



2022 ANNUAL COMPLIANCE REPORT  
CRC184159 & CRC211511

1 DECEMBER 2023

## QUALITY CONTROL SHEET

|                  |                                      |
|------------------|--------------------------------------|
| TITLE            | BCI Annual Compliance Report 2023    |
| RESOURCE CONSENT | CRC211511 and CRC184159              |
| CLIENT           | Barrhill Chertsey Irrigation Limited |
| VERSION          | FINAL                                |
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## EXECUTIVE SUMMARY

The Barrhill Chertsey Irrigation Limited (BCI) nitrogen discharge resource consents CRC184159 and CRC211511 commenced on the 14<sup>th</sup> 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 **1<sup>st</sup> July 2022 to 30<sup>th</sup> June 2023**.

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 updated EMS was prepared to meet the requirements of the renewed consents in consultation with Te Rūnanga o Arowhenua, and certified by Environment Canterbury on 28<sup>th</sup> November 2022. In November 2023, our EMS and how we implement it was externally peer reviewed (Appendix D).

Nitrogen losses from the BCI ASM programme are calculated using The Matrix methodology<sup>1</sup>, a catchment nitrogen load calculator formally recognised as "equivalent" to Overseer by Environment Canterbury in April 2020. In Overseer version 6.5.2, for the land managed under CRC184159 in the 2022-23 reporting year, the Nitrogen Discharge Allowance (NDA) for Hekaeo/Hinds was calculated to be **555.5 T N**. For the 2022-23 reporting season, BCI shareholders discharged **483.1 T N**, 87% of the current consented N load limit.

For land consented under Ashburton zoned resource consent CRC211511 in the 2022-23 reporting year, the revised consented NDA was calculated to be **2,108.6 T N**. For the 2022-23 reporting season, BCI and AFIC shareholders discharged **1,832.4 T N**, 87% of the consented N load limit.

BCI also invest significantly in an extension programme and work collaboratively with industry to support shareholders with methods to improve their resource use efficiency. Overall, 19% of BCI and AFIC farm audited in the 2022-23 reporting year achieved "Advanced Mitigation" audit grades and a further 59% achieved an "A". Only one farm was graded a "C", the first in three years for the scheme. A higher proportion of farms were graded "B" this year relative to the 2021-22 reporting year due to a change in auditing standards, with the majority of "B" grades due to minor inconsistencies with their irrigation maintenance.

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

Overall, there are no issues to report in relation to compliance of resource consents CRC184159 and CRC211511.

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<sup>1</sup> Updated to Overseer version 6.5.2, calculated by Dr. Glen Treweek of Ground Sense Limited.

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## INTRODUCTION

Barrhill Chertsey Irrigation Limited (BCI) are consented to take up to 17 m<sup>3</sup>/s of water from the Rakaia River, of which up to 3 m<sup>3</sup>/s is licensed to Acton Farmers Irrigation Co-Operative (AFIC), east of Rakaia. Only 13.48m<sup>3</sup>/s of water was allocated to BCI and AFIC shareholders in the 2022-23 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 14<sup>th</sup> October 2021 to manage the effects of farming land use activities onto over 58,000 ha 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".

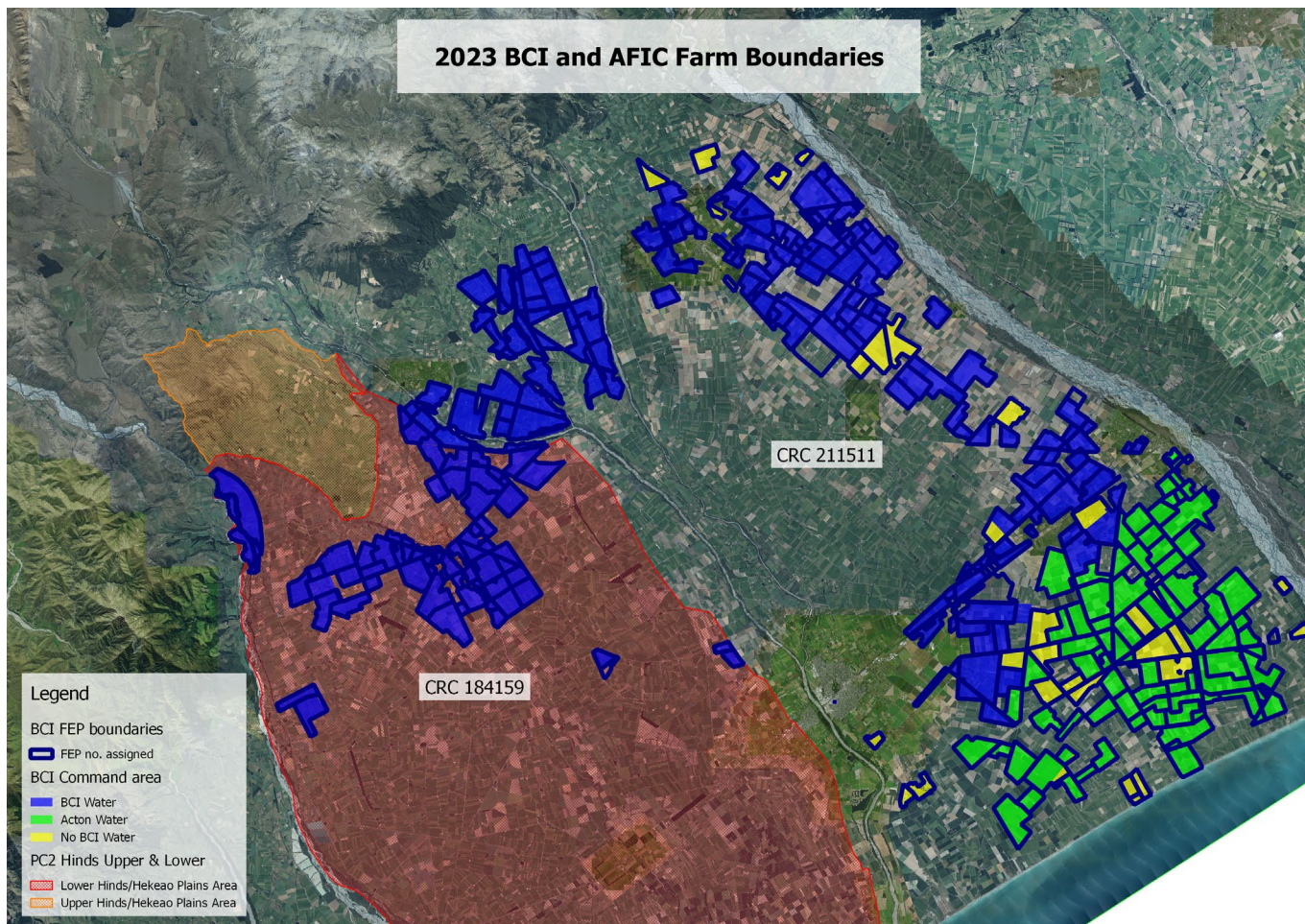


FIGURE 1: 2023 BCI AND AFIC FARM BOUNDARIES

This annual report is due 1<sup>st</sup> December each year to provide a summary of compliance with resource consent CRC184159 and CRC211511 for the period **1<sup>st</sup> July 2022 to 30<sup>th</sup> June 2023**.

## 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 catchment.

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

Our ASM programme requires all BCI and AFIC shareholders to implement Farm Environment Plans, which are independently audited, as well as comply with catchment nitrogen load limits, supported by a water quality monitoring programme. As part of the ASM programme, the Enviro Collective Limited (ECL) environmental team provide wrap-around environmental services to all BCI and AFIC shareholder farmers, which includes the following:

- Development of the Environmental Management Strategy;
- 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 programme utilises trained facilitators to deliver the information our farmers need to make the best decisions they can and has resulted in 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 2023, we have delivered the following for our shareholders:

- GMP Winter Grazing series
- *"Aiming for Advanced Mitigation"* – Dairy and Arable Field days
- Shed talks
- Resources to support good practice irrigation management and adoption of Advanced Mitigation

Overall, we have had nearly two hundred people attend our field days 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

|                                        |                                                                                                                                                                                                                                                                  |
|----------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Dry Land</b>                        | Land that is not irrigated but where nitrogen losses are managed under this consent.                                                                                                                                                                             |
| <b>Existing Scheme Irrigated Land</b>  | Land lawfully supplied with irrigation water supplied by an irrigation scheme or principal water supplier prior to 9 September 2013.                                                                                                                             |
| <b>Lawfully Irrigated PC2 Land</b>     | 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). |
| <b>Lawfully Intensified (PC5) Land</b> | Land which lawfully increased its nutrient losses above its baseline nitrogen loss rate between 31 December 2013 and 13 February 2016.                                                                                                                           |
| <b>Other Irrigated Land</b>            | 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                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
|-------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Advanced Mitigation</b>                      | The undertaking of farming on a property that is consistent with the Advanced Mitigation targets described in Condition 18 (CRC211511).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| <b>Associated Properties</b>                    | 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.                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| <b>Authorised Properties</b>                    | Properties that the Consent Holder has elected to treat as Authorised Properties for the purposes of Condition 9 (CRC184159) and Condition 8 (CRC211511).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| <b>Certified Freshwater Farm Plan</b>           | 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                                                                                                                                                                                                                                                                                                                                                                                            |
| <b>CDWPZ Impacted Land</b>                      | <p>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 &amp; CRC211511).</p> <p>Advisory note: For example:</p> <ul style="list-style-type: none"> <li>it will typically not be possible to provide differential stock grazing within the same paddock; and</li> <li>it may be possible to provide differential management for a cropping or horticultural operation in the same paddock.</li> </ul>                                                                                |
| <b>Commencement Date</b>                        | 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).                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| <b>Community Drinking Water Protection Zone</b> | A Community Drinking Water Protection Zone as identified in Schedule 1 of the Canterbury Land and Water Regional Plan.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| <b>Farming activity</b>                         | 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.                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| <b>Farm Environment Plan</b>                    | <p>A Farm Environment Plan in the form set out in Schedules CRC211511C and CRC184159C:</p> <ul style="list-style-type: none"> <li>as may be amended following mutual agreement with the Regional Leader - Monitoring and Compliance, Canterbury Regional Council; or</li> <li>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).</li> </ul> |
| <b>HPZ gmp</b>                                  | <p>The farming practices described in Schedule 24a of the operative Canterbury Land and Water Regional Plan (at the Commencement Date), taking into account:</p> <p>(a) the type of farming activity; and</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |

| Term                                          | Definition                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
|-----------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                                               | <p>(b) the drainage characteristics of the soils; and</p> <p>(c) the climatic conditions and topography of the Property; and the type of irrigation system used.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| <b>Good Management Practice (GMP)</b>         | The farming practices which are described in the document titled Industry Agreed Good Management Practices relating to water quality (2015).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| <b>Management Plan for Farming Activities</b> | <p>A Management Plan for Farming Activities in the form set out in Schedule CRC211511D:</p> <ul style="list-style-type: none"> <li>as may be amended following mutual agreement with the Regional Leader - Monitoring and Compliance, Canterbury Regional Council; or</li> <li>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).</li> </ul> |
| <b>NES Equivalent Farm</b>                    | <p>A Property on which:</p> <ul style="list-style-type: none"> <li>(a) 20 hectares or more is in arable land use; or</li> <li>(b) 5 hectares or more is in horticultural land use; or</li> <li>(c) 20 hectares or more is in pastoral land use; or</li> <li>(d) 20 hectares or more is in a combination of any two or more of the land uses described above;</li> </ul> <p>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.</p>                                        |
| <b>Nutrient Allocation Zone</b>               | A nutrient allocation zone within the area shown as CRC184159/CRC211511 Nutrient Discharge Area on Plan CRC184159A/CRC211511A.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| <b>Nutrient Discharge Allowance (NDA)</b>     | The Nutrient Discharge Allowance as determined by Condition 3 to 6 (CRC211511)/7(CRC184159).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| <b>Property</b>                               | 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.                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| <b>Schedule 24A Plan</b>                      | <p>A <i>Schedule 24a Plan</i> in the form set out in Schedule CRC184159D:</p> <ul style="list-style-type: none"> <li>as may be amended following mutual agreement with the Regional Leader - Monitoring and Compliance, CanterburyRegional Council; or</li> <li>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).</li> </ul>         |
| <b>Sensitive Receptor</b>                     | 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.                                                                                                                                                                                                                                                                                                                                                         |

| Term               | Definition                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
|--------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Significant change | <p>In relation to the farming activity on a Property means:</p> <ul style="list-style-type: none"> <li>(a) an increase in the area irrigated by more than 10 hectares;</li> <li>(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;</li> <li>(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</li> <li>(d) any increase in the area on a property of dairy support land (being the farming of non-milking dairy cows, including heifers),</li> </ul> <p>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.</p> |

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).

Schedules CRC184159A and CRC211511A have been prepared by Dr. Glen Treweek of Ground Sense Limited for all land currently managed under the BCI ASM programme (See 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 6.9mg/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 Ground Sense Limited has calculated the Nitrogen Discharge Allowance (NDA) for CRC184159 in accordance with the consent (See Appendix B and C) in version 6.5.2 of Overseer.

