	Decreasing
K36/0088	63	0.111	7	0.735	-0.006 to 0.057	Stable
K36/0145	8	-	-	-	-	Insufficient data
K36/0172	47	0.388	-0.053	-1.363	-0.165 to 0.062	Stable
K36/0244	39	0.675	0.000	0.000	0.000 to 0.000	Stable
L36/1242	67	0.000	0.266	2.094	0.164 to 0.384	Increasing
L36/2414	36	0.000	0.205	2.531	0.115 to 0.301	Increasing
L37/0010	7	-	-	-	-	Insufficient data
L37/0016	8	-	-	-	-	Insufficient data
L37/0020	71	0.000	0.204	2.616	0.185 to 0.231	Increasing
L37/0197	61	0.000	0.050	0.514	0.028 to 0.069	Increasing
L37/0297	59	0.008	0.225	1.033	0.081 to 0.382	Increasing
L37/0556	28	0.461	0.025	0.354	-0.036 to 0.079	Stable
L37/0867	71	0.023	0.132	1.338	0.011 to 0.254	Increasing
L37/1566	14	0.324	0.238	1.766	-0.837 to 0.479	Stable
L37/1595	6	-	-	-	-	Insufficient data

Of the 13 bores with more than ten samples, the nitrate-N trends are as follows:

- ✧ One bore has a decreasing trend (8%)
- ✧ Six bores are stable (46%)
- ✧ Six bores have increasing trends (46%).

Four of the six bores with increasing nitrate-N trends are located downgradient of Ashburton, while the remaining two bores are located near the Rakaia River, upgradient of Rakaia township (Figure A4, Appendix A). The bore with a decreasing nitrate-N trend (K36/0033) is located near Ashburton Forks.

4.0 Surface Water Quality and Ecological Assessments

Surface water assessments were completed by BCIL staff, following the approved methodology outlined in the BCIL Environmental Monitoring Plan (EMP)¹. BCIL staff underwent a field training day with PDP Ecologist, Tim Green, on 28 October 2022 to ensure staff were competent with the specified sampling methodology.

Regular auditing of BCIL sampling methodology is required, as detailed in the BCIL Environmental Monitoring Plan. This is yet to be undertaken, and PDP recommends that this is included as part of the summer 2024/2025 monitoring programme.

The location of the monitoring sites is shown in Figure B1 (Appendix B).

Surface water quality and ecological monitoring results are presented in full in Appendix B. Summary results for the 1 July 2023 to 30 June 2024 hydrological year are presented below. This includes comparisons with relevant national and regional standards for surface water quality and ecology (Table 3)².

¹ Green, T. and Nicol, R. (2022) BCIL environmental monitoring plan. Pattle Delamore Partners Limited.

² Minimum sampling time-frames exist for appropriate comparison with many regional and national water quality guidelines (Table 3). Until the BCIL monitoring programme meets these minimum timeframes, guideline comparisons are made with annual summary results.

Table 3: National and regional standards for surface water quality and ecology

Parameter	NPS-FM 2020 Bottom-Line/Lowest Attribute Band ^{1,2}	LWRP ³ Freshwater Outcome/Water Quality Limit (Hill-fed Lower)	LWRP ³ Freshwater Outcome/Water Quality Limit (Alpine Lower)
Temperature	-	> 20°C	> 20°C
Total Ammoniacal-Nitrogen ⁴	Annual median: ≥ 0.24 mg/L Annual 95 th percentile: ≥ 0.40 mg/L	Annual median > 0.03 mg/L Annual 95 th percentile > 0.05 mg/L	Annual median > 0.03 mg/L Annual 95 th percentile > 0.05 mg/L
Nitrate-Nitrogen	Annual median ≥ 2.4 mg/L Annual 95 th percentile ≥ 3.5 mg/L	-	-
Dissolved Reactive Phosphorus	Five-year median > 0.018 mg/L Five-year 95 th percentile > 0.054 mg/L	-	-
<i>Escherichia coli</i>	Five-year median > 260 n/100 mL Five-year 95 th percentile > 1200 n/100 mL $> 30\%$ of records > 540 n/100 mL (five-year) $> 50\%$ of records > 260 n/100 mL (five-year)	Five-year median > 130 n/100 mL Five-year 95 th percentile > 1000 n/100 mL	Five-year median > 130 n/100 mL Five-year 95 th percentile > 1000 n/100 mL
Long Filamentous Periphyton	-	$> 30\%$ cover	$> 20\%$ cover
Cyanobacteria Mat Cover	-	$> 50\%$ cover	$> 30\%$ cover
Periphyton Biomass	200 mg chl-a/m ² exceeded by no more than 8% of samples over a minimum 3 years	$> 8\%$ of samples > 200 mg chl-a/m ² over three-year period	$> 8\%$ of samples > 120 mg chl-a/m ² over three-year period

Table 3: National and regional standards for surface water quality and ecology

Parameter	NPS-FM 2020 Bottom-Line/Lowest Attribute Band ^{1,2}	LWRP ³ Freshwater Outcome/Water Quality Limit (Hill-fed Lower)	LWRP ³ Freshwater Outcome/Water Quality Limit (Alpine Lower)
Macroinvertebrates	Five-year median QMCI < 4.5 Five-year median MCI < 90	QMCI < 6	QMCI < 6
Deposited Fine Sediment	Five-year median > 27%	> 15%	> 15%

Notes:

1. National Policy Statement for Freshwater Management 2020. Refer to Appendices 2A and 2B of the document (<https://environment.govt.nz/assets/publications/National-Policy-Statement-for-Freshwater-Management-2020.pdf>).
2. NPS-FM 2020 lowest Attribute Band presented as neither dissolved reactive phosphorus nor Escherichia coli currently have a national bottom line.
3. Canterbury Land and Water Regional Plan. Refer to Table 1a of the document (<https://www.ecan.govt.nz/your-region/plans-strategies-and-bylaws/canterbury-land-and-water-regional-plan/canterbury-land-and-water-regional-plan/>).
4. Numeric attribute states based on pH 8 and temperature of 20°C. Compliance with the numeric attribute states should be undertaken after pH adjustment.

"-" indicates no value set

4.1 Surface Water Quality

4.1.1 Physicochemical Surface Water Quality

Physicochemical surface water quality summary statistics varied minimally across most monitoring sites (Table 4). However, median and maximum water temperatures, and maximum pH, were elevated at the Rakaia River South Braid site. Maximum and 95th percentile temperatures measured from the Rakaia River South Braid site exceeded the Freshwater Outcome specified within the Canterbury Land and Water Regional Plan (LWRP; Table 4).

Table 4: Physicochemical surface water quality results					
Parameter	Statistic	Bowyers Stream	Taylors Stream	Ashburton River South	Rakaia River South Braid
Temperature (°C)	Minimum	5.5	5.3	5.0	9.4
	Median	11.8	11.6	12.4	15.0
	95th Percentile	17.3	16.1	16.9	20.0
	Maximum	17.3	16.5	17.0	20.5
	n	10	12	10	9
Conductivity (µs/cm)	Minimum	50.9	27.6	38.9	40.2
	Median	57.7	57.0	49.5	46.2
	95th Percentile	65.5	72.4	58.8	59.1
	Maximum	65.7	75.4	59.2	60.7
	n	10	12	10	9
pH	Minimum	7.1	7.1	7.4	7.3
	Median	7.3	7.5	7.6	7.7
	95th Percentile	7.6	7.9	7.7	8.4
	Maximum	7.7	8.0	7.8	8.7
	n	10	12	10	9
Notes 1. Red values indicate exceedance of Freshwater Outcomes (Table 1a), or Region-wide Water Quality Limits (Schedule 8) as presented in the Canterbury Land and Water Regional Plan.					

4.1.2 Nutrients and Microbial Water Quality

Nutrient and microbial water quality results were assessed against the NPS-FM 2020 attribute bands for water quality, and the LWRP Freshwater Outcomes and Schedule 8 Water Quality Limits. Annual summary statistics are used for comparisons with these guidelines, but only provide an indicative result due to the limited time monitoring has been undertaken thus far (i.e., dissolved reactive phosphorus (DRP) and *Escherichia coli* require five years of data) (Table 3). The attribute tables for nitrate-nitrogen (nitrate-N) and total ammoniacal-nitrogen (TAN) include a national bottom-line, below which the NPS-FM 2020 requires an improvement in water quality. No bottom-line value exists for either *E. coli* or DRP.

Median TAN concentrations were below laboratory detection limits at all sites (<0.01 mg/L), while 95th percentile concentrations were variable (0.007-0.030 mg/L) (Table 5). No clear spatial pattern was recorded between river monitoring sites. When compared to the NPS-FM 2020 attribute bands for ammonia toxicity, TAN concentrations³ were consistent with the lowest level of degradation (attribute band A) at all sites. This was within both the NPS-FM 2020 national bottom-line and LWRP Water Quality Limits at all sites.

Median and 95th percentile concentrations of nitrate-nitrite-nitrogen were elevated at Taylors Stream and Bowyers Stream when compared to the lower Ashburton River and Rakaia River sites (Table 5). When compared to the NPS-FM 2020 attribute bands for nitrate toxicity, all sites except for Bowyers Stream were consistent with attribute band A, the lowest level of degradation. Bowyers Stream was consistent with attribute band B, which is indicative of toxicity impacts (growth effects) on up to 5% of species. National bottom-line limits for nitrate-nitrogen were not exceeded at any site.

DRP concentrations were consistently recorded below laboratory detection limits (<0.004 mg/L) at all but the Bowyers Stream monitoring site (95th percentile: 0.01 mg/L) (Table 5). Summary statistic concentrations measured from all sites were consistent with the NPS-FM 2020 attribute band A, indicating the lowest level of degradation.

Median concentrations of the faecal indicator bacteria *E. coli* ranged between 14 and 63 n/100 mL across sampling sites (Table 5). A greater range in 95th percentile concentrations were recorded (54-584 n/100 mL). Summary *E. coli* statistics measured at the Ashburton River site were consistent with the NPS-FM 2020 attribute band B, indicating an average campylobacter infection risk of 2% following primary contact (i.e., swimming). *E. coli* metrics from remaining sites were consistent with the lowest risk category (attribute band A).

³ Total ammoniacal nitrogen scaled for ammonia toxicity at pH 8 and 20°C, as per the NPS-FM 2020 guidance.