The "Lawfully Irrigated PC2 Land" nitrogen loss rate was also updated to version 6.5.2 Overseer as 56 kg N/ha.

The overall nitrogen load limit for land listed in Schedule CRC184159A is **555.5 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 Ground Sense Limited has calculated the Nitrogen Discharge Allowance (NDA) for the Plan Change 5 area in accordance with the consent (See Appendix B and C) in version 6.5.2 of Overseer.

The "Lawfully Intensified PC5 Land" nitrogen loss rate was also updated to version 6.5.2 Overseer as 56 kg N/ha.

The overall nitrogen load limit for land listed in Schedule CRC211511A is **2108.6 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 below<sup>2</sup>.

<sup>2</sup> Note summary excludes Authorised Properties

**TABLE 1: SUMMARY OF PROGRESS AGAINST AM TARGET (2023)**

|                    | Overall<br>(PC5 only) | 2025 Target | AM Achievement | % AM |
|--------------------|-----------------------|-------------|----------------|------|
| # PC5 Farm Plans   | 141                   | 22          | 7              | 5%   |
| PC5 Land Area (ha) | 47,658                | 7,145       | 3,332          | 7%   |

### 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 2023 is about 12 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 Ground Sense Limited has calculated the 2023 nitrogen losses for land listed in schedules CRC184159A and CRC211511A in version 6.5.2 of Overseer using The Matrix method based on the farm system, irrigation and winter grazing<sup>3</sup> area reported for the property for the 2022-23 season (Appendix B).

In the Plan Change 2 area, the total nitrogen losses were **483.1 T N**, 87% of the nitrogen discharge allowance for CRC184159.

In the Plan Change 5 area, the total nitrogen losses were **1,832.4 T N**, 87% of the nitrogen discharge allowance for CRC211511.

<sup>3</sup> Winter grazing as defined by the Canterbury Land and Water Regional Plan

## CONDITION 7 (CRC184159)/CONDITION 6 (CRC211511)

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

- a. 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 Ground Sense Limited has calculated the Nitrogen Discharge Allowance (NDA) in accordance with the consents (See Appendix B) in version 6.5.2 of Overseer, which was the current version at the date this report was prepared.

- b. 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.

Any changes to the information used to calculate the NDA for land listed within schedules CRC184159A and CRC211511A were completed by 14<sup>th</sup> October 2022.

## 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.

Table 2 summarises the land which joined the BCI resource consents CRC211511 and CRC184159 in the 2022-23 season.

**TABLE 2: SUMMARY OF LAND WHICH JOINED BCI OR AFIC IN 2022-23 SEASON**

| Schedule Reference | New Area Added | PC 2/PC5 | Baseline Received Y/N | Water Delivered |
|--------------------|----------------|----------|-----------------------|-----------------|
| 9074               | 8 ha           | PC5      | Yes                   | March 2023      |
| 9096               | 100.4 ha       | PC5      | Yes                   | Sept 2023       |
| 9164               | 78 ha          | PC5      | Yes                   | Sept 2023       |
| 9165               | 393.3 ha       | PC5      | Yes                   | Sept 2023       |

Note, new properties joining BCI or AFIC purchase shares significantly earlier than when water can be delivered. We have included land for reporting purposes which has been shared for scheme water but may not necessarily have been irrigated by BCI or AFIC during the reporting period.

## AUTHORISED PROPERTIES

### CONDITION 9 (CRC184159)

Any Property that is:

- less than 5 hectares in area; or
- 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:

- less than 10 hectares in area; or
- greater than 10 hectares, and where:
  - the area of the property authorised to be irrigated with irrigation water from any source is:
    - less than 50 hectares; and
    - 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
  - the area used for winter grazing (as defined in the Canterbury Land & Water Regional Plan at the Commencement Date) is less than:
    - 10 hectares, for any property that is less than 100 hectares in area; or
    - 10% of the area of the property for any property between 100 hectares and 1000 hectares in area; or
    - 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 17 BCI and AFIC shareholder properties managed under CRC211511 are defined as Authorised Properties in accordance with Conditions 8(a) and 8(b).

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 13<sup>th</sup> September 2022. Environment Canterbury certified the BCI EMS on 28<sup>th</sup> 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.
- c. 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;
- d. 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);
- e. 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;
- f. be consistent with the Environmental Monitoring Plan and associated requirements provided for in Conditions 22 to 29;
- g. 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

h. 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

i. 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 13<sup>th</sup> of September 2022 and certified on 28<sup>th</sup> 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 on to 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 13<sup>th</sup> of September 2022 and certified on 28<sup>th</sup> 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 2022-23 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 29<sup>th</sup> 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 28<sup>th</sup> 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 review of the EMS was completed in November 2023 by Paul Reese of Matai Consultants. The full report is attached as Appendix D. In summary, the report states:

*“The EMS has very thorough processes and the BCI scheme provides strong support to enable properties to achieve A grades. The analysis of the data provided from the audits and subsequent actions has played a strong part in A grade achievement. The achievement, and progression of achievement, to A and AM grades is evident in the results reported.”*

#### **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 2022-2023 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 17<sup>th</sup> 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.

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 fifty hectares of irrigation and ten 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*.

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**

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <p><i>Irrigation Management</i></p> <ol style="list-style-type: none"> <li><i>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.</i></li> <li><i>The irrigation manager(s) understands the relationship between the irrigation system, soil and climate in order to achieve the Irrigation Management requirement (a)</i></li> </ol>                                               |
| <p><i>Nutrient Management</i></p> <ol style="list-style-type: none"> <li><i>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.</i></li> <li><i>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.</i></li> </ol> |



#### 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 2022-23 auditing season, 19% 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                               |                                            |
|---------------------|-----------------------------------------------|--------------------------------------------|
|                     | No change in management or significant change | Change in management or significant change |
| 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 2022-23 FEP Audit season was assessed from 1<sup>st</sup> of July 2022 to the 30<sup>th</sup> of June 2023 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

Three new properties have been added Schedule CRC211511-2, all of which are due to be audited before June 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 2022-2023 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 fifteen audits were deferred in the 2022-23 reporting year.

| FEP Number | Reason for deferral                                   | Updated Audit due date |
|------------|-------------------------------------------------------|------------------------|
| 8006       | Shareholder's son in serious car accident             | 30/06/2024             |
| 8061       | Shareholder's son in serious car accident             | 30/06/2024             |
| 8013       | Property changed ownership                            | 15/07/2024             |
| 8035       | Property changed ownership                            | 18/11/2023             |
| 8048       | Shareholder's son in serious car accident             | 30/6/2024              |
| 8049       | Property split between brothers, change in management | 4/09/2024              |
| 8050       | Shareholder's son in serious car accident             | 30/06/2024             |
| 8051       | Shareholder's son in serious car accident             | 30/06/2024             |
| 9109       | Shareholder passed away                               | 28/11/2023             |
| 9024       | Property on market                                    | 11/03/2023             |
| 9007       | Shareholder's wife passed away                        | 29/11/2023             |
| 9037       | Change in lease and ill health                        | 2/07/2024              |
| 9059       | Change in leaseholder                                 | 25/02/2024             |
| 9071       | MPI NOD in place and property on market               | 25/08/2024             |
| 9150       | Purchased new block                                   | 30/08/2024             |

In one case, there was a car accident where children or close relatives of four shareholders covering five properties were seriously injured. All deferrals were first approved from Environment Canterbury.

- 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 may be 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 2022-23 season were conducted in accordance with the '*Certified Farm Environment Plan Auditor Manual*', May 2020.

The Advanced Mitigation Auditor Guidance document was compiled and included in BCI's Environmental Management Strategy which was certified for use on 28<sup>th</sup> November 2022. All audits for 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 2022-23 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 and submitted to Environment Canterbury on 17<sup>th</sup> 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 are not required until 17<sup>th</sup> February 2025.

- 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.

- 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 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.

Not applicable for the 2022-23 reporting year. There has been no material change to properties or water supplies which will trigger a review of the CDWPZ risk assessments.

- 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 2022-23 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 14<sup>th</sup> of April 2022 following extensive consultation with the Environment Canterbury groundwater science team.

The EMP for CRC184159 was prepared by MHV Water Limited and submitted to Environment Canterbury on 13<sup>th</sup> October 2021 as part of their own EMP required by their discharge consent CRC185857. Both EMPs were approved by Environment Canterbury on 28<sup>th</sup> 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 14<sup>th</sup> of April 2022 and certified on 28<sup>th</sup> November 2022.



The EMP for CRC184159 was prepared by MHV Water Limited and submitted to Environment Canterbury on 13<sup>th</sup> 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 the 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 Table 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<br>NO <sub>3</sub> - N mg/L    | Monthly                                                                                  | Median and 95 <sup>th</sup> percentile of previous five years of data.                                                                                                          | Where the annual (1 July to 30 June) median and/or 95 <sup>th</sup> percentile NO <sub>3</sub> - N mg/L are greater than the calculated base attribute state.                             |
| Dissolved reactive phosphorous<br>DRP mg/L      | Monthly                                                                                  | Median and 95 <sup>th</sup> percentile of previous five years of data.                                                                                                          | Where the annual (1 July to 30 June) median and/or 95 <sup>th</sup> percentile DRP mg/L are greater than the calculated base attribute state.                                             |
| Escherichia coli<br>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<br>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<br>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.

Water quality monitoring has been completed in accordance with the Environmental Monitoring Plans.

### 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. Deteriorating trends can be identified once five years of monitoring data has been collected.

## 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 28<sup>th</sup> 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 <sup>th</sup> October 2022 (ha) | Total (ha)      | Change from 14 <sup>th</sup> October 2022 (ha) |
| <b>2021-22</b> | 10,128          | 0ha                                            | 48,580          | 0ha                                            |
| <b>2022-23</b> | 10,161          | 33 ha                                          | 49,192          | 612 ha                                         |

A review of the groundwater monitoring programme for CRC211511 will be completed within the next three months to determine if the more than 200 ha of new land joining the BCI scheme over the past 12 months has impacted on the representativeness of the monitoring bores.

## 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 14<sup>th</sup> 2022 and certified 28<sup>th</sup> 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 14<sup>th</sup> 2022 and certified 28<sup>th</sup> 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 seventy audits were completed between 1<sup>st</sup> July 2022 to 30<sup>th</sup> June 2023. Auditors who completed FEP audits for BCI and AFIC last season include:

- Ali Van Polanen (EnviroPlan);
- Leah Gorman (EnviroPlan);
- Dave Lucock (The Agribusiness Group);
- Julie Lambie (The Agribusiness Group); and
- Steph Wright (Enviro Collective Limited)
- Asure Quality (Synlait's Lead with Pride Programme)

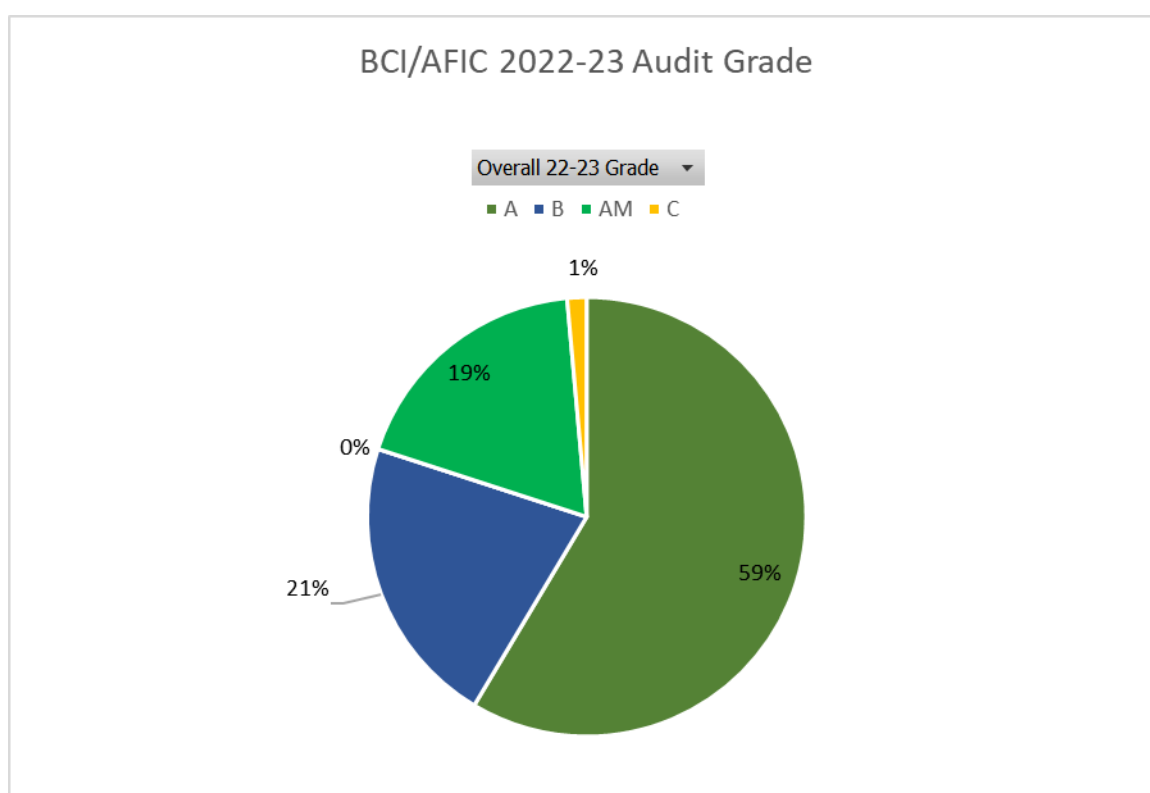
All FEP Auditors are certified by Environment Canterbury and the FEP Audits were completed in accordance with the Environment Canterbury *'Certified Farm Environment Plan Auditor Manual'*, May 2020. Steph Wright completed two audits as part of her auditing accreditation and was not a FEP advisor for these properties.