Table 5: Nutrients and microbial surface water quality

Parameter	Statistic	Bowyers Stream	Taylors Stream	Ashburton River South	Rakaia River South Braid
Total Ammoniacal-Nitrogen (mg/L)	Minimum	0.005	0.005	0.005	0.005
	Median	0.005	0.005	0.005	0.005
	95th percentile	0.007	0.030	0.010	0.021
	Maximum	0.010	0.060	0.016	0.034
	n	12	12	12	10
Total Ammoniacal-Nitrogen (pH 8 converted) (mg/L)	Minimum	0.0022	0.0022	0.0026	0.0024
	Median	0.0025	0.0026	0.0032	0.0034
	95th percentile	0.0040	0.0047	0.0036	0.0053
	Maximum	0.0045	0.0050	0.0038	0.0057
	n	10	11	10	7
Nitrite-Nitrogen (mg/L)	Minimum	0.001	0.001	0.001	0.001
	Median	0.001	0.001	0.001	0.001
	95th percentile	0.001	0.001	0.005	0.006
	Maximum	0.001	0.001	0.010	0.010
	n	12	12	12	10
Nitrate-Nitrogen (mg/L)	Minimum	0.35	0.28	0.08	0.03
	Median	0.58	0.47	0.14	0.08
	95th percentile	1.83	1.36	0.43	0.19
	Maximum	1.95	1.39	0.59	0.28
	n	12	12	12	10
Total Oxidised Nitrogen (mg/L)	Minimum	0.35	0.28	0.08	0.03
	Median	0.58	0.47	0.14	0.08
	95th percentile	1.83	1.36	0.43	0.19
	Maximum	1.95	1.39	0.59	0.28
	n	12	12	12	10

Table 5: Nutrients and microbial surface water quality

Parameter	Statistic	Bowyers Stream	Taylors Stream	Ashburton River South	Rakaia River South Braid
Dissolved Reactive Phosphorus (mg/L)	Minimum	0.002	0.002	0.002	0.002
	Median	0.002	0.002	0.002	0.002
	95th percentile	0.010	0.002	0.002	0.002
	Maximum	0.011	0.002	0.002	0.002
	n	12	12	12	10
<i>Escherichia coli</i> (n/100 mL)	Minimum	2	2	6	2
	Median	63	36	51	14
	95th percentile	185	137	584	54
	Maximum	248	152	629	54
	n	12	12	12	10
Notes - No values exceeded Canterbury Land and Water Regional Plan (cLWRP) Freshwater Outcomes (Table 1a), cLWRP Region-wide Water Quality Limits (Schedule 8), or National Policy Statement—Freshwater Management (2020) national 'bottom-line' values for surface water quality. - Data recorded below laboratory detection limit reported at 0.5-times the laboratory detection limit					

4.2 Periphyton

Summary periphyton cover monitoring results are presented in Table 6. Monitoring was completed following consistent methodology at all four sites, in accordance with the EMP.

The median percentage cover of the 'no algae' periphyton category measured across the monitoring sites ranged between 72% (Rakaia River South Braid) and 90% (Bowyers Stream). Median results across the periphyton categories recorded indicate that all sites were typically characterised by low coverage of a mix of periphyton sludge, short filamentous periphyton, and long filamentous periphyton.

Maximum cover levels of long filamentous periphyton and cyanobacteria did not exceed the LWRP Freshwater Outcomes at any sites. Periphyton biomass (as determined by chlorophyll- α mg/m²) was consistent with the NPS-FM 2020 attribute band A and did not exceed either the NPS-FM 2020 national bottom-line or the LWRP Freshwater Outcome.

Table 6: Periphyton cover monitoring results

Site	Statistic	No Algae (% Cover)	Sludge (% Cover)	Thin Film (% Cover)	Medium Mat (% Cover)	Thick Mat (% Cover)	Cyanobacteria Mat (% Cover)	Short Filaments (% Cover)	Long Filaments (% Cover)	Chlorophyll- <i>a</i> (mg/m ²)
Ashburton River South	Minimum	49	2	0	0	0	0	0	0	0.02
	Median	84	7	0	0	0	0	6	2	1.59
	Maximum	97	32	2	0	0	0	9	18	4.90
	n	12	12	12	12	12	12	12	12	12
Bowyers Stream	Minimum	44	0	0	0	0	0	0	0	0.03
	Median	90	2	4	0	0	0	5	2	1.15
	Maximum	96	6	40	3	0	4	15	17	23.00
	n	11	11	11	11	11	11	11	11	12
Rakaia River South Braid	Minimum	44	0	0	0	0	0	0	0	0.02
	Median	72	11	0	0	0	0	5	9	1.66
	Maximum	98	19	2	11	27	0	12	15	5.40
	n	10	10	10	10	10	10	10	10	10
Taylors Stream	Minimum	60	1	0	0	0	0	1	0	0.03
	Median	88	3	0	0	0	0	6	2	1.22
	Maximum	98	6	3	0	0	0	20	16	16.10
	n	12	12	12	12	12	12	12	12	12

Notes:

1. No values exceeded Canterbury Land and Water Regional Plan Freshwater Outcomes (Table 1a) .

4.3 Deposited Sediment

Median deposited fine sediment cover varied across monitoring sites, ranging between 2% (Taylors Stream) and 11% (Ashburton River South) (Table 7).

Records from both the Taylors Stream and Rakaia River South sites were consistently in accordance with national and regional standards (Table 3). The 95th percentile and maximum values measured from the Bowyers Stream and Ashburton River sites exceeded the LWRP Freshwater Outcome (Table 3).

Median deposited sediment cover at all assessment sites was consistent with the NPS-FM (2020) 'A' Attribute Band (Sediment Class 4), indicating minimal impact from deposited fine sediment on instream biota. Accordingly, no sites had median values exceeding NPS-FM (2020) national 'bottom-line'.

Table 7: Deposited fine sediment monitoring results

Statistic	Bowyers Stream	Taylors Stream	Ashburton River South	Rakaia River South Braid
Minimum	2	0	0	1
Median	7	2	11	3
95 th Percentile	27	5	18	6
Maximum	32	6	19	6
n	12	11	10	12
Notes: 1. Red values indicate exceedance of Freshwater Outcomes (Table 1a) or Region-wide Water Quality Limits (Schedule 8) as presented in the Canterbury Land and Water Regional Plan.				

4.4 Macrophyte Cover Assessments

Macrophyte cover monitoring data was not provided to PDP prior to preparing this report.

4.5 Macroinvertebrates

Macroinvertebrate monitoring data was not provided to PDP prior to preparing this report. It is understood that BCIL in the process of organising the first round of macroinvertebrate surveys to occur during summer 2024/2025.

5.0 Monitoring Review Clause

Condition 27 of CRC211511 states:

The Consent Holder shall undertake a review of the groundwater and surface water monitoring required under Condition 24:

- a. within the 6 month period that begins on the date that is 5 years after the Commencement Date, being the date which the Base Attribute State has been determined for all listed contaminants in Table CRC211511-3,*
- b. at any other time that may be determined by the Consent Holder; or*
- c. on making any change to Schedule CRC211511A that results in increasing the area managed by the scheme on a Property or adjoining Properties by more than 200 hectares over that occurring at the Commencement Date, provided that in the case of a review under this Condition 27(c), the review shall be limited to the effects of the change and the need to consider further groundwater and/or surface water monitoring sites.*

The location of new land added to the scheme after October 2021 is shown in Figure C1 (Appendix C). The total BCIL area covered by CRC211511 is approximately 49,000 ha and the new land area is 595 ha (1% of the BCIL area covered by CRC211511).

As shown in Figure C1, the new land is located near existing BCIL farms and existing monitoring sites. Therefore, we are of the view that no additional monitoring is required in response to the new land.

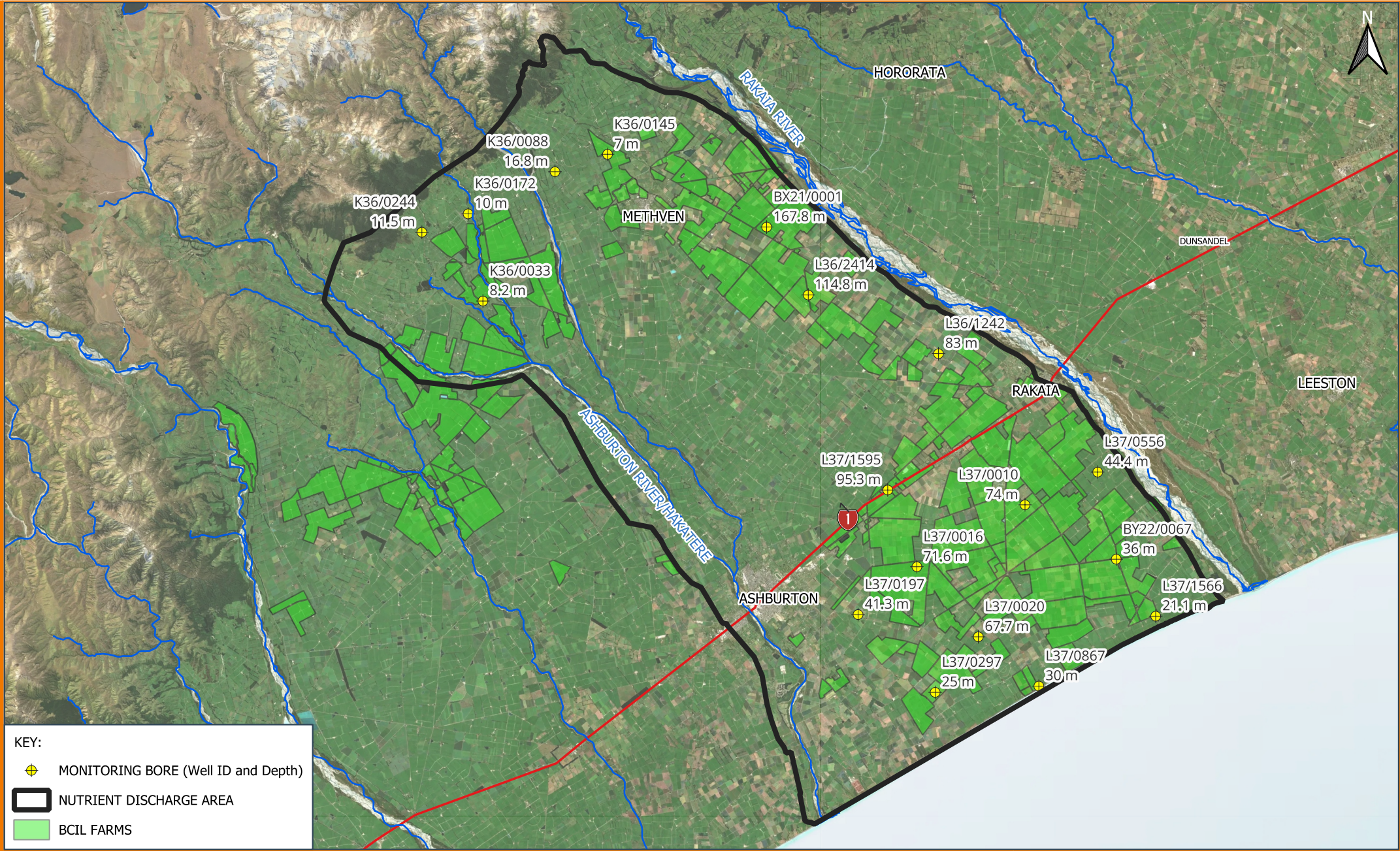
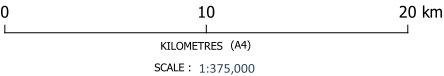


FIGURE A1: LOCATION OF MONITORING BORES

NOTES:
1. AERIAL IMAGERY SOURCED FROM THE LINZ DATA SERVICE (<https://data.linz.govt.nz/>) AND LICENCED BY LINZ FOR RE-USE UNDER THE CREATIVE COMMONS ATTRIBUTION 4.0 INTERNATIONAL LICENCE.

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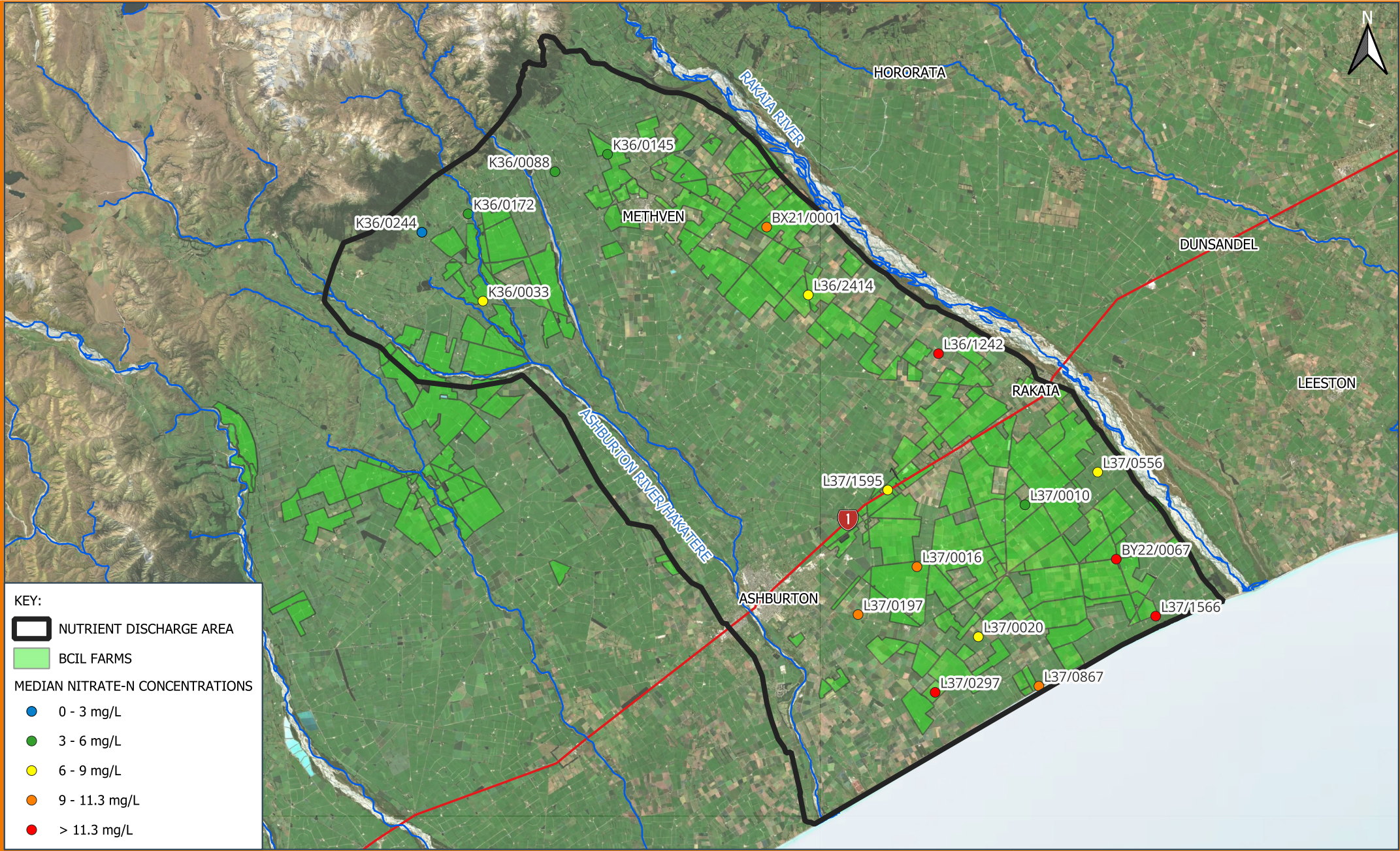
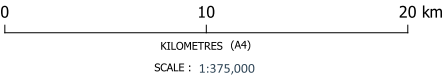


FIGURE A2: MEDIAN NITRATE-N CONCENTRATIONS IN BORES

BCIL ANNUAL MONITORING REPORT

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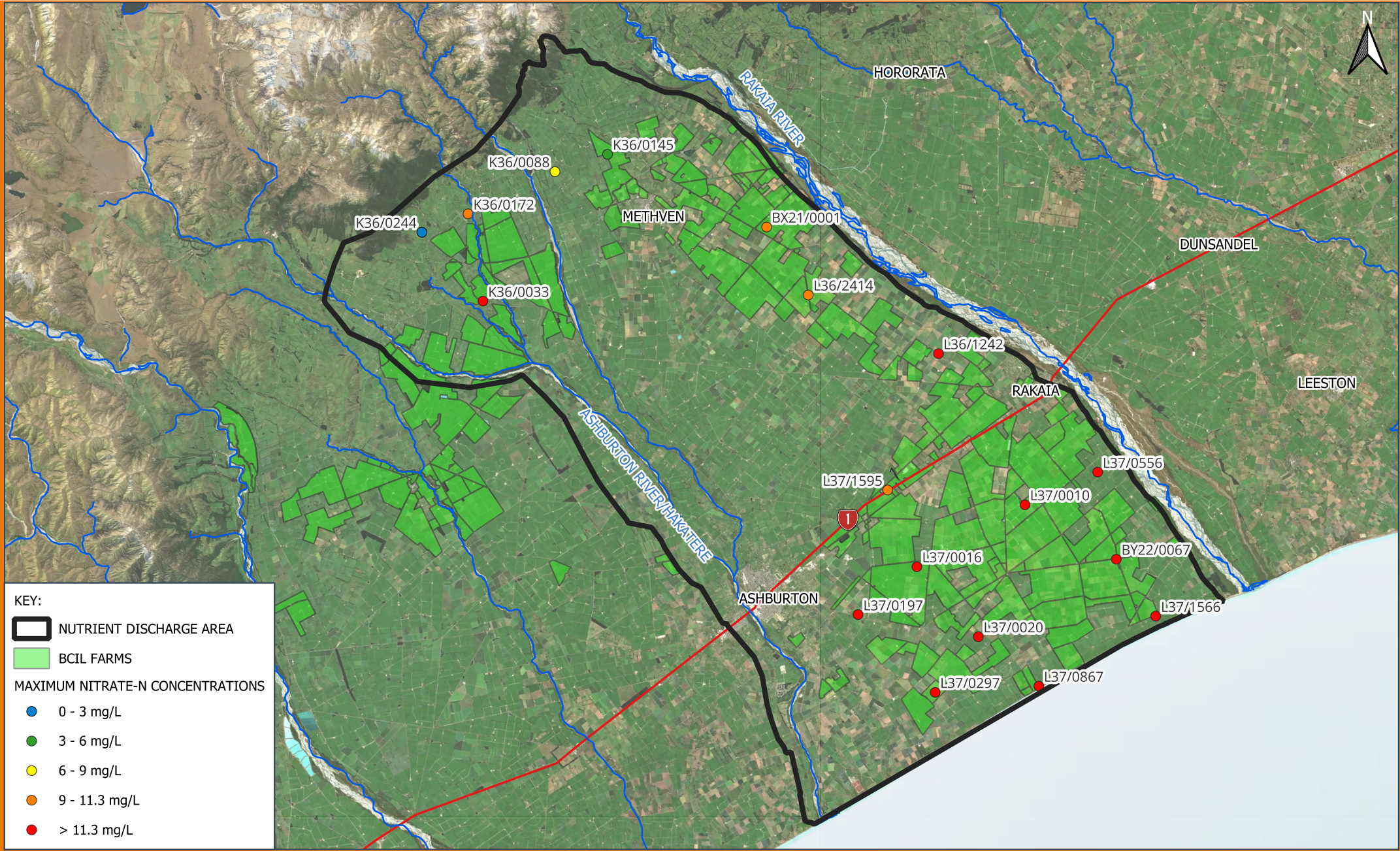
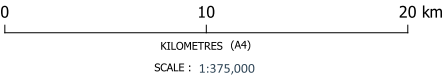