Table 5 shows the audit grades for the 2022-23 season by land use.

TABLE 5: BCI 2022-23 FEP AUDIT GRADES BY LAND USE

| Land Use      | AM        | A         | B         | C        | D        | Total     |
|---------------|-----------|-----------|-----------|----------|----------|-----------|
| Arable        | 4         | 23        | 8         | 0        | 0        | 35        |
| Dairy         | 5         | 9         | 1         | 1        | 0        | 16        |
| Dairy Support | 2         | 7         | 4         | 0        | 0        | 13        |
| Other         | 2         | 2         | 2         | 0        | 0        | 6         |
| <b>Total</b>  | <b>13</b> | <b>41</b> | <b>15</b> | <b>1</b> | <b>0</b> | <b>70</b> |

Grades for the 2022-23 season are shown in Figure 2 below. Overall, 19% of farms achieved Advanced Mitigation, 59% “A”, and 21% “B” and 1% “C” grade. No “D” audit grades were issued this season.



**FIGURE 2: BCI/AFIC OVERALL AUDIT RESULTS 2022-23**

No BCI or AFIC properties received repeated fail grades. The property which received a “C” grade had previously been audited as an “A” and is scheduled to be re-audited this season following significant upgrades to their effluent system.

The increase in “B” grades is disappointing for BCI, as the past season was the first where achievement of “GMP” was less than the previous year since we started the ASM programme. The increase in “B” grades relates primarily to the irrigation maintenance and calibration targets. Historically, auditors had some discretion on their grading where there were minor anomalies in irrigation assessments, but they were still confident the overall efficiency outcomes were being met.

In the past auditing season, the most recent auditor guidance removed this discretion and required all systems to be assessed as meeting the standards. Analysis of the target “Level of Confidence” grading for the irrigation calibration and maintenance target between the 2021-22 and 2022-23 auditing seasons shows similar grading, however a “medium” grade for the target now means a “B” grade when traditionally they could have been awarded an “A”.

Therefore, we are confident the decrease in achievement of “A” grades this past season was not due to a deterioration in performance by shareholders, but a change in expectations of the auditing programme.

- 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 and concentrations for the 2022-23 reporting period were calculated using The Matrix methodology by Dr. Glen Treweek of Ground Sense Limited in Overseer version 6.5.2 (Appendix B) and summarised in Table 3 and Table 4 below.

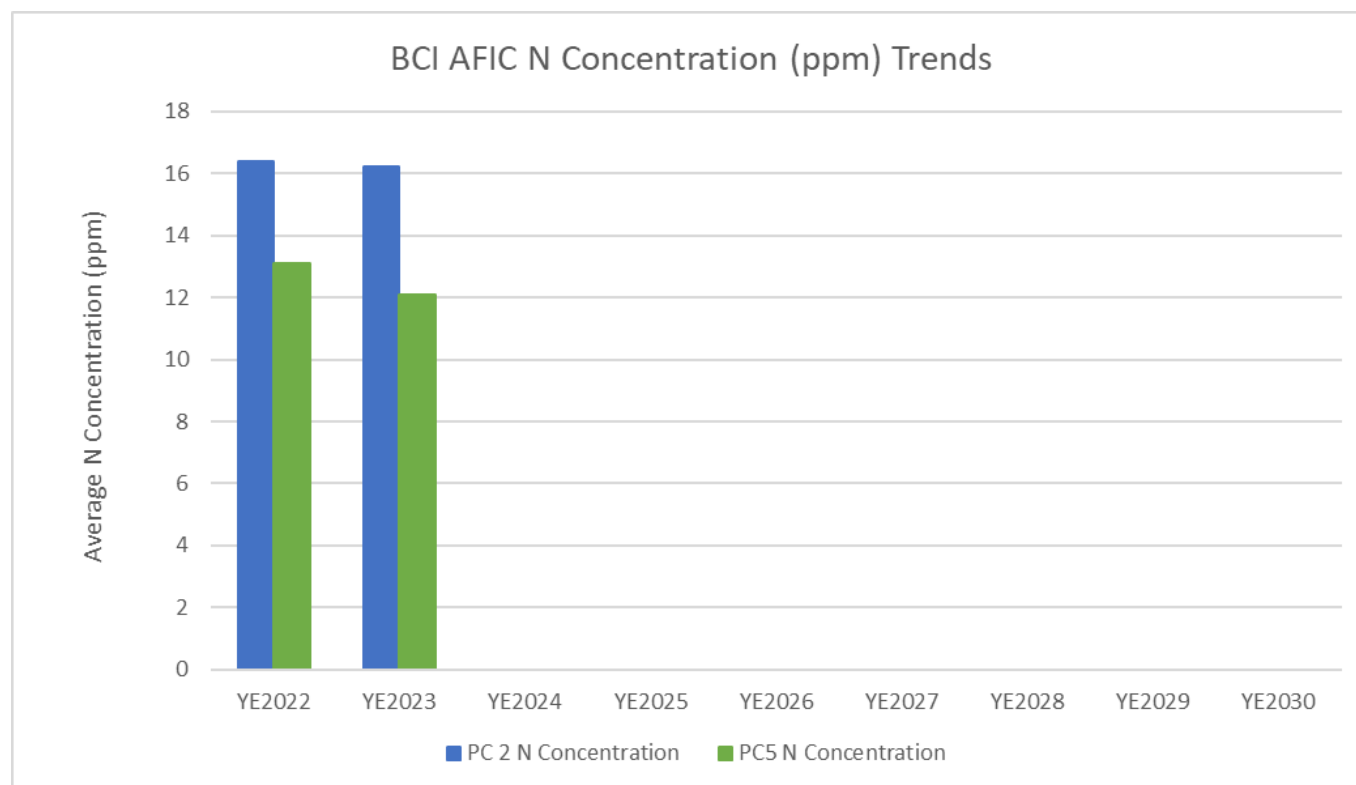
**TABLE 3: CRC184159 NUTRIENT ALLOCATION ZONE NITROGEN LOSSES (TREWEEK, GROUND SENSE) v6.5.2**

|                             | Lower Hinds-Hekeao<br>Plains NAZ | Upper Hinds-Hekeao<br>Plains NAZ | CRC184159 Total |
|-----------------------------|----------------------------------|----------------------------------|-----------------|
| <b>2023 NDA (t N/yr)</b>    | 555.5                            | 0                                | 555.5           |
| <b>2023 N load (t N/yr)</b> | 0                                | 0                                | 0               |

**TABLE 4: CRC211511 NUTRIENT ALLOCATION ZONE NITROGEN LOSSES (TREWEEK, GROUND SENSE) v6.5.2**

|                             | Ashburton -<br>Rakaia NAZ | Ashburton NAZ | Rakaia NAZ | CRC211511 Total |
|-----------------------------|---------------------------|---------------|------------|-----------------|
| <b>2023 NDA (t N/yr)</b>    | 1,683.4                   | 419.6         | 5.6        | 2,108.6         |
| <b>2023 N load (t N/yr)</b> | 1,451.7                   | 374.8         | 6.0        | 1,832.4         |

Nitrogen concentration losses from the BCI ASM programme have been calculated using The Matrix since 2022 and have been summarised in Figure 3 below.



**FIGURE 3: N CONCENTRATION TRENDS TO DATE**

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

The Environmental Monitoring Plan for CRC211511 was submitted to Environment Canterbury in April 2022 and certified 28<sup>th</sup> November 2022. See Appendix E and F for a summary of the environmental monitoring programme completed by PDP Limited (PC5 zone) and MHV Water Limited (PC2 zone).

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

Four significant change applications were assessed in the 2022-23 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 5: SUMMARY OF SIGNIFICANT CHANGE DECISIONS (2022-23)**

| Applicant   | Status   | Change Requested                                                                                               | Assessment                                                                                                                                                                                                                                                             |
|-------------|----------|----------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>9150</b> | Approved | Change in land use from dairy support to arable, increase irrigated area by 36.5 ha                            | <p>Strong performance history</p> <p>No sensitive receptors</p> <p>Will adopt Advanced Mitigation practices</p> <p>Will be able to achieve N load reduction targets</p> <p>Change will comply with National Regulations and any resource consent</p>                   |
| <b>9010</b> | Approved | Increase in irrigated area by 15 ha.                                                                           | <p>No sensitive receptors</p> <p>Advanced Mitigation practices were audited as implemented</p> <p>Will be able to achieve N load reduction targets</p> <p>Change will comply with National Regulations and any resource consent</p>                                    |
| <b>9060</b> | Approved | Increase in irrigated area by 30 ha and convert 17.6 ha of winter grazing by sheep to winter grazing by cattle | <p>Strong performance history of the applicant.</p> <p>No sensitive receptors</p> <p>Will adopt Advanced Mitigation practices</p> <p>Will be able to achieve N load reduction targets</p> <p>Change will comply with National Regulations and any resource consent</p> |

| Applicant | Status   | Change Requested                 | Assessment                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
|-----------|----------|----------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 9058      | Approved | Increase irrigated area by 50 ha | <p>New irrigation originally approved in 2020, however not implemented until after consent CRC211511 was granted.</p> <p>New irrigation unlikely to affect sensitive receptors on the property.</p> <p>Consultation with Te Rūnanga o Arowhenua sought.</p> <p>Strong performance history of the applicant.</p> <p>Will adopt Advanced Mitigation practices</p> <p>Will be able to achieve N load reduction targets</p> <p>Change will comply with National Regulations and any resource consent</p> |

In addition to the above Significant Change applications, a further seven applications for non-significant changes in farm system or new irrigation were assessed 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 4 shows the Level of Confidence analysis for the 2022-23 audit season for BCI and AFIC.

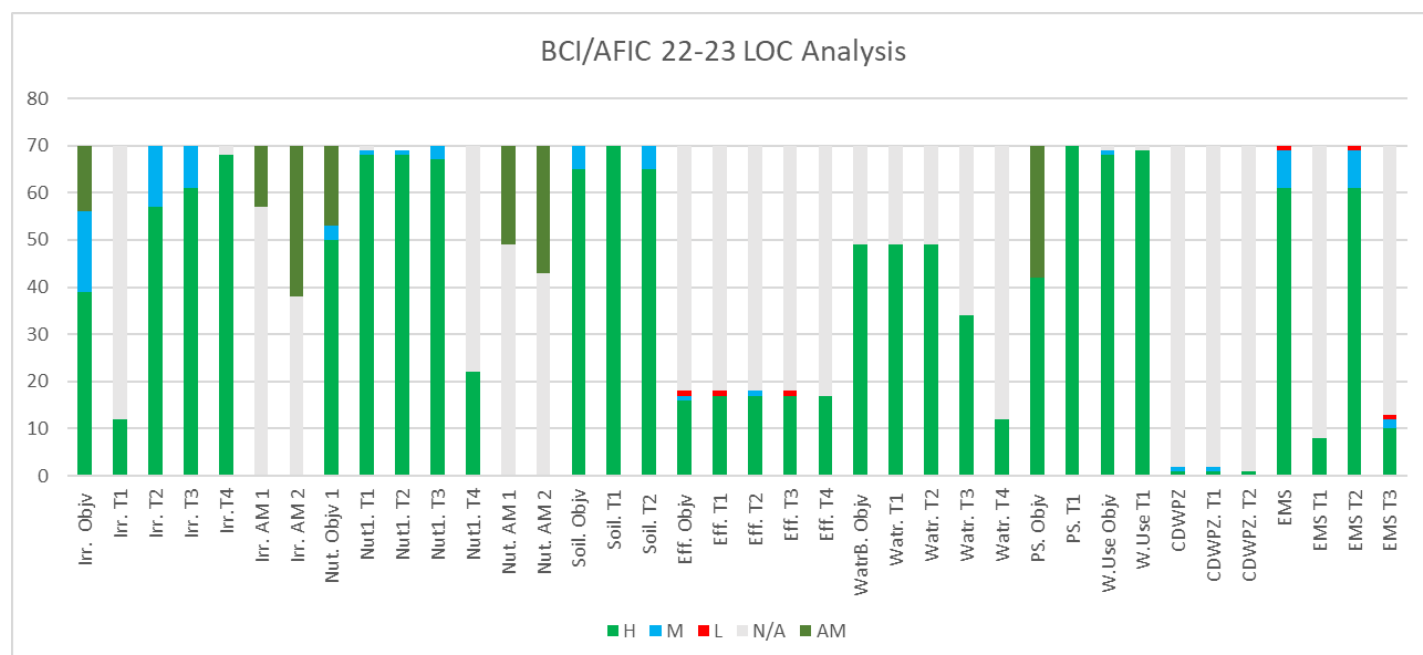


FIGURE 4: BCI & AFIC 2021/22 LEVEL OF CONFIDENCE ANALYSIS

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

The first review of Environmental Management Strategy and Matrix parameters was completed in November 2023 by Paul Reese of Matai Consultants Limited. The full detail of the review is available in Appendix D.