FIGURE A3: MAXIMUM NITRATE-N CONCENTRATIONS IN BORES

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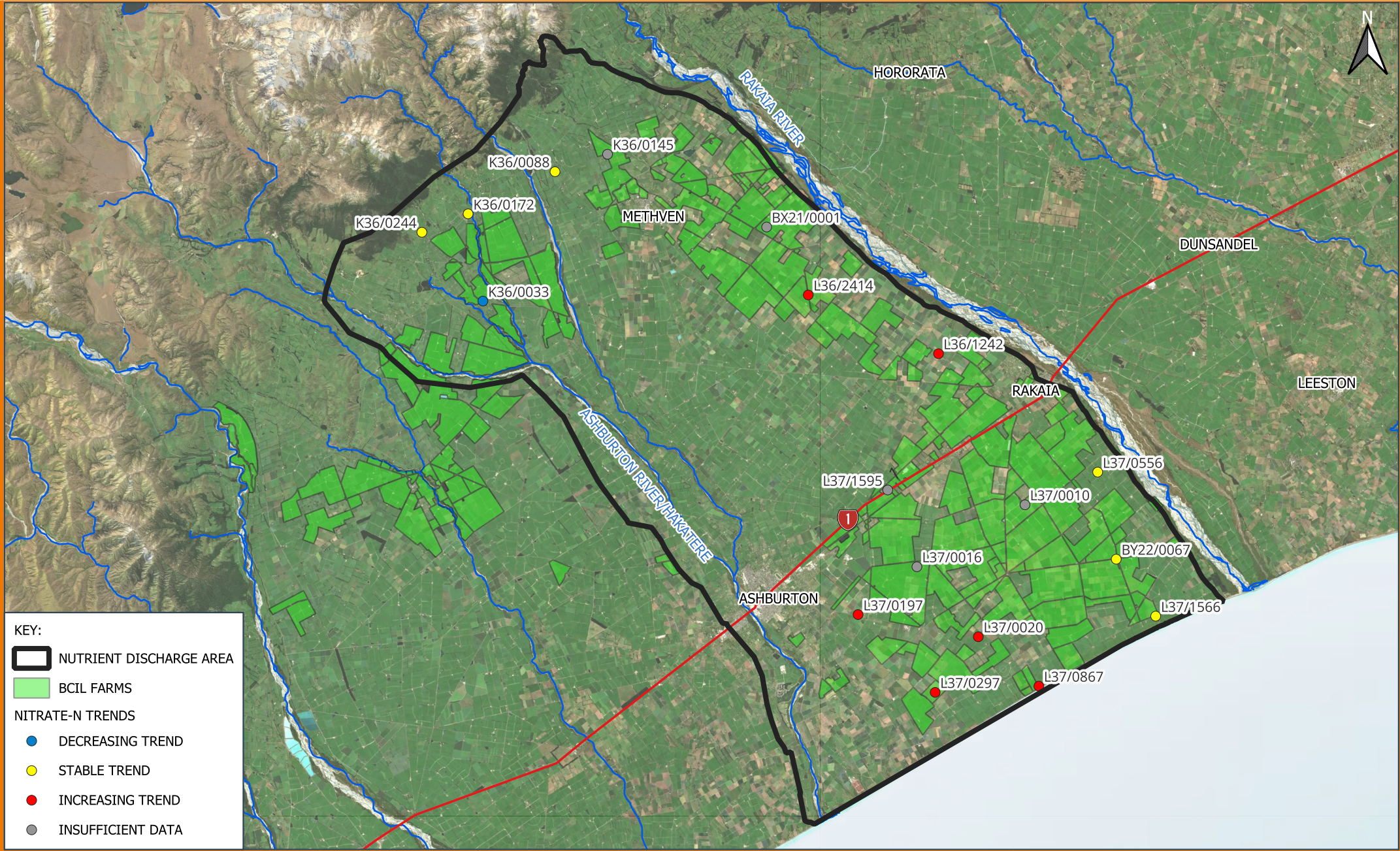
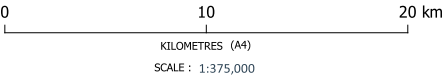


FIGURE A4: TRENDS IN NITRATE-N CONCENTRATION

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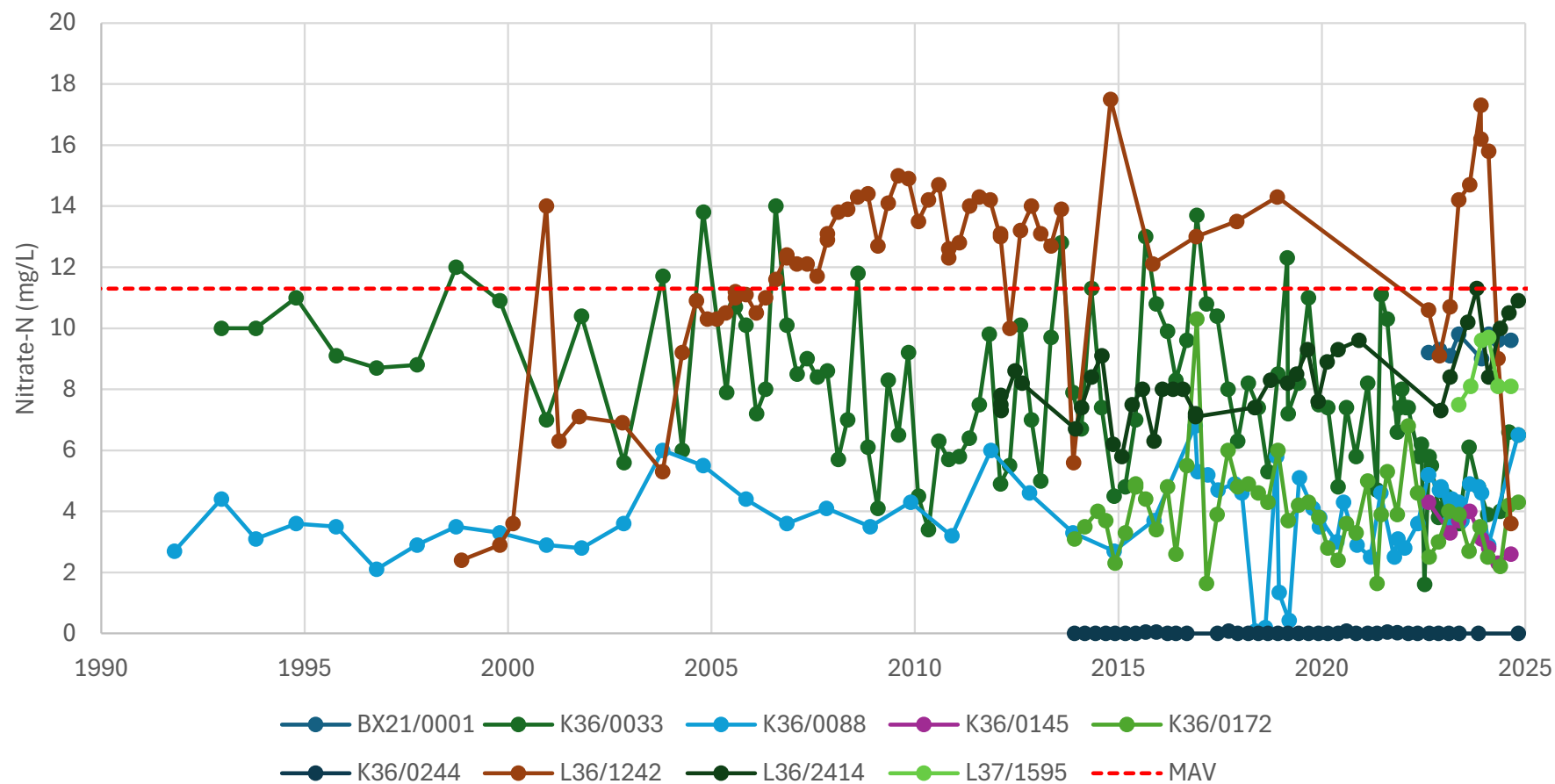