### 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 1<sup>st</sup> of December 2023.

### 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

(sourced from Lisa Scott, Senior Scientist: Groundwater, 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.

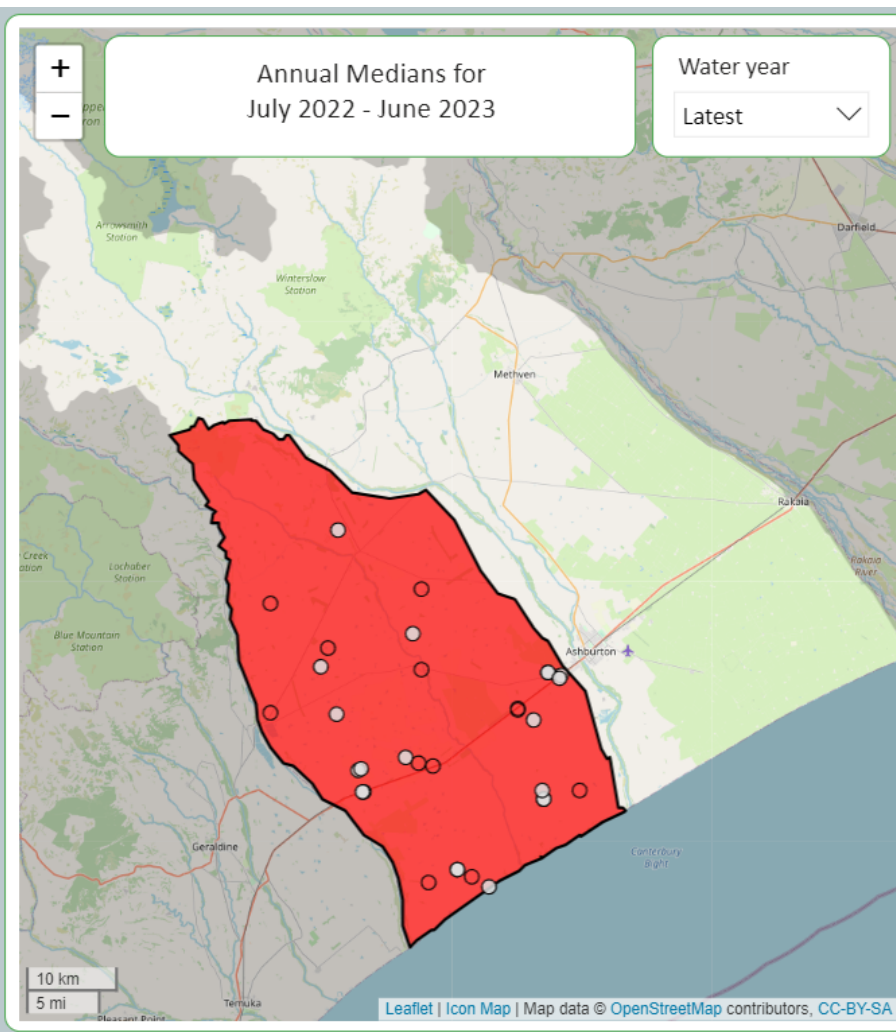
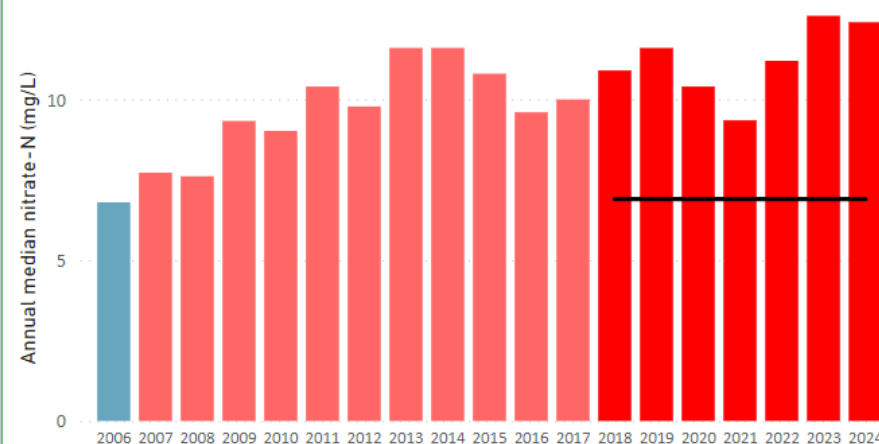
**Method:** Since wells could be sampled at different frequencies (typically annually or quarterly), equal weighting is ensured by first determining the annual median for each well before calculating the median for the sub-zone. Only wells shown in grey are used for the median, wells shown as empty circles 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

**WARNING: 2024 results are preliminary until 1 July.**

● Target did not apply but exceeded curre... ● Target did not apply but ... ● Target exceeded ● Target





## APPENDIX B – NITROGEN LOAD REPORT 2023 (GROUNDSense LIMITED)

# Memorandum

Investigation: 2023 Annual Reporting CRC184159 & CRC211511

Prepared by: Dr Glen Treweek

Prepared for: Barrhill Chertsey Irrigation Ltd

Date: November 2023

Document status: Final

Document version: V1

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### Summary

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.

### Calculated Nitrogen Discharge Allowance

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 v6.5.2. Accordingly, all Nitrogen loss values used in The Matrix method for this assessment were updated to v6.5.2

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.

The farmed area included in Table 1 and Table 2 presented in Table 3 and Table 4 below 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 2023 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<br>Plains NAZ | Upper Hinds-Hekeao<br>Plains NAZ | BCI Total |
|------------|----------------------------------|----------------------------------|-----------|
|            | Area (ha)                        | Area (ha)                        | Area (ha) |
| NDA        | 10,161                           | 0                                | 10,161    |
| Authorised | 0                                | 0                                | 0         |

*Table 2: Farm area for 2023 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 -<br>Rakaia NAZ | Ashburton NAZ | Rakaia NAZ | BCI Total |
|------------|---------------------------|---------------|------------|-----------|
|            | Area (ha)                 | Area (ha)     | Area (ha)  | Area (ha) |
| NDA        | 39,162                    | 8,313         | 182        | 47,658    |
| Authorised | 1,503                     | 0             | 31         | 1,534     |

*Table 3: Calculated Nitrogen Discharge Allowance and Nitrogen Load for the 2023 year for BCI farms in the Hinds-Hekeao Plains (PC2) zones authorised by CRC184159 (Overseer V6.5.2).*

|      | Lower Hinds-Hekeao<br>Plains NAZ | Upper Hinds-Hekeao<br>Plains NAZ | BCI Total       |
|------|----------------------------------|----------------------------------|-----------------|
|      | N load (t N/yr)                  | N load (t N/yr)                  | N load (t N/yr) |
| NDA  | 555.5                            | 0                                | 555.5           |
| 2023 | 483.1                            | 0                                | 483.1           |

*Table 4: Calculated Nitrogen Discharge Allowance and Nitrogen Load for the 2023 year for BCI farms in the Ashburton & Rakaia (PC5) zones authorised by CRC211511 (Overseer v6.5.2).*

|      | Ashburton -<br>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  | 1,683.4                   | 419.6           | 5.6             | 2,108.6         |
| 2023 | 1,451.7                   | 374.8           | 6.0             | 1,832.4         |

Condition 8 (a) of CRC184159 and condition 7 (a) of CRC211511 require a scheme-wide map showing all properties managed under the consent, and the relevant nutrient allocation zone. Those maps are below (Figure 1, Figure 2) and supplied electronically.

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 2023 year for BCI farms in the Hinds-Hekeao Plains (PC2) zones authorised by CRC184159 (Overseer V6.5.2).*

|      | Lower Hinds-Hekeao<br>Plains NAZ | Upper Hinds-Hekeao<br>Plains NAZ | BCI Total |
|------|----------------------------------|----------------------------------|-----------|
|      | mg N/L                           | mg N/L                           | mg N/L    |
| 2022 | 16.5                             | 0                                | 16.5      |
| 2023 | 16.2                             | 0                                | 16.2      |

*Table 6: Calculated Nitrogen concentration for the 2023 year for BCI farms in the Ashburton & Rakaia (PC5) zones authorised by CRC211511 (Overseer v6.5.2).*

|      | Ashburton -<br>Rakaia NAZ | Ashburton NAZ | Rakaia NAZ | BCI Total |
|------|---------------------------|---------------|------------|-----------|
|      | mg N/L                    | mg N/L        | mg N/L     | mg N/L    |
| 2022 | 11.8                      | 16.2          | 9.9        | 12.5      |
| 2023 | 11.5                      | 15.8          | 9.8        | 12.1      |