FIGURE A5: LONG-TERM NITRATE-N DATA IN BORES NORTH OF STATE HIGHWAY 1

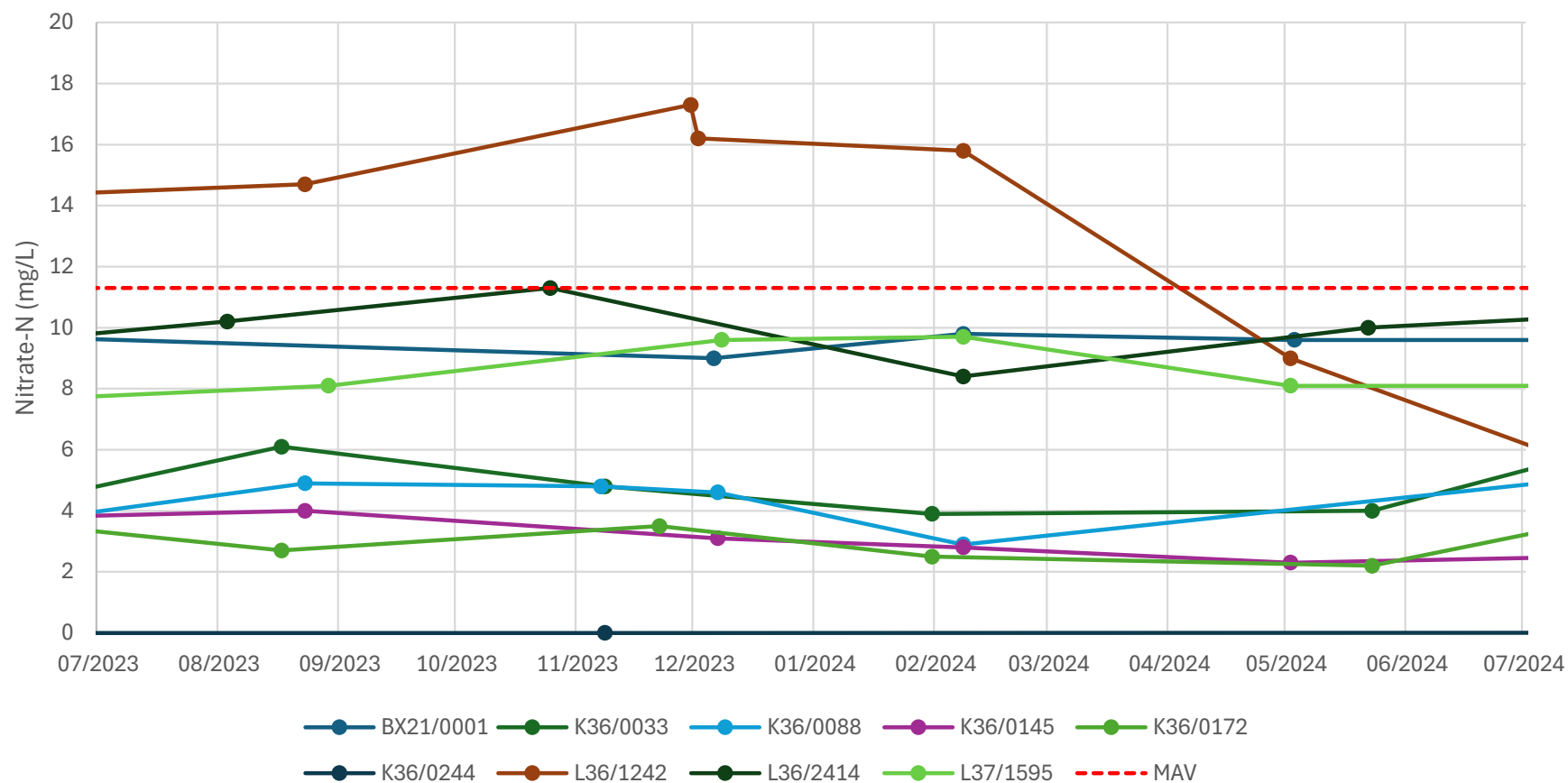


FIGURE A6: 2023-24 NITRATE-N DATA IN BORES NORTH OF STATE HIGHWAY 1

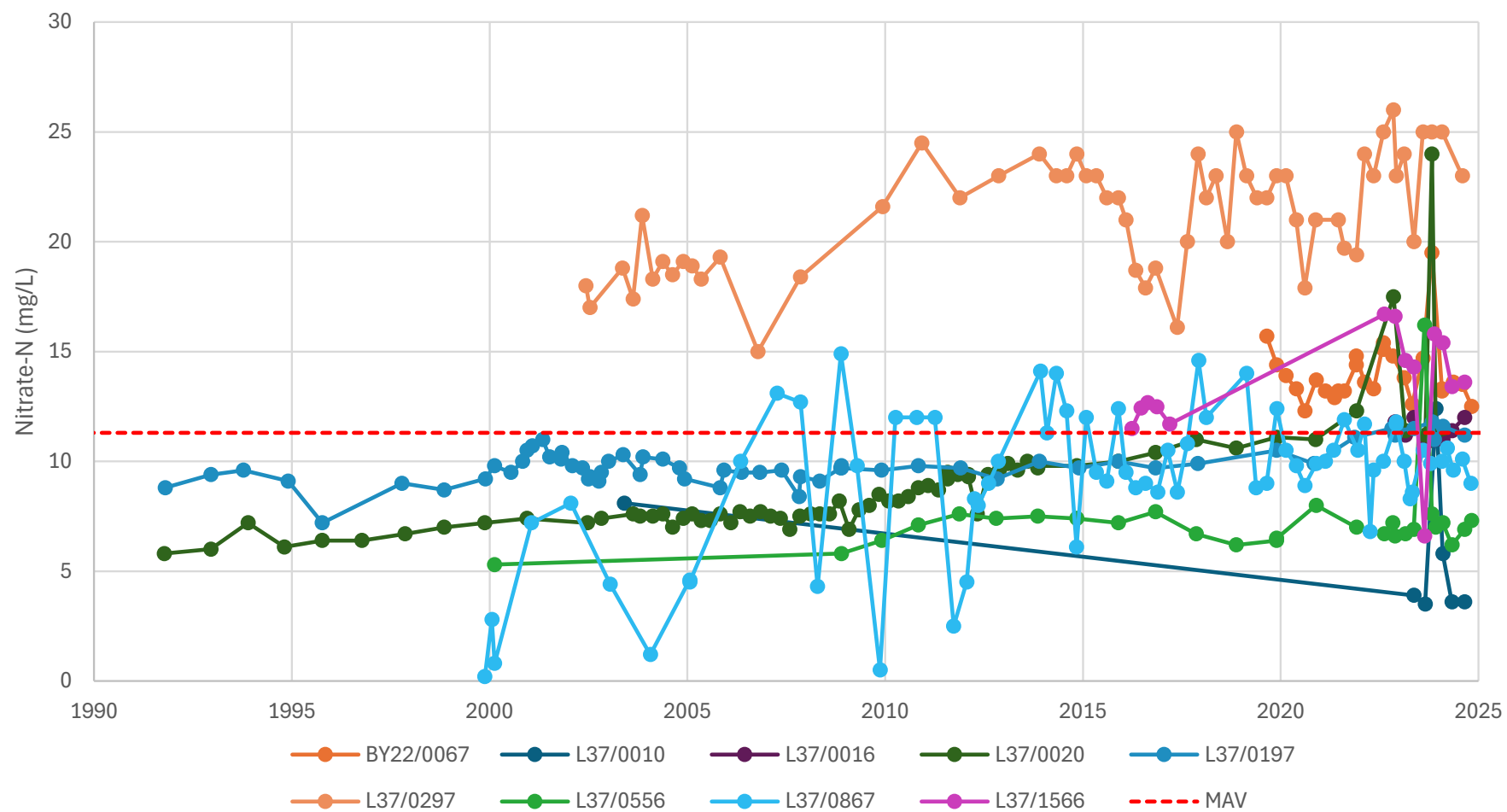


FIGURE A7: LONG-TERM NITRATE-N DATA IN BORES SOUTH OF STATE HIGHWAY 1

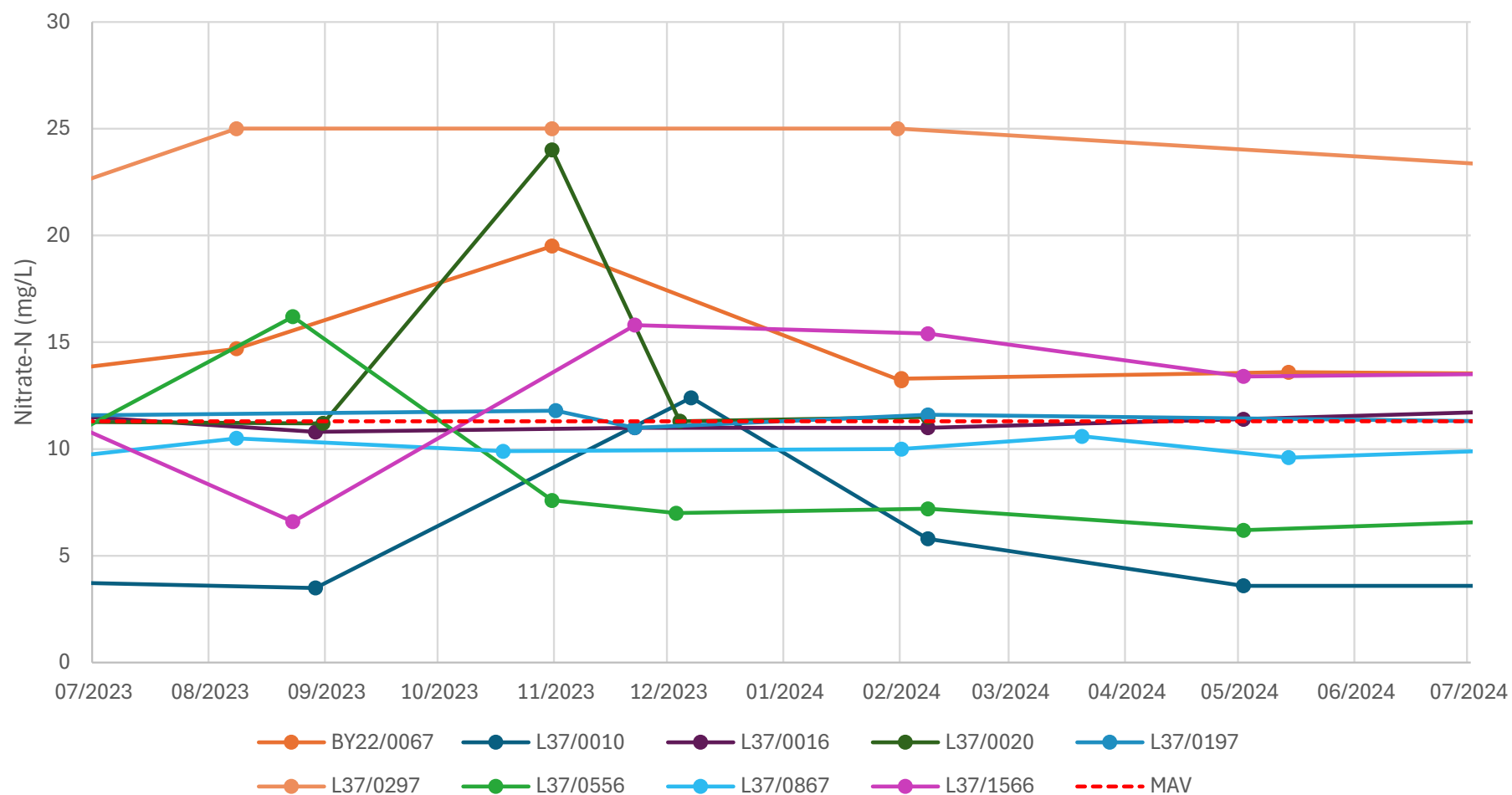


FIGURE A8: 2023-24 NITRATE-N DATA IN BORES SOUTH OF STATE HIGHWAY 1

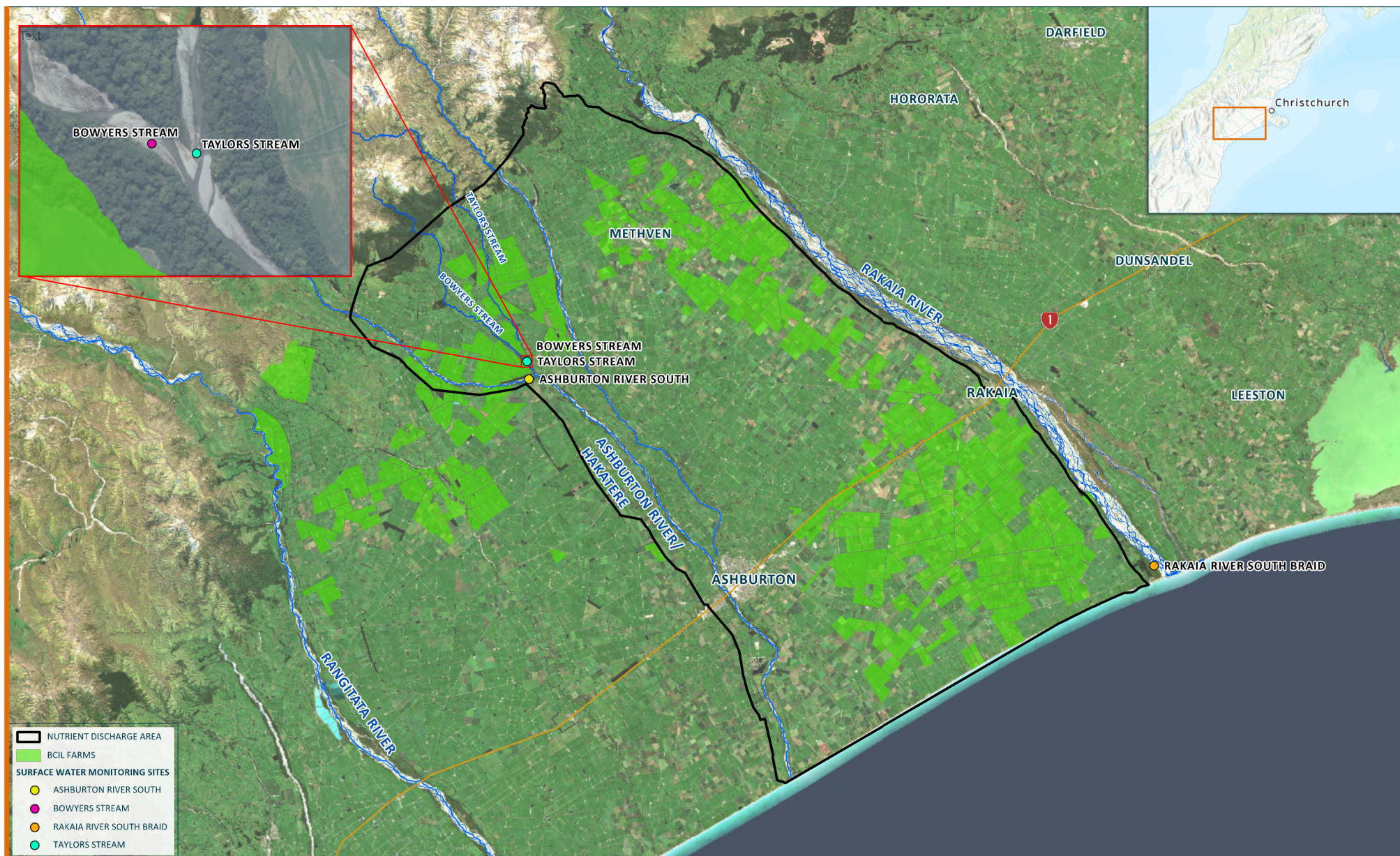


FIGURE B1: LOCATION OF SURFACE WATER MONITORING SITES

SOURCE:
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Table B1: Physicochemical surface water quality monitoring results					
Date	Parameter	Bowyers Stream	Taylor's Stream	Ashburton River South	Rakaia River South Braid
31/07/2023	Temperature (°C)	5.5	5.8	6.2	8.7
23/08/2023		7.3	10.5	7.7	6.7
13/09/2023		8.6	12.1	8.9	7.1
20/10/2023		11.5	15.3	11	10.6
23/11/2023		15.7	19	16.8	15.5
8/12/2023		13.6	19.3	15.2	12.9
31/01/2024		17.3	-	17	15.8
8/02/2024		17.2	-	16.7	16.5
13/03/2024		-	20.5	-	-
14/03/2024		15.8	-	12.5	12.5
16/04/2024		-	15.7	12.8	13.6
3/05/2024		-	13	-	8.7
20/06/2024		5.6	9.4	5	5.3
31/07/2023	Conductivity (µS/cm)	55.4	58.5	23.7	41.6
23/08/2023		50.9	45.7	41.1	60.3
13/09/2023		61.3	40.2	41.4	54.6
20/10/2023		52.4	46.2	38.9	39.2
23/11/2023		65.7	54.5	51.1	61.4
8/12/2023		52.3	53.3	43.6	55.4
31/01/2024		64.6	-	59.2	27.6
8/02/2024		65.3	-	58.2	75.4
13/03/2024		-	56.6	-	-
14/03/2024		58.5	-	53.3	68
16/04/2024		-	45.8	47.9	47.3
3/05/2024		-	44.9	-	53.2
20/06/2024		56.8	60.7	51.2	70
31/07/2023	pH	7.27	7.34	7.42	7.87
23/08/2023		7.35	8.05	7.71	7.44
13/09/2023		7.42	7.71	7.62	7.64

Table B1: Physicochemical surface water quality monitoring results					
Date	Parameter	Bowyers Stream	Taylors Stream	Ashburton River South	Rakaia River South Braid
20/10/2023		7.16	7.8	7.36	7.33
23/11/2023		7.15	7.6	7.53	7.52
8/12/2023		7.1	7.9	7.65	7.48
31/01/2024		7.5	-	7.76	7.44
8/02/2024		7.52	-	7.65	7.95
13/03/2024		-	8.66	-	-
14/03/2024		7.67	-	7.69	7.9
16/04/2024		-	7.28	7.5	7.25
3/05/2024		-	7.57	-	7.69
20/06/2024		7.17	7.66	7.55	7.14
Notes:					
“-“ indicates no data.					

Table B2: Surface water quality monitoring results for nitrate-nitrogen

Date	Nitrate-Nitrogen (mg/L)			
	Bowyers Stream	Taylors Stream	Ashburton River South	Rakaia River South Braid
31/07/2023	1.95	1.30	0.59	0.09
23/8/2023	1.73	1.33	0.29	0.081
13/9/2023	1.67	1.39	0.197	0.09
20/10/2023	0.95	0.43	0.159	0.084
23/11/2023	1.09	0.53	0.122	0.058
8/12/2023	0.65	0.46	0.129	0.05
31/1/2024	0.51	0.53	0.083	-
8/2/2024	0.51	0.48	0.086	-
14/3/2024	0.41	0.44	0.094	0.032
16/4/2024	0.35	0.36	0.147	0.089
4/5/2024	0.37	0.29	0.129	0.06
20/6/2024	0.46	0.28	0.22	0.28
<i>Notes:</i> "- " indicates no data.				

Table B3: Surface water quality monitoring results for dissolved reactive phosphorus

Date	Dissolved Reactive Phosphorus (mg/L)			
	Bowyers Stream	Taylors Stream	Ashburton River South	Rakaia River South Braid
31/07/2023	0.005	0.002	0.002	0.002
23/8/2023	0.002	0.002	0.002	0.002
13/9/2023	0.002	0.002	0.002	0.002
20/10/2023	0.01	0.002	0.002	0.002
23/11/2023	0.005	0.002	0.002	0.002
8/12/2023	0.011	0.002	0.002	0.002
31/1/2024	0.004	0.002	0.002	-
8/2/2024	0.002	0.002	0.002	-
14/3/2024	0.002	0.002	0.002	0.002
16/4/2024	0.002	0.002	0.002	0.002
4/5/2024	0.002	0.002	0.002	0.002
20/6/2024	0.002	0.002	0.002	0.002
Notes: "-" indicates no data.				

Table B4: Surface water quality monitoring results for *Escherichia coli*

Date	<i>Escherichia coli</i> (n/100 mL)			
	Bowyers Stream	Taylors Stream	Ashburton River South	Rakaia River South Braid
31/07/2023	47	13	13	2
23/8/2023	2	2	6	2
13/9/2023	6	16	7	3
20/10/2023	133	57	127	11
23/11/2023	65	47	629	54
8/12/2023	65	25	185	17
31/1/2024	60	54	548	-
8/2/2024	248	152	345	-
14/3/2024	111	125	36	34
16/4/2024	45	20	20	54
4/5/2024	79	17	16	35
20/6/2024	57	50	66	10
Notes: "-" indicates no data. "*" indicates caution with interpretation as the sample was not analysed within 24 hours of sample collection				

Table B5: Periphyton cover monitoring results

Site	Date	Periphyton Cover (%)														
		No Algae	Sludge	Thin Green Mat	Thin Brown Mat	Thin Cyanobacteria Mat	Medium Green Mat	Medium Brown Mat	Medium Cyanobacteria Mat	Thick Green Mat	Thick Brown Mat	Thick Cyanobacteria Mat	Short Green Filament	Short Brown Filament	Long Green Filament	Long Brown Filament
Ashburton River South	31/07/2023	95.3	2.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.3	0.0	0.0	0.0
	23/08/2023	82.5	2.4	1.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.3	0.0	8.3	0.0
	13/09/2023	83.3	6.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	8.5	0.3	1.5
	20/10/2023	85.5	7.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.8	0.0	1.8	0.0
	23/11/2023	85.3	6.5	0.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.2	3.4	0.4	1.4
	8/12/2023	57.0	18.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	8.5	0.8	16.8	0.8
	31/01/2024	49.0	31.8	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	6.0	0.0	13.0	0.0
	8/02/2024	0.0	15.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	9.5	0.0
	14/03/2024	67.3	21.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	6.0	0.0	3.3	0.0
	16/04/2024	52.7	1.6	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	1.4	0.0
	4/05/2024	84.6	8.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	6.2	0.0	1.4	0.0
	20/06/2024	87.6	2.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	8.3	0.0	2.0	0.0
Bowyers Stream	31/07/2023	95.4	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.2	0.0	0.7	0.1
	23/08/2023	87.9	1.7	8.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	1.5	0.3
	13/09/2023	68.0	6.3	4.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	13.8	0.0	6.8	0.5
	20/10/2023	91.3	3.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.0	0.0	0.0	0.0
	23/11/2023	92.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.4	0.0	1.4	0.5
	8/12/2023	92.8	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.8	0.5	0.3	0.3
	31/01/2024	44.8	4.3	15.5	20.8	3.5	1.3	1.3	0.0	0.0	0.0	0.0	0.3	0.0	5.3	3.8
	8/02/2024	0.0	3.0	2.0	15.3	0.0	0.0	1.0	0.0	0.0	0.0	0.0	7.3	7.3	4.8	12.0
	14/03/2024	68.1	3.3	4.5	0.8	4.3	0.0	0.0	0.0	0.0	0.0	0.0	7.0	5.3	3.8	3.0
	4/05/2024	90.2	0.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	7.7	0.0	1.1	0.0
	20/06/2024	91.9	0.4	5.8	1.3	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.2
	31/07/2023	73.8	4.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	10.0	0.0	12.0	0.0

Table B5: Periphyton cover monitoring results

Site	Date	Periphyton Cover (%)														
		No Algae	Sludge	Thin Green Mat	Thin Brown Mat	Thin Cyanobacteria Mat	Medium Green Mat	Medium Brown Mat	Medium Cyanobacteria Mat	Thick Green Mat	Thick Brown Mat	Thick Cyanobacteria Mat	Short Green Filament	Short Brown Filament	Long Green Filament	Long Brown Filament
Rakaia River South Braid	23/08/2023	54.0	13.8	0.0	0.3	0.0	0.0	10.5	0.0	1.8	0.0	0.0	6.8	1.5	11.5	0.0
	13/09/2023	60.8	11.0	0.0	2.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.3	10.5	14.5	0.0
	20/10/2023	77.8	10.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.8	0.0	6.5	0.0
	23/11/2023	70.8	11.8	0.0	0.0	0.0	0.0	0.0	0.0	1.8	0.0	0.0	6.8	1.5	7.5	0.0
	8/12/2023	95.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.0	0.0	0.0	0.0
	14/03/2024	43.5	19.0	0.0	0.0	0.0	0.0	0.0	0.0	27.3	0.0	0.0	0.0	0.0	10.3	0.0
	16/04/2024	97.9	2.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	3/05/2024	72.4	18.6	0.0	0.0	0.0	0.0	0.0	0.0	5.0	0.0	0.0	0.0	0.0	0.0	0.0
	20/06/2024	65.3	18.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.0	0.0	13.0	0.0
	Taylors Stream	31/07/2023	85.5	5.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	9.5	0.0	0.0
23/08/2023		90.8	3.3	2.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.1	0.5	1.2	0.0
13/09/2023		75.0	6.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	8.0	6.5	3.8	0.0
20/10/2023		87.0	5.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.3	0.0	1.5	0.0
23/11/2023		87.1	1.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.0	2.3	3.9	0.0
8/12/2023		89.3	1.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.3	0.0	2.0	0.8
31/01/2024		76.8	2.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	9.5	4.1	5.0	3.0
8/02/2024		0.0	4.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	9.3	10.5	9.3	6.8
14/03/2024		80.3	4.3	3.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	6.8	0.0	5.5	0.3
16/04/2024		98.1	1.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.8	0.0	0.3	0.0
3/05/2024		87.5	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.1	0.0	1.6	0.0
20/06/2024		93.6	0.8	1.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.1	0.0	1.1	0.1
Notes:																
“-“ indicates no data.																