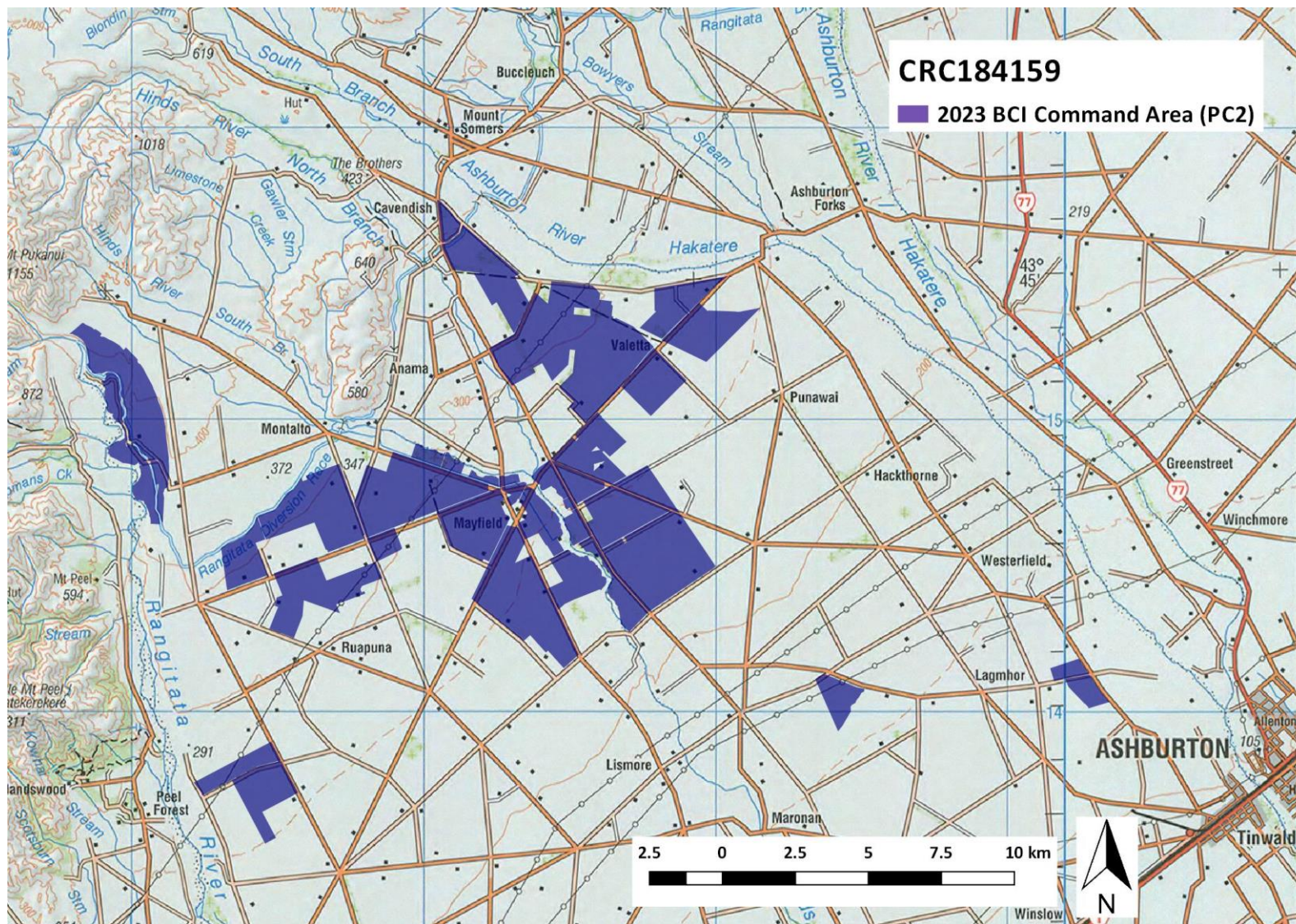


Figure 1: Map of Properties authorised by CRC184159 for the year 2023



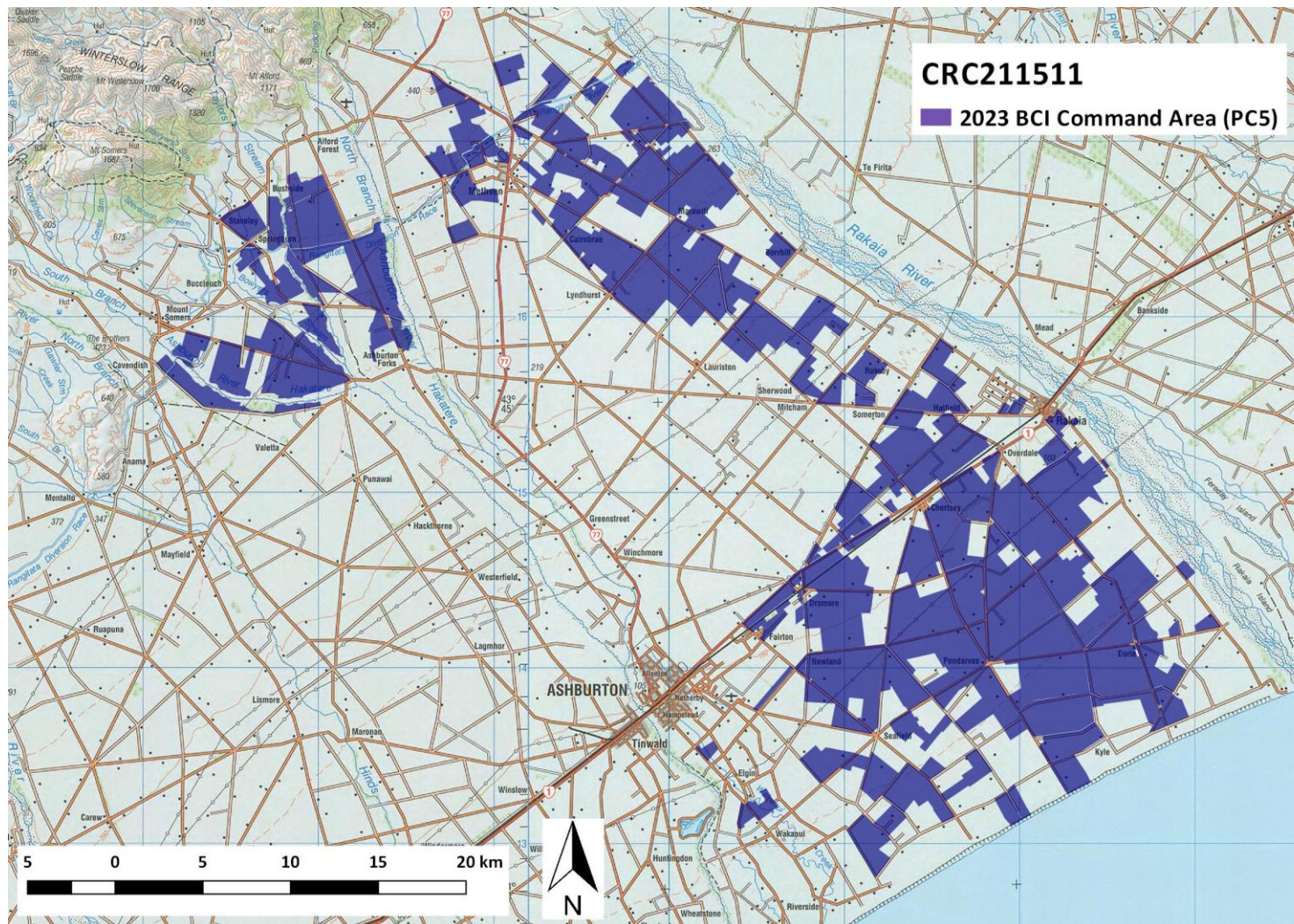


Figure 2: Map of Properties authorised by CRC211511 for the year 2023



| Farm Identifier | NDA – Lower Hinds-Hekeao Plains<br>Nutrient Allocation Zone<br>(kg N/yr) | NDA – Upper Hinds-Hekeao Plains<br>Nutrient Allocation Zone<br>(kg N/yr) |
|-----------------|--------------------------------------------------------------------------|--------------------------------------------------------------------------|
| 116             | 19,123                                                                   | 0                                                                        |
| 454             | 9,009                                                                    | 0                                                                        |
| 348             | 10,298                                                                   | 0                                                                        |
| 138             | 29,229                                                                   | 0                                                                        |
| 502             | 5,611                                                                    | 0                                                                        |
| 866             | 18,978                                                                   | 0                                                                        |
| 766             | 2,185                                                                    | 0                                                                        |
| 743             | 14,493                                                                   | 0                                                                        |
| 957             | 16,589                                                                   | 0                                                                        |
| 114             | 3,121                                                                    | 0                                                                        |
| 162             | 21,219                                                                   | 0                                                                        |
| 399             | 19,774                                                                   | 0                                                                        |
| 549             | 4,138                                                                    | 0                                                                        |
| 716             | 16,221                                                                   | 0                                                                        |
| 630             | 23,741                                                                   | 0                                                                        |
| 400             | 12,127                                                                   | 0                                                                        |
| 730             | 8,412                                                                    | 0                                                                        |
| 687             | 2,876                                                                    | 0                                                                        |
| 754             | 3,329                                                                    | 0                                                                        |
| 361             | 18,588                                                                   | 0                                                                        |
| 547             | 8,365                                                                    | 0                                                                        |
| 833             | 13,967                                                                   | 0                                                                        |
| 225             | 2,631                                                                    | 0                                                                        |
| 49              | 18,041                                                                   | 0                                                                        |
| 344             | 34,600                                                                   | 0                                                                        |
| 864             | 20,532                                                                   | 0                                                                        |
| 70              | 20,589                                                                   | 0                                                                        |
| 683             | 16,725                                                                   | 0                                                                        |
| 115             | 20,181                                                                   | 0                                                                        |
| 358             | 7,807                                                                    | 0                                                                        |
| 33              | 1,033                                                                    | 0                                                                        |
| 231             | 37,560                                                                   | 0                                                                        |
| 250             | 20,106                                                                   | 0                                                                        |
| 295             | 8,118                                                                    | 0                                                                        |
| 340             | 6,438                                                                    | 0                                                                        |
| 554             | 8,498                                                                    | 0                                                                        |
| 823             | 7,730                                                                    | 0                                                                        |

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| Farm Identifier | NDA – Lower Hinds-Hekeao Plains<br>Nutrient Allocation Zone<br>(kg N/yr) | NDA – Upper Hinds-Hekeao Plains<br>Nutrient Allocation Zone<br>(kg N/yr) |
|-----------------|--------------------------------------------------------------------------|--------------------------------------------------------------------------|
| 206             | 5,418                                                                    | 0                                                                        |
| 24              | 12,012                                                                   | 0                                                                        |
| 314             | 14,347                                                                   | 0                                                                        |
| 576             | 903                                                                      | 0                                                                        |
| 325             | 6,467                                                                    | 0                                                                        |
| 159             | 4,373                                                                    | 0                                                                        |
| Total           | 555,499                                                                  | 0                                                                        |

Schedule CRC211511A v23 – November 2023 (Overseer version 6.5.2)

| Farm Identifier | NDA – Ashburton - Rakaia<br>Nutrient Allocation Zone<br>(kg N/yr) | NDA – Ashburton<br>Nutrient Allocation<br>Zone<br>(kg N/yr) | NDA – Rakaia<br>Nutrient Allocation<br>Zone<br>(kg N/yr) |
|-----------------|-------------------------------------------------------------------|-------------------------------------------------------------|----------------------------------------------------------|
| 881             | 0                                                                 | 0                                                           | 0                                                        |
| 694             | 13,665                                                            | 0                                                           | 0                                                        |
| 986             | 11,594                                                            | 0                                                           | 0                                                        |
| 77              | 10,498                                                            | 0                                                           | 0                                                        |
| 662             | 26,813                                                            | 0                                                           | 0                                                        |
| 315             | 10,445                                                            | 0                                                           | 0                                                        |
| 686             | 8,524                                                             | 0                                                           | 0                                                        |
| 722             | 10,339                                                            | 0                                                           | 630                                                      |
| 261             | 15,227                                                            | 2,421                                                       | 0                                                        |
| 91              | 12,103                                                            | 0                                                           | 0                                                        |
| 701             | 11,691                                                            | 0                                                           | 0                                                        |
| 105             | 6,408                                                             | 0                                                           | 0                                                        |
| 485             | 2,368                                                             | 0                                                           | 303                                                      |
| 939             | 10,071                                                            | 0                                                           | 0                                                        |
| 991             | 24,704                                                            | 0                                                           | 0                                                        |
| 89              | 11,287                                                            | 0                                                           | 0                                                        |
| 562             | 11,612                                                            | 0                                                           | 0                                                        |
| 641             | 11,482                                                            | 0                                                           | 0                                                        |
| 442             | 12,785                                                            | 0                                                           | 0                                                        |
| 558             | 13,245                                                            | 0                                                           | 0                                                        |
| 629             | 9,413                                                             | 0                                                           | 0                                                        |
| 174             | 22,519                                                            | 0                                                           | 0                                                        |
| 514             | 19,323                                                            | 0                                                           | 0                                                        |
| 339             | 19,825                                                            | 0                                                           | 0                                                        |
| 724             | 15,168                                                            | 0                                                           | 0                                                        |
| 130             | 49,144                                                            | 0                                                           | 0                                                        |
| 619             | 23,425                                                            | 0                                                           | 0                                                        |
| 209             | 2,008                                                             | 0                                                           | 0                                                        |
| 428             | 14,715                                                            | 0                                                           | 0                                                        |
| 255             | 9,450                                                             | 0                                                           | 0                                                        |
| 229             | 108,290                                                           | 0                                                           | 0                                                        |
| 996             | 7,648                                                             | 0                                                           | 0                                                        |
| 609             | 9,491                                                             | 0                                                           | 0                                                        |
| 964             | 8,882                                                             | 0                                                           | 0                                                        |
| 505             | 43,215                                                            | 0                                                           | 0                                                        |

| Farm Identifier | NDA – Ashburton - Rakaia<br>Nutrient Allocation Zone<br>(kg N/yr) | NDA – Ashburton<br>Nutrient Allocation<br>Zone<br>(kg N/yr) | NDA – Rakaia<br>Nutrient Allocation<br>Zone<br>(kg N/yr) |
|-----------------|-------------------------------------------------------------------|-------------------------------------------------------------|----------------------------------------------------------|
| 500             | 27,049                                                            | 0                                                           | 0                                                        |
| 628             | 20,471                                                            | 0                                                           | 0                                                        |
| 974             | 18,898                                                            | 0                                                           | 0                                                        |
| 281             | 13,516                                                            | 0                                                           | 0                                                        |
| 959             | 29,835                                                            | 0                                                           | 0                                                        |
| 154             | 17,133                                                            | 0                                                           | 0                                                        |
| 984             | 12,107                                                            | 0                                                           | 0                                                        |
| 848             | 13,563                                                            | 0                                                           | 0                                                        |
| 913             | 36,765                                                            | 0                                                           | 0                                                        |
| 393             | 18,604                                                            | 0                                                           | 0                                                        |
| 332             | 24,368                                                            | 0                                                           | 0                                                        |
| 402             | 22,147                                                            | 0                                                           | 0                                                        |
| 58              | 0                                                                 | 0                                                           | 0                                                        |
| 356             | 2,240                                                             | 0                                                           | 0                                                        |
| 411             | 11,048                                                            | 0                                                           | 0                                                        |
| 348             | 0                                                                 | 1,851                                                       | 0                                                        |
| 6               | 17,792                                                            | 0                                                           | 0                                                        |
| 134             | 16,167                                                            | 0                                                           | 0                                                        |
| 755             | 0                                                                 | 8,553                                                       | 0                                                        |
| 698             | 0                                                                 | 13,521                                                      | 0                                                        |
| 863             | 6,017                                                             | 0                                                           | 0                                                        |
| 9               | 10,936                                                            | 0                                                           | 0                                                        |
| 236             | 6,964                                                             | 0                                                           | 3,273                                                    |
| 592             | 0                                                                 | 11,539                                                      | 0                                                        |
| 846             | 0                                                                 | 2,932                                                       | 0                                                        |
| 781             | 4,709                                                             | 13,270                                                      | 0                                                        |
| 296             | 0                                                                 | 16,081                                                      | 0                                                        |
| 759             | 22,301                                                            | 0                                                           | 0                                                        |
| 8               | 16,284                                                            | 0                                                           | 0                                                        |
| 904             | 0                                                                 | 12,902                                                      | 0                                                        |
| 25              | 18,646                                                            | 0                                                           | 0                                                        |
| 577             | 3,701                                                             | 0                                                           | 0                                                        |
| 530             | 13,502                                                            | 0                                                           | 0                                                        |
| 922             | 0                                                                 | 0                                                           | 0                                                        |
| 664             | 0                                                                 | 14,856                                                      | 0                                                        |
| 804             | 0                                                                 | 27,952                                                      | 0                                                        |
| 757             | 6,792                                                             | 0                                                           | 0                                                        |
| 663             | 5,822                                                             | 0                                                           | 0                                                        |