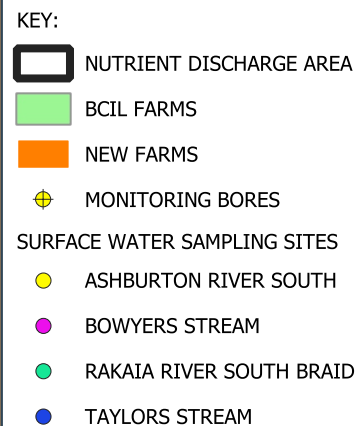
Table B6: Surface water quality monitoring results for periphyton biomass monitoring results

Date	Chlorophyll- <i>a</i> (mg/m ²)			
	Bowyers Stream	Taylors Stream	Ashburton River South	Rakaia River South Braid
31/07/2023	0.04	0.03	0.00	2.60
23/8/2023	0.72	0.57	1.68	5.40
13/9/2023	13.50	6.10	4.90	2.80
20/10/2023	0.03	0.03	0.02	0.27
23/11/2023	0.58	0.36	1.26	2.60
8/12/2023	0.51	0.64	1.69	0.32
31/1/2024	1.58	12.70	2.30	-
8/2/2024	15.20	16.10	3.20	-
14/3/2024	23.00	3.40	1.49	2.00
16/4/2024	5.80	1.63	0.42	0.02
4/5/2024	4.30	3.00	1.94	1.32
20/6/2024	0.25	0.80	0.84	1.04
<i>Notes:</i> "-" indicates no data.				

Table B7: Deposited fine sediment cover monitoring results

Date	Deposited Fine Sediment Cover (%)			
	Bowyers Stream	Taylors Stream	Ashburton River South	Rakaia River South Braid
31/07/2023	0.6	5.0	2.5	4.3
23/08/2023	1.7	3.3	2.4	15.5
13/09/2023	6.3	6.3	6.0	11.0
20/10/2023	3.5	5.3	7.0	10.0
23/11/2023	0.0	1.9	6.5	11.8
8/12/2023	0.5	1.8	22.3	0.0
31/01/2024	4.3	2.9	31.8	-
8/02/2024	3.0	4.5	15.8	-
14/03/2024	3.3	4.3	21.5	19.0
16/04/2024	-	0.8	15.7	2.2
4/05/2024	0.8	1.5	7.5	17.9
20/06/2024	0.4	0.8	2.2	15.0

Appendix C: Change in Scheme Area from Commencement Date



BCIL ANNUAL MONITORING REPORT

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APPENDIX G – CRC184159 ENVIRONMENTAL MONITORING PLAN 2023-2024 REPORT (MHV WATER LIMITED)

MEMORANDUM

To	Eva Harris
Company	EnviroCollective
CC	Nicole Matheson - MHV
From	Justin Legg
Date	14 November 2024
Subject	Groundwater Monitoring for CRC185857 Compliance Report December 2024
Doc. Ref	CRC185857_2024_Hydro_Compliance_Report_EnviroCollective

Background

This document is an excerpt of CRC185857 Compliance Report December 2024

1.1 Catchment groundwater monitoring

Condition 24

- a. Subject to Condition 27, the Consent Holder shall undertake (either directly or through a catchment group) water quality sampling on a minimum of 10 bores, with all bores being sampled quarterly for nitrate-nitrogen in accordance with the requirements of the National Environmental Monitoring Standards Water Quality – Part 1 Groundwater dated March 2019.

Bore details are included in the approved Environmental Monitoring Programme (EMP) provided to Environment Canterbury on the 13 October 2021 which specifies that sampling is undertaken quarterly in September, December, March and June each year.

The data presented is for the reporting period 1 July 2023 to 30 June 2024. The specified monitoring bores are presented in Table 2.

Table 1 Specified monitoring bores for CRC185857

WELL NO	NZTM mE	NZTM mN	Drilled	Depth	Est Water Column	Use
BZ20/0079	1481717	5117008	2020	30.0	17.5 - 22.5	Domestic and Stock water
K36/1072	1478173	5152240	2011	97.0	27.1 – 27.4	Domestic and Stock water
K37/0442	1476960	5131945	1991	24.0	13.2 - 16.6	Domestic Supply
K37/0948†	1480897	5139885	1999	10.0	1.3 - 2.5	Water Level Observation
K37/1290	1466787	5134604	2001	53.0	12.2 -17.0	Domestic and Stock water
K37/2162	1473649	5137895	2004	48.16	21.9 - 32.5	Domestic and Stock water
K37/2766	1483493	5119767	2006	53.5	40.9 - 44.5	Irrigation
K37/3000	1481771	5144529	2007	77.25	25.9 – 47.3	Domestic and Stock water
K37/3155	1488759	5144768	2008	38.0	21.3 - 36.5	Domestic and Stock water
K37/3500	1480912	5128041	2010	42.0	29.7 - 35.1	Irrigation

† K37/0948 went dry during the summer of 2023-2024. Water levels were not sufficient to obtain a suitable sample during the reporting period.

Nitrate (NO₃-N) groundwater monitoring results

- The nitrate (NO₃-N) results for the specified monitoring bores for the reporting period are tabulated in **Error! Reference source not found.**
- The nitrate (NO₃-N) results for the specified monitoring bores are presented in Table 3

Table 2 Nitrate results for specified monitoring bores for CRC185857

WELL NO	Sep-23	Dec-23	Mar-24	Jun-24	Average	Median
BZ20/0079	9.40	9.50	9.3	9.1	9.33	9.35
K36/1072	2.60	3.00	7.1	2.8	3.86	2.88
K37/0442	11.50	11.00	11	10.4	10.98	11.00
K37/0948	7.60	7.60			7.60	7.60
K37/1290	11.10	10.50	11.2	10.2	10.74	10.80
K37/2162	9.70	9.60	9.4	9.6	9.58	9.61
K37/2766	7.60	7.70	7.4	5.9	7.14	7.50
K37/3000	13.50	14.10	15.3	14.1	14.26	14.12
K37/3155	9.60	10.00	11.5	10.6	10.44	10.32
K37/3500	12.70	10.50	9.9	10.3	10.85	10.40
Average	9.53	9.35	10.23	9.22		
Median	9.65	9.80	9.90	10.16		

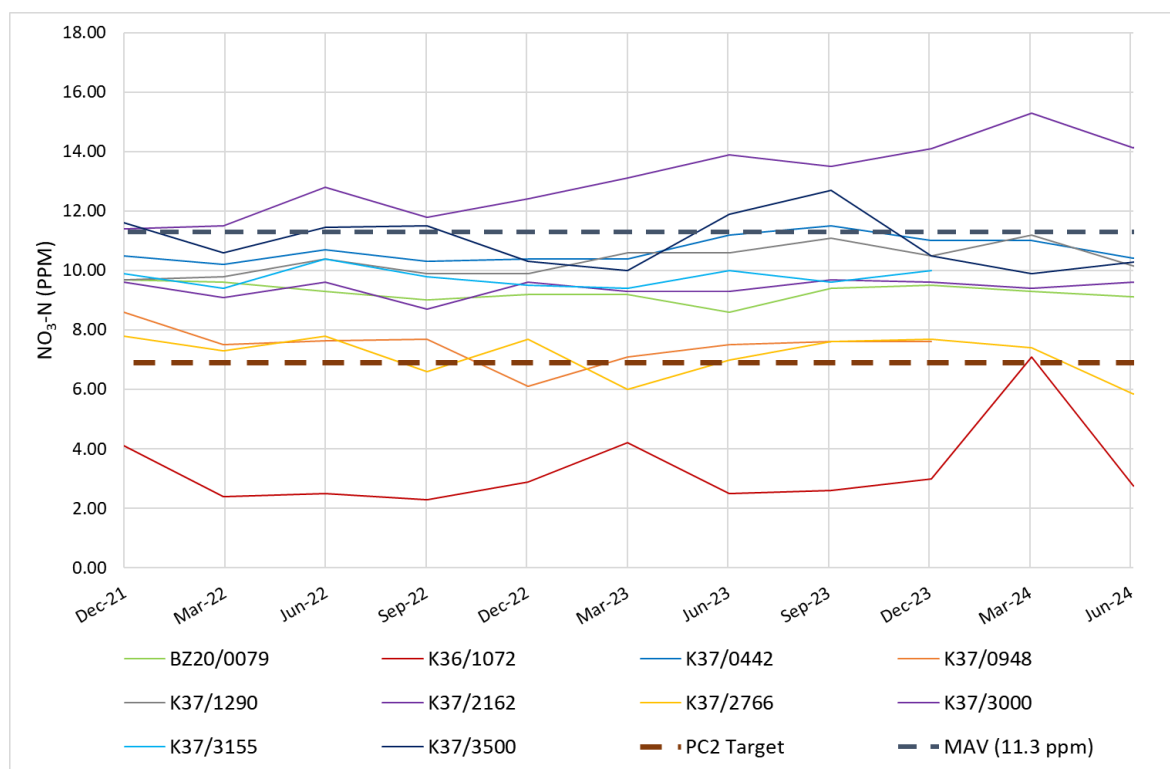


Figure 1 Nitrate results for specified monitoring bores for CRC185857

For simplicity, **Error! Reference source not found.** presents the median NO₃-N values with $\pm 12\%$ error bars as specified by Hill Laboratories¹.

¹ The reported uncertainty is an expanded uncertainty with a level of confidence of approximately 95 percent (i.e. two standard deviations, calculated using a coverage factor of 2). Reported uncertainties are calculated from the performance of typical matrices, and do not include variation due to sampling.

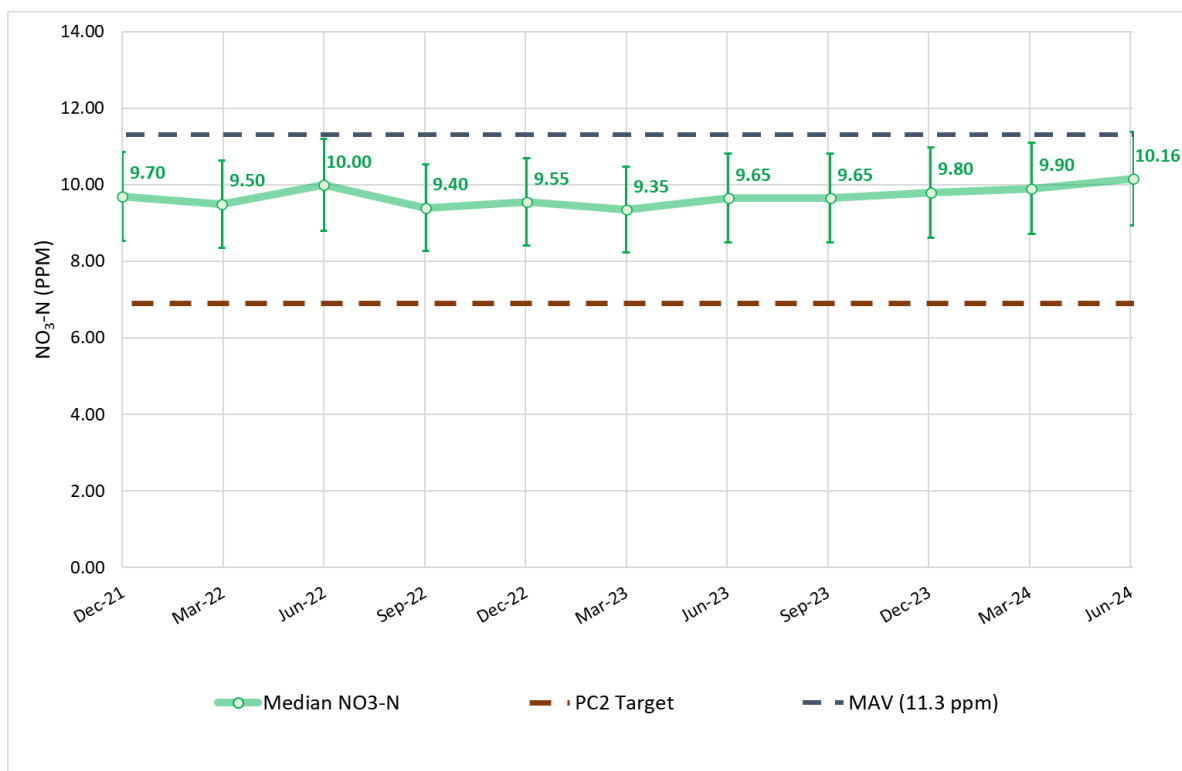


Figure 2 Median NO₃-N values with $\pm 12\%$ error bars as specified by Hill Laboratories

Note, as the 2023-24 season was the third full year of implementation of the Environmental Monitoring Programme, this information will be used to form the Base Attribute State. The Base Attribute State is due to be provided to Environment Canterbury after five years of data collection under condition 27(a).

Discussion of Nitrate (NO₃-N) groundwater monitoring results

Figure 7 presents the arithmetic mean and median of the NO₃-N data collected from the 10 monitoring bores specified in Table 3, with the average rainfall across the Hekeao Hinds Plains (refer to Appendix G for details). Notably, bore K37/0948 was dry for sampling between January and August 2024, which potentially may affect the reported results

The data indicates that all of the specified bores were consistently below the MAV of 11.3 ppm NO₃-N for drinking water.

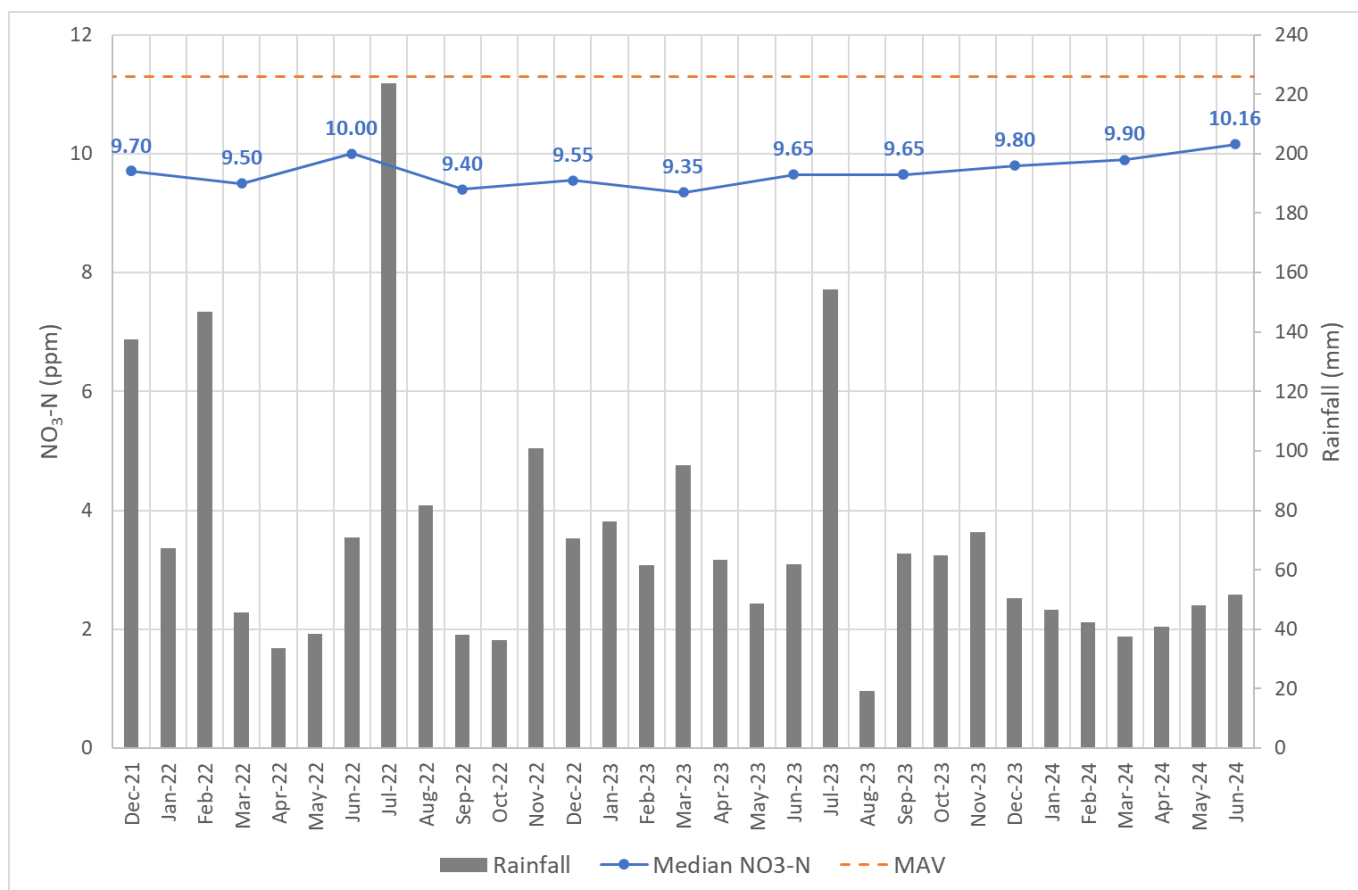


Figure 3 Median NO₃-N results for monitoring bores

Note, as the 2023-24 season was the third full year of implementation of the Environmental Monitoring Programme, this information will be used to form the Base Attribute State. The Base Attribute State is due to be provided to Environment Canterbury after five years of data collection under condition 27(a).

Discussion of localised surface water monitoring results

As discussed in the Environmental Monitoring Plan, through consultation with Te Rūnanga o Arowhenua and Environment Canterbury an upstream site and downstream site have been sampled on each of the Oakdale Drain, Harris Drain and Hinds River.

Instream Consulting Limited have carried out the monthly sampling (i.e. Nitrate toxicity, dissolved reactive phosphorus, E Coli, deposited fine sediment, periphyton and macrophytes), and the annual sampling of macroinvertebrates.

The data presented is for the reporting period 1 July 2023 to 30 June 2024.

The results as outlined in Table CRC185857-2 are included in the following tables;

Table 3 – Nitrate toxicity results – Nitrate Nitrogen (mg/L)

	Season July - June	Oakdale Drain Upstream	Oakdale Drain Downstream	Harris Drain Upstream	Harris Drain Downstream	Hinds River Upstream	Hinds River Downstream
Median	2024	10.8	11.25	11.70	11.05	6.70	6.60
95th Percentile	2024	12.7	13.24	13.15	12.74	6.99	9.94

Table 4 – Dissolved Reactive phosphorus results (mg/L)

	Season	Oakdale Drain Upstream	Oakdale Drain Downstream	Harris Drain Upstream	Harris Drain Downstream	Hinds River Upstream	Hinds River Downstream
Median	2024	0.01	0.002	0.005	0.008	0.01	0.01
95th Percentile	2024	0.01	0.325	0.006	0.02	0.01	0.02

	Season	Oakdale Drain Upstream	Oakdale Drain Downstream	Harris Drain Upstream	Harris Drain Downstream	Hinds River Upstream	Hinds River Downstream
Attribute Band	2024	Red	Orange	Orange	Red	Green	Blue

Table 5 – Macroinvertebrates (percentage cover)

	Season	Oakdale Drain Upstream	Oakdale Drain Downstream	Harris Drain Upstream	Harris Drain Downstream	Hinds River Upstream	Hinds River Downstream
MCI Attribute Band	2024	C	D	D	D	C	B
QMCI Attribute Band	2024	D	C	D	D	A	A

Table 6 – Deposited fine sediment (percentage cover) – results

	Season	Oakdale Drain Upstream	Oakdale Drain Downstream	Harris Drain Upstream	Harris Drain Downstream	Hinds River Upstream	Hinds River Downstream
Attribute Band	2024	B	B	D	B	A	B

Note all six sites have been defined as Sediment Class 1 as defined by Table 26 of the NPSFM 2020 (August 2020) (i.e. warm-dry climate, lowland topography and alluvium geology).

Table 7 – Chlorophyll-a results

	Season	Oakdale Drain Upstream	Oakdale Drain Downstream	Harris Drain Upstream	Harris Drain Downstream	Hinds River Upstream	Hinds River Downstream
Attribute Band	2024	B	B	D	B	A	B

Note – Macrophyte (percentage cover) and Periphyton (percentage cover) does not have a defined Deterioration, however Instream Consulting Ltd provided the following comment on Periphyton and Macrophytes percentage cover;

- *Periphyton biomass was generally low at the monitored sites, and comparable with the previous monitoring rounds. The only notable exception was at Harris Upstream, where chlorophyll-a biomass has increased. Harris Upstream shifted from the C band in 2022-23, to the D band in 2023-24.*

- *Nuisance forms of periphyton (i.e., long filaments, thick mats, and cyanobacteria) were sparse at all sites.*
- *Macrophyte cover has consistently been moderate to abundant in Harris Drain Upstream, and both Oakdale Drain sites. All of these sites exceeded, or neared, the LWRP Freshwater Outcome Value of 50% cover over the 2023-24 monitoring period. Harris Drain Downstream and both Hinds River sites have consistently had minimal macrophyte cover.*

Note, as the 2023-24 season was the third full year of implementation of the Environmental Monitoring Programme, this information will be used to form the Base Attribute State. The Base Attribute State is due to be provided to Environment Canterbury after five years of data collection under condition 27(a).