| Farm Identifier | NDA – Ashburton - Rakaia<br>Nutrient Allocation Zone<br>(kg N/yr) | NDA – Ashburton<br>Nutrient Allocation<br>Zone<br>(kg N/yr) | NDA – Rakaia<br>Nutrient Allocation<br>Zone<br>(kg N/yr) |
|-----------------|-------------------------------------------------------------------|-------------------------------------------------------------|----------------------------------------------------------|
| 44              | 13,302                                                            | 0                                                           | 0                                                        |
| 28              | 22,612                                                            | 0                                                           | 0                                                        |
| 21              | 11,251                                                            | 0                                                           | 0                                                        |
| 453             | 7,767                                                             | 0                                                           | 0                                                        |
| 247             | 16,573                                                            | 0                                                           | 918                                                      |
| 956             | 13,141                                                            | 0                                                           | 0                                                        |
| 277             | 0                                                                 | 0                                                           | 0                                                        |
| 973             | 0                                                                 | 11,622                                                      | 0                                                        |
| 379             | 103,225                                                           | 0                                                           | 0                                                        |
| 708             | 0                                                                 | 21,158                                                      | 0                                                        |
| 542             | 9,233                                                             | 0                                                           | 0                                                        |
| 401             | 0                                                                 | 4,646                                                       | 0                                                        |
| 85              | 0                                                                 | 79,833                                                      | 0                                                        |
| 630             | 0                                                                 | 74                                                          | 0                                                        |
| 57              | 11,231                                                            | 0                                                           | 0                                                        |
| 156             | 16,345                                                            | 0                                                           | 0                                                        |
| 31              | 12,577                                                            | 0                                                           | 0                                                        |
| 969             | 3,973                                                             | 0                                                           | 0                                                        |
| 503             | 2,500                                                             | 0                                                           | 0                                                        |
| 570             | 0                                                                 | 30,400                                                      | 0                                                        |
| 493             | 6,712                                                             | 0                                                           | 0                                                        |
| 501             | 5,323                                                             | 0                                                           | 0                                                        |
| 47              | 0                                                                 | 8,504                                                       | 0                                                        |
| 23              | 4,775                                                             | 0                                                           | 20                                                       |
| 512             | 5,277                                                             | 0                                                           | 0                                                        |
| 272             | 0                                                                 | 0                                                           | 0                                                        |
| 334             | 12,465                                                            | 0                                                           | 0                                                        |
| 841             | 3,671                                                             | 0                                                           | 0                                                        |
| 319             | 0                                                                 | 14,633                                                      | 0                                                        |
| 153             | 7,949                                                             | 0                                                           | 479                                                      |
| 432             | 0                                                                 | 7,876                                                       | 0                                                        |
| 492             | 0                                                                 | 0                                                           | 0                                                        |
| 859             | 10,200                                                            | 0                                                           | 0                                                        |
| 365             | 10,531                                                            | 0                                                           | 0                                                        |
| 941             | 7,153                                                             | 0                                                           | 0                                                        |
| 374             | 3,195                                                             | 0                                                           | 0                                                        |
| 729             | 5,696                                                             | 0                                                           | 0                                                        |
| 50              | 9,045                                                             | 0                                                           | 0                                                        |

| Farm Identifier | NDA – Ashburton - Rakaia<br>Nutrient Allocation Zone<br>(kg N/yr) | NDA – Ashburton<br>Nutrient Allocation<br>Zone<br>(kg N/yr) | NDA – Rakaia<br>Nutrient Allocation<br>Zone<br>(kg N/yr) |
|-----------------|-------------------------------------------------------------------|-------------------------------------------------------------|----------------------------------------------------------|
| 417             | 3,880                                                             | 0                                                           | 0                                                        |
| 788             | 61,121                                                            | 0                                                           | 0                                                        |
| 717             | 6,025                                                             | 0                                                           | 0                                                        |
| 15              | 0                                                                 | 14,808                                                      | 0                                                        |
| 283             | 0                                                                 | 12,886                                                      | 0                                                        |
| 607             | 3,175                                                             | 0                                                           | 0                                                        |
| 611             | 47,204                                                            | 0                                                           | 0                                                        |
| 301             | 0                                                                 | 19,137                                                      | 0                                                        |
| 463             | 9,042                                                             | 0                                                           | 0                                                        |
| 246             | 11,501                                                            | 0                                                           | 0                                                        |
| 799             | 13,210                                                            | 0                                                           | 0                                                        |
| 901             | 0                                                                 | 11,067                                                      | 0                                                        |
| 353             | 0                                                                 | 11,724                                                      | 0                                                        |
| 397             | 14,573                                                            | 0                                                           | 0                                                        |
| 238             | 2,275                                                             | 0                                                           | 0                                                        |
| 491             | 3,688                                                             | 0                                                           | 0                                                        |
| 758             | 1,513                                                             | 0                                                           | 0                                                        |
| 362             | 14,168                                                            | 12,585                                                      | 0                                                        |
| 515             | 7,071                                                             | 4,832                                                       | 0                                                        |
| 744             | 17,007                                                            | 0                                                           | 0                                                        |
| 692             | 1,592                                                             | 0                                                           | 0                                                        |
| 256             | 0                                                                 | 0                                                           | 0                                                        |
| 891             | 0                                                                 | 0                                                           | 0                                                        |
| 507             | 0                                                                 | 11,878                                                      | 0                                                        |
| 900             | 0                                                                 | 15,914                                                      | 0                                                        |
| 824             | 0                                                                 | 0                                                           | 0                                                        |
| 645             | 0                                                                 | 0                                                           | 0                                                        |
| 448             | 9,028                                                             | 0                                                           | 0                                                        |
| 14              | 0                                                                 | 0                                                           | 0                                                        |
| 929             | 22,530                                                            | 0                                                           | 0                                                        |
| 280             | 11,471                                                            | 0                                                           | 0                                                        |
| 921             | 0                                                                 | 0                                                           | 0                                                        |
| 24              | 0                                                                 | 137                                                         | 0                                                        |
| 513             | 0                                                                 | 0                                                           | 0                                                        |
| 972             | 0                                                                 | 0                                                           | 0                                                        |
| 19              | 9,407                                                             | 0                                                           | 0                                                        |
| 249             | 22,673                                                            | 0                                                           | 0                                                        |
| 436             | 0                                                                 | 0                                                           | 0                                                        |



| Farm Identifier | NDA – Ashburton - Rakaia<br>Nutrient Allocation Zone<br>(kg N/yr) | NDA – Ashburton<br>Nutrient Allocation<br>Zone<br>(kg N/yr) | NDA – Rakaia<br>Nutrient Allocation<br>Zone<br>(kg N/yr) |
|-----------------|-------------------------------------------------------------------|-------------------------------------------------------------|----------------------------------------------------------|
| 845             | 0                                                                 | 0                                                           | 0                                                        |
| 968             | 1,195                                                             | 0                                                           | 0                                                        |
| 1777            | 5,645                                                             | 0                                                           | 0                                                        |
| 2586            | 2,133                                                             | 0                                                           | 0                                                        |
| 3395            | 13,581                                                            | 0                                                           | 0                                                        |
| 4204            | 18,243                                                            | 0                                                           | 0                                                        |
| Total           | 1,683,426                                                         | 419,593                                                     | 5,623                                                    |

APPENDIX C – LAWFULLY INTENSIFIED/IRRIGATED LOAD CALCULATION 2023  
(GROUNDSense LIMITED)

# Memorandum

Investigation: Update to The Matrix

Prepared by: Dr Glen Treweek

Prepared for: Ashburton Lyndhurst Irrigation Ltd, Barrhill Chertsey Irrigation Ltd, MHV Water Limited

Date: 28<sup>th</sup> September 2023

Document status: Final

Document version: V1

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## Summary

Ashburton Lyndhurst Irrigation Ltd. (ALIL) holds 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 nitrogen loss value for Lawfully Irrigated Land when Overseer v6.5.2 is used is **56 kg N/ha/yr**.

The soil water drainage value for Lawfully Irrigated Land when Overseer v6.5.2 is used is **383 mm/yr**.

## 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 CRC185469, CRC184159, CRC211511 and CRC185857 require the most recent version of Overseer to be used if nitrogen losses are modelled using Overseer. The current version of Overseer as at 28<sup>th</sup> September 2023 was v6.5.2.

## File modification

Updates to the Overseer 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 v6.5.2, four of the representative files (Sheep and Beef 2, DPD, L, MH, and VL soils, Advanced Mitigation) failed to generate a viable analysis. The farm analysis showed a 164% over-feeding error in August for Sheep.

The procedure for amending representative Matrix Overseer files approved by the Chief Executive of Environment Canterbury is outlined in the flow diagram below (Figure 1).

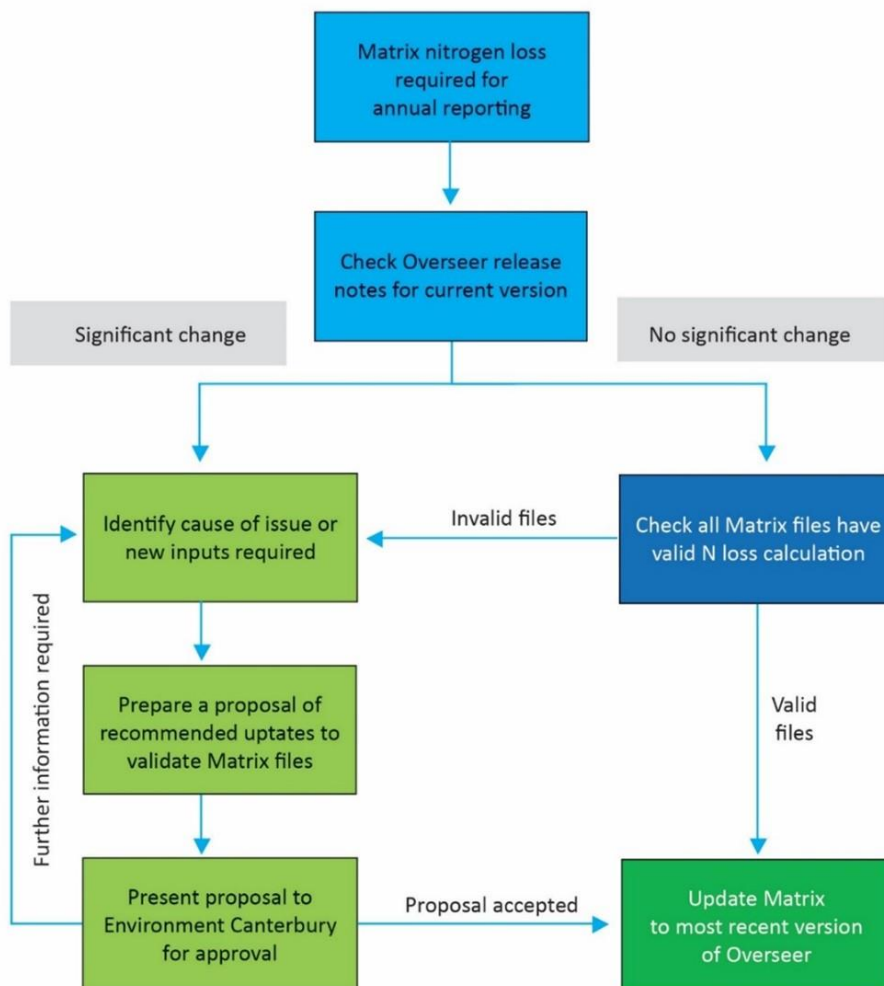


Figure 1: Process for modifying representative Overseer files used by The Matrix method as approved by the Chief Executive of the Canterbury Regional Council, 29th April 2020.

Advice from Overseer Ltd was sought, and a solution proposed by Alastair Taylor. The solution altered the final defoliation on the block BD (Kale>Kale) so that sheep received 28% of the available feed, rather than 30% of the available feed. The small modification resolved the over-feeding error, and the model was able to generate a viable analysis.

Approval of the proposed solution was sought from Environment Canterbury on 19<sup>th</sup> September 2023, and granted on 22<sup>nd</sup> September 2023 (Appendix 1).

### Lawfully Irrigated Land

Condition 4 (b) of CRC185469, CRC184159, CRC211511 and CRC185857 provide 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 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
  - **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 v6.5.2 as follows (Table 1):

- 60% Dairy @ 57.2 kg N/ha/yr = 34.3 kg N/ha/yr
- 20% Dairy support @ 60 kg N/ha/yr = 12 kg N/ha/yr
- 20% Arable – 47.2 kg N/ha/yr = 9.4 kg N/ha/yr
  - **Total 55.7 kg N/ha/yr**

Consents CRC185469, CRC184159, CRC211511 and CRC185857 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 **383 mm/yr** (Table 1).

Table 1: Updated nitrogen loss and soil water drainage values using Overseer version 6.4.3.

|                       | Nitrogen loss | Soil Water Drainage |
|-----------------------|---------------|---------------------|
|                       | (kg N/ha/yr)  | (mm/yr)             |
| Dairy 1 (D1)          | 57.2          | 376                 |
| Dairy Support 1 (DS1) | 60            | 390                 |
| Arable 2 (Ar2)        | 47.2          | 397                 |
| <b>Total</b>          | <b>56</b>     | <b>383</b>          |

The updated Matrix values for nitrogen loss and soil water drainage using Overseer v6.5.2 can be found in Appendix 2.

#### *Mitigations not modelled by Overseer*

Original modelling when preparing the projected load of 27 kg N/ha/yr included some mitigations not able to 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 65.2 kg N/ha/yr to 57.2 kg N/ha/yr (Table 1).

This memorandum has been prepared by Ground Sense Ltd on the specific instructions of Ashburton Lyndhurst Irrigation Ltd, Barrhill Chertsey Irrigation Ltd, and MHV Water Ltd for the limited purposes described in this memorandum. Ground Sense Ltd accepts no liability if the information presented is used for any purpose other than those described here.



## Appendix 1

**glen@groundsense.co.nz**

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**From:** Terry Hewitt <Terry.Hewitt@ecan.govt.nz>  
**Sent:** Friday, 22 September 2023 10:46 am  
**To:** Eva Harris  
**Cc:** Jenny Watters; Nick Daniels; Rebecca Whillans; Melanie Brooks; Glen Treweek; Nikki Jenkins  
**Subject:** RE: Request for Approval to Update Matrix Representative Files

Good morning Eva,

I write to confirm that Environment Canterbury agree that the best way forward would be to modify the Matrix "Sheep and Beef" files in accordance with the proposed "fix".

Accordingly, approval is granted to proceed with your fix.

Kind regards,  
Terry

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**From:** Eva Harris <eva@envirocollective.co.nz>  
**Sent:** Tuesday, 19 September 2023 10:21 am  
**To:** Terry Hewitt <Terry.Hewitt@ecan.govt.nz>  
**Cc:** Jenny Watters <Jenny.Watters@ecan.govt.nz>; Nick Daniels <nickd@bcwater.co.nz>; Rebecca Whillans <Rebecca@alil.co.nz>; Melanie Brooks <Mel@mhvwater.nz>; Glen Treweek <glen@groundsense.co.nz>  
**Subject:** Request for Approval to Update Matrix Representative Files  
**Importance:** High

**Caution:** This is an email from an external party. Please take care when clicking links or opening attachments.

Good Morning Terry,

It's that time of the year again when we start calculations for our compliance reporting according to The Matrix. As part of this process, we update The Matrix into the most recent version of Overseer (v6.5.2). This year's Overseer model update included a change in how defoliation is modelled resulting in some files including an additional event resulting in a ME error (see [Overseer 6.5.2 release notes](#), point 6). We have identified all 28 of the "Sheep and Beef" representative Matrix files report this error in v6.5.2 and need minor modifications for the model to run.

According to the Matrix equivalence approval document and the BCI, MHV and ALIL EMS's, the process we need to follow when a file ceases to work in a later version of Overseer is attached. In short, we:

1. Propose the amendment necessary for the file to work to ECan
2. ECan reviews the proposal and either approves or provides feedback
3. Once ECan is satisfied, the changes are made to the files and the Matrix can be updated.

We have sought advice from Overseer on the best way to modify the Matrix "Sheep and Beef" files (see email attached). The "fix" is unlikely to result in significant change to the nitrogen loss calculations for these files. Furthermore, the "Sheep and Beef" files apply to a small proportion for each scheme (~5%).

Can you please review the attached information and advise if we can proceed with the "fix" to the 28 "Sheep and Beef" representative nutrient budgets? We would appreciate a prompt response (if possible) so we can complete the model update as soon as practicable.

I am happy to arrange a meeting to discuss.

Regards,

Eva

## Appendix 2

| Matrix code    | Nitrogen loss v6.5.2<br>(kg N/yr) | Soil water drainage<br>v6.5.2 (mm/yr) |
|----------------|-----------------------------------|---------------------------------------|
| Ar_BD_DPD_MRB  | 118                               | 1,724                                 |
| Ar_BD_L_MRB    | 118                               | 1,729                                 |
| Ar_BD_MH_MRB   | 120                               | 1,724                                 |
| Ar_BD_VL_MRB   | 117                               | 1,733                                 |
| Ar_Piv_DPD_MRB | 36                                | 534                                   |
| Ar_Piv_L_MRB   | 50                                | 555                                   |
| Ar_Piv_MH_MRB  | 43                                | 552                                   |
| Ar_Piv_VL_MRB  | 52                                | 557                                   |
| Ar_RR_DPD_MRB  | 40                                | 595                                   |
| Ar_RR_L_MRB    | 57                                | 683                                   |
| Ar_RR_MH_MRB   | 49                                | 624                                   |
| Ar_RR_VL_MRB   | 58                                | 682                                   |
| Ar_Dry_DPD_MRB | 20                                | 201                                   |
| Ar_Dry_L_MRB   | 31                                | 269                                   |
| Ar_Dry_MH_MRB  | 25                                | 246                                   |
| Ar_Dry_VL_MRB  | 32                                | 275                                   |
| D1_BD_DPD_MRB  | 146                               | 1,373                                 |
| D1_BD_L_MRB    | 182                               | 1,620                                 |
| D1_BD_MH_MRB   | 161                               | 1,620                                 |
| D1_BD_VL_MRB   | 192                               | 1,621                                 |
| D1_Piv_DPD_MRB | 82                                | 422                                   |
| D1_Piv_L_MRB   | 115                               | 501                                   |
| D1_Piv_MH_MRB  | 93                                | 501                                   |
| D1_Piv_VL_MRB  | 123                               | 501                                   |
| D1_RR_DPD_MRB  | 75                                | 419                                   |
| D1_RR_L_MRB    | 114                               | 625                                   |
| D1_RR_MH_MRB   | 91                                | 563                                   |
| D1_RR_VL_MRB   | 122                               | 605                                   |
| D1_Dry_DPD_MRB | 24                                | 195                                   |
| D1_Dry_L_MRB   | 41                                | 246                                   |
| D1_Dry_MH_MRB  | 32                                | 230                                   |
| D1_Dry_VL_MRB  | 44                                | 250                                   |
| D2_BD_DPD_MRB  | 146                               | 1,373                                 |
| D2_BD_L_MRB    | 182                               | 1,620                                 |
| D2_BD_MH_MRB   | 161                               | 1,620                                 |
| D2_BD_VL_MRB   | 192                               | 1,621                                 |
| D2_Piv_DPD_MRB | 70                                | 422                                   |
| D2_Piv_L_MRB   | 100                               | 501                                   |

| Matrix code     | Nitrogen loss v6.5.2<br>(kg N/yr) | Soil water drainage<br>v6.5.2 (mm/yr) |
|-----------------|-----------------------------------|---------------------------------------|
| D2_Piv_MH_MRB   | 80                                | 501                                   |
| D2_Piv_VL_MRB   | 107                               | 501                                   |
| D2_RR_DPD_MRB   | 75                                | 419                                   |
| D2_RR_L_MRB     | 114                               | 625                                   |
| D2_RR_MH_MRB    | 91                                | 563                                   |
| D2_RR_VL_MRB    | 122                               | 605                                   |
| D2_Dry_DPD_MRB  | 24                                | 195                                   |
| D2_Dry_L_MRB    | 41                                | 246                                   |
| D2_Dry_MH_MRB   | 32                                | 230                                   |
| D2_Dry_VL_MRB   | 44                                | 250                                   |
| DS_BD_DPD_MRB   | 119                               | 1,570                                 |
| DS_BD_L_MRB     | 139                               | 1,680                                 |
| DS_BD_MH_MRB    | 130                               | 1,676                                 |
| DS_BD_VL_MRB    | 142                               | 1,682                                 |
| DS_Piv_DPD_MRB  | 62                                | 503                                   |
| DS_Piv_L_MRB    | 85                                | 538                                   |
| DS_Piv_MH_MRB   | 74                                | 538                                   |
| DS_Piv_VL_MRB   | 89                                | 539                                   |
| DS_RR_DPD_MRB   | 64                                | 513                                   |
| DS_RR_L_MRB     | 92                                | 666                                   |
| DS_RR_MH_MRB    | 77                                | 601                                   |
| DS_RR_VL_MRB    | 97                                | 656                                   |
| DS_Dry_DPD_MRB  | 24                                | 195                                   |
| DS_Dry_L_MRB    | 41                                | 246                                   |
| DS_Dry_MH_MRB   | 32                                | 230                                   |
| DS_Dry_VL_MRB   | 44                                | 250                                   |
| WIN_BD_DPD_MRB  | 166                               | 1,712                                 |
| WIN_BD_L_MRB    | 191                               | 1,723                                 |
| WIN_BD_MH_MRB   | 180                               | 1,716                                 |
| WIN_BD_VL_MRB   | 194                               | 1,726                                 |
| WIN_Piv_DPD_MRB | 91                                | 563                                   |
| WIN_Piv_L_MRB   | 122                               | 566                                   |
| WIN_Piv_MH_MRB  | 107                               | 566                                   |
| WIN_Piv_VL_MRB  | 126                               | 567                                   |
| WIN_RR_DPD_MRB  | 93                                | 581                                   |
| WIN_RR_L_MRB    | 134                               | 697                                   |
| WIN_RR_MH_MRB   | 113                               | 629                                   |
| WIN_RR_VL_MRB   | 139                               | 693                                   |
| WIN_Dry_DPD_MRB | 33                                | 226                                   |
| WIN_Dry_L_MRB   | 57                                | 266                                   |

| Matrix code        | Nitrogen loss v6.5.2<br>(kg N/yr) | Soil water drainage<br>v6.5.2 (mm/yr) |
|--------------------|-----------------------------------|---------------------------------------|
| WIN_Dry_MH_MRB     | 45                                | 249                                   |
| WIN_Dry_VL_MRB     | 62                                | 270                                   |
| S&B_BD_DPD_MRB     | 80                                | 1,428                                 |
| S&B_BD_L_MRB       | 94                                | 1,635                                 |
| S&B_BD_MH_MRB      | 87                                | 1,633                                 |
| S&B_BD_VL_MRB      | 97                                | 1,636                                 |
| S&B_Piv_DPD_MRB    | 37                                | 443                                   |
| S&B_Piv_L_MRB      | 52                                | 509                                   |
| S&B_Piv_MH_MRB     | 44                                | 509                                   |
| S&B_Piv_VL_MRB     | 55                                | 509                                   |
| S&B_RR_DPD_MRB     | 39                                | 442                                   |
| S&B_RR_L_MRB       | 57                                | 634                                   |
| S&B_RR_MH_MRB      | 47                                | 570                                   |
| S&B_RR_VL_MRB      | 60                                | 617                                   |
| S&B_Dry_DPD_MRB    | 15                                | 156                                   |
| S&B_Dry_L_MRB      | 27                                | 214                                   |
| S&B_Dry_MH_MRB     | 21                                | 199                                   |
| S&B_Dry_VL_MRB     | 29                                | 218                                   |
| Ar_BD_DPD_HPZ_gmp  | 71                                | 606                                   |
| Ar_BD_L_HPZ_gmp    | 126                               | 1,097                                 |
| Ar_BD_MH_HPZ_gmp   | 119                               | 914                                   |
| Ar_BD_VL_HPZ_gmp   | 126                               | 1,100                                 |
| Ar_Piv_DPD_HPZ_gmp | 31                                | 436                                   |
| Ar_Piv_L_HPZ_gmp   | 46                                | 494                                   |
| Ar_Piv_MH_HPZ_gmp  | 39                                | 480                                   |
| Ar_Piv_VL_HPZ_gmp  | 49                                | 495                                   |
| Ar_RR_DPD_HPZ_gmp  | 42                                | 631                                   |
| Ar_RR_L_HPZ_gmp    | 57                                | 638                                   |
| Ar_RR_MH_HPZ_gmp   | 48                                | 620                                   |
| Ar_RR_VL_HPZ_gmp   | 59                                | 641                                   |
| Ar_Dry_DPD_HPZ_gmp | 20                                | 201                                   |
| Ar_Dry_L_HPZ_gmp   | 31                                | 269                                   |
| Ar_Dry_MH_HPZ_gmp  | 25                                | 246                                   |
| Ar_Dry_VL_HPZ_gmp  | 32                                | 275                                   |
| D1_BD_DPD_HPZ_gmp  | 57                                | 435                                   |
| D1_BD_L_HPZ_gmp    | 153                               | 971                                   |
| D1_BD_MH_HPZ_gmp   | 106                               | 787                                   |
| D1_BD_VL_HPZ_gmp   | 162                               | 974                                   |
| D1_Piv_DPD_HPZ_gmp | 41                                | 284                                   |
| D1_Piv_L_HPZ_gmp   | 81                                | 410                                   |

| Matrix code        | Nitrogen loss v6.5.2<br>(kg N/yr) | Soil water drainage<br>v6.5.2 (mm/yr) |
|--------------------|-----------------------------------|---------------------------------------|
| D1_Piv_MH_HPZ_gmp  | 60                                | 398                                   |
| D1_Piv_VL_HPZ_gmp  | 89                                | 410                                   |
| D1_RR_DPD_HPZ_gmp  | 59                                | 448                                   |
| D1_RR_L_HPZ_gmp    | 94                                | 532                                   |
| D1_RR_MH_HPZ_gmp   | 70                                | 488                                   |
| D1_RR_VL_HPZ_gmp   | 103                               | 533                                   |
| D1_Dry_DPD_HPZ_gmp | 24                                | 195                                   |
| D1_Dry_L_HPZ_gmp   | 41                                | 246                                   |
| D1_Dry_MH_HPZ_gmp  | 32                                | 230                                   |
| D1_Dry_VL_HPZ_gmp  | 44                                | 250                                   |
| D2_BD_DPD_HPZ_gmp  | 57                                | 435                                   |
| D2_BD_L_HPZ_gmp    | 153                               | 971                                   |
| D2_BD_MH_HPZ_gmp   | 106                               | 787                                   |
| D2_BD_VL_HPZ_gmp   | 162                               | 974                                   |
| D2_Piv_DPD_HPZ_gmp | 33                                | 304                                   |
| D2_Piv_L_HPZ_gmp   | 68                                | 410                                   |
| D2_Piv_MH_HPZ_gmp  | 49                                | 398                                   |
| D2_Piv_VL_HPZ_gmp  | 75                                | 410                                   |
| D2_RR_DPD_HPZ_gmp  | 59                                | 448                                   |
| D2_RR_L_HPZ_gmp    | 94                                | 532                                   |
| D2_RR_MH_HPZ_gmp   | 70                                | 488                                   |
| D2_RR_VL_HPZ_gmp   | 103                               | 533                                   |
| D2_Dry_DPD_HPZ_gmp | 24                                | 195                                   |
| D2_Dry_L_HPZ_gmp   | 41                                | 246                                   |
| D2_Dry_MH_HPZ_gmp  | 32                                | 230                                   |
| D2_Dry_VL_HPZ_gmp  | 44                                | 250                                   |
| DS_BD_DPD_HPZ_gmp  | 58                                | 535                                   |
| DS_BD_L_HPZ_gmp    | 112                               | 1,031                                 |
| DS_BD_MH_HPZ_gmp   | 92                                | 852                                   |
| DS_BD_VL_HPZ_gmp   | 115                               | 1,035                                 |
| DS_Piv_DPD_HPZ_gmp | 46                                | 389                                   |
| DS_Piv_L_HPZ_gmp   | 78                                | 465                                   |
| DS_Piv_MH_HPZ_gmp  | 64                                | 451                                   |
| DS_Piv_VL_HPZ_gmp  | 82                                | 467                                   |
| DS_RR_DPD_HPZ_gmp  | 62                                | 549                                   |
| DS_RR_L_HPZ_gmp    | 92                                | 594                                   |
| DS_RR_MH_HPZ_gmp   | 76                                | 551                                   |
| DS_RR_VL_HPZ_gmp   | 97                                | 596                                   |
| DS_Dry_DPD_HPZ_gmp | 24                                | 195                                   |
| DS_Dry_L_HPZ_gmp   | 41                                | 246                                   |

| Matrix code         | Nitrogen loss v6.5.2<br>(kg N/yr) | Soil water drainage<br>v6.5.2 (mm/yr) |
|---------------------|-----------------------------------|---------------------------------------|
| DS_Dry_MH_HPZ_gmp   | 32                                | 230                                   |
| DS_Dry_VL_HPZ_gmp   | 44                                | 250                                   |
| WIN_BD_DPD_HPZ_gmp  | 85                                | 607                                   |
| WIN_BD_L_HPZ_gmp    | 159                               | 1,074                                 |
| WIN_BD_MH_HPZ_gmp   | 136                               | 899                                   |
| WIN_BD_VL_HPZ_gmp   | 162                               | 1,078                                 |
| WIN_Piv_DPD_HPZ_gmp | 69                                | 453                                   |
| WIN_Piv_L_HPZ_gmp   | 114                               | 507                                   |
| WIN_Piv_MH_HPZ_gmp  | 95                                | 491                                   |
| WIN_Piv_VL_HPZ_gmp  | 119                               | 509                                   |
| WIN_RR_DPD_HPZ_gmp  | 93                                | 622                                   |
| WIN_RR_L_HPZ_gmp    | 137                               | 639                                   |
| WIN_RR_MH_HPZ_gmp   | 114                               | 596                                   |
| WIN_RR_VL_HPZ_gmp   | 142                               | 642                                   |
| WIN_Dry_DPD_HPZ_gmp | 33                                | 226                                   |
| WIN_Dry_L_HPZ_gmp   | 57                                | 266                                   |
| WIN_Dry_MH_HPZ_gmp  | 45                                | 249                                   |
| WIN_Dry_VL_HPZ_gmp  | 62                                | 270                                   |
| S&B_BD_DPD_HPZ_gmp  | 35                                | 463                                   |
| S&B_BD_L_HPZ_gmp    | 70                                | 985                                   |
| S&B_BD_MH_HPZ_gmp   | 55                                | 803                                   |
| S&B_BD_VL_HPZ_gmp   | 73                                | 989                                   |
| S&B_Piv_DPD_HPZ_gmp | 25                                | 326                                   |
| S&B_Piv_L_HPZ_gmp   | 42                                | 422                                   |
| S&B_Piv_MH_HPZ_gmp  | 33                                | 410                                   |
| S&B_Piv_VL_HPZ_gmp  | 45                                | 423                                   |
| S&B_RR_DPD_HPZ_gmp  | 36                                | 475                                   |
| S&B_RR_L_HPZ_gmp    | 53                                | 546                                   |
| S&B_RR_MH_HPZ_gmp   | 42                                | 501                                   |
| S&B_RR_VL_HPZ_gmp   | 56                                | 547                                   |
| S&B_Dry_DPD_HPZ_gmp | 15                                | 156                                   |
| S&B_Dry_L_HPZ_gmp   | 27                                | 214                                   |
| S&B_Dry_MH_HPZ_gmp  | 21                                | 199                                   |
| S&B_Dry_VL_HPZ_gmp  | 29                                | 218                                   |
| Ar_BD_DPD_AM1       | 99                                | 1,764                                 |
| Ar_BD_L_AM1         | 103                               | 1,784                                 |
| Ar_BD_MH_AM1        | 103                               | 1,779                                 |
| Ar_BD_VL_AM1        | 102                               | 1,787                                 |
| Ar_Piv_DPD_AM1      | 20                                | 310                                   |
| Ar_Piv_L_AM1        | 31                                | 350                                   |



| Matrix code    | Nitrogen loss v6.5.2<br>(kg N/yr) | Soil water drainage<br>v6.5.2 (mm/yr) |
|----------------|-----------------------------------|---------------------------------------|
| Ar_Piv_MH_AM1  | 26                                | 336                                   |
| Ar_Piv_VL_AM1  | 33                                | 357                                   |
| Ar_RR_DPD_AM1  | 24                                | 328                                   |
| Ar_RR_L_AM1    | 38                                | 358                                   |
| Ar_RR_MH_AM1   | 31                                | 344                                   |
| Ar_RR_VL_AM1   | 41                                | 368                                   |
| Ar_Dry_DPD_AM1 | 20                                | 201                                   |
| Ar_Dry_L_AM1   | 31                                | 269                                   |
| Ar_Dry_MH_AM1  | 25                                | 246                                   |
| Ar_Dry_VL_AM1  | 32                                | 275                                   |
| D1_BD_DPD_AM1  | 89                                | 1,418                                 |
| D1_BD_L_AM1    | 114                               | 1,675                                 |
| D1_BD_MH_AM1   | 98                                | 1,674                                 |
| D1_BD_VL_AM1   | 119                               | 1,675                                 |
| D1_Piv_DPD_AM1 | 30                                | 283                                   |
| D1_Piv_L_AM1   | 49                                | 337                                   |
| D1_Piv_MH_AM1  | 36                                | 317                                   |
| D1_Piv_VL_AM1  | 51                                | 326                                   |
| D1_RR_DPD_AM1  | 23                                | 249                                   |
| D1_RR_L_AM1    | 36                                | 328                                   |
| D1_RR_MH_AM1   | 28                                | 300                                   |
| D1_RR_VL_AM1   | 44                                | 366                                   |
| D1_Dry_DPD_AM1 | 20                                | 195                                   |
| D1_Dry_L_AM1   | 35                                | 246                                   |
| D1_Dry_MH_AM1  | 27                                | 230                                   |
| D1_Dry_VL_AM1  | 37                                | 250                                   |
| D2_BD_DPD_AM1  | 89                                | 1,418                                 |
| D2_BD_L_AM1    | 114                               | 1,675                                 |
| D2_BD_MH_AM1   | 98                                | 1,674                                 |
| D2_BD_VL_AM1   | 119                               | 1,675                                 |
| D2_Piv_DPD_AM1 | 30                                | 283                                   |
| D2_Piv_L_AM1   | 50                                | 337                                   |
| D2_Piv_MH_AM1  | 36                                | 317                                   |
| D2_Piv_VL_AM1  | 52                                | 326                                   |
| D2_RR_DPD_AM1  | 23                                | 249                                   |
| D2_RR_L_AM1    | 36                                | 328                                   |
| D2_RR_MH_AM1   | 28                                | 300                                   |
| D2_RR_VL_AM1   | 44                                | 366                                   |
| D2_Dry_DPD_AM1 | 20                                | 195                                   |
| D2_Dry_L_AM1   | 35                                | 246                                   |

| Matrix code     | Nitrogen loss v6.5.2<br>(kg N/yr) | Soil water drainage<br>v6.5.2 (mm/yr) |
|-----------------|-----------------------------------|---------------------------------------|
| D2_Dry_MH_AM1   | 27                                | 230                                   |
| D2_Dry_VL_AM1   | 37                                | 250                                   |
| DS_BD_DPD_AM1   | 100                               | 1,617                                 |
| DS_BD_L_AM1     | 119                               | 1,735                                 |
| DS_BD_MH_AM1    | 110                               | 1,730                                 |
| DS_BD_VL_AM1    | 122                               | 1,736                                 |
| DS_Piv_DPD_AM1  | 27                                | 270                                   |
| DS_Piv_L_AM1    | 51                                | 352                                   |
| DS_Piv_MH_AM1   | 41                                | 339                                   |
| DS_Piv_VL_AM1   | 53                                | 345                                   |
| DS_RR_DPD_AM1   | 27                                | 290                                   |
| DS_RR_L_AM1     | 50                                | 356                                   |
| DS_RR_MH_AM1    | 39                                | 332                                   |
| DS_RR_VL_AM1    | 55                                | 380                                   |
| DS_Dry_DPD_AM1  | 20                                | 195                                   |
| DS_Dry_L_AM1    | 35                                | 246                                   |
| DS_Dry_MH_AM1   | 27                                | 230                                   |
| DS_Dry_VL_AM1   | 37                                | 250                                   |
| WIN_BD_DPD_AM1  | 137                               | 1,760                                 |
| WIN_BD_L_AM1    | 162                               | 1,778                                 |
| WIN_BD_MH_AM1   | 151                               | 1,771                                 |
| WIN_BD_VL_AM1   | 164                               | 1,780                                 |
| WIN_Piv_DPD_AM1 | 37                                | 307                                   |
| WIN_Piv_L_AM1   | 70                                | 363                                   |
| WIN_Piv_MH_AM1  | 58                                | 355                                   |
| WIN_Piv_VL_AM1  | 73                                | 359                                   |
| WIN_RR_DPD_AM1  | 37                                | 320                                   |
| WIN_RR_L_AM1    | 70                                | 377                                   |
| WIN_RR_MH_AM1   | 54                                | 355                                   |
| WIN_RR_VL_AM1   | 77                                | 390                                   |
| WIN_Dry_DPD_AM1 | 27                                | 226                                   |
| WIN_Dry_L_AM1   | 47                                | 266                                   |
| WIN_Dry_MH_AM1  | 37                                | 249                                   |
| WIN_Dry_VL_AM1  | 51                                | 270                                   |
| S&B_BD_DPD_AM1  | 65                                | 1,474                                 |
| S&B_BD_L_AM1    | 77                                | 1,689                                 |
| S&B_BD_MH_AM1   | 70                                | 1,687                                 |
| S&B_BD_VL_AM1   | 80                                | 1,690                                 |
| S&B_Piv_DPD_AM1 | 19                                | 294                                   |
| S&B_Piv_L_AM1   | 28                                | 340                                   |

| Matrix code         | Nitrogen loss v6.5.2<br>(kg N/yr) | Soil water drainage<br>v6.5.2 (mm/yr) |
|---------------------|-----------------------------------|---------------------------------------|
| S&B_Piv_MH_AM1      | 22                                | 321                                   |
| S&B_Piv_VL_AM1      | 29                                | 330                                   |
| S&B_RR_DPD_AM1      | 17                                | 261                                   |
| S&B_RR_L_AM1        | 27                                | 333                                   |
| S&B_RR_MH_AM1       | 22                                | 307                                   |
| S&B_RR_VL_AM1       | 31                                | 368                                   |
| S&B_Dry_DPD_AM1     | 12                                | 156                                   |
| S&B_Dry_L_AM1       | 21                                | 214                                   |
| S&B_Dry_MH_AM1      | 17                                | 199                                   |
| S&B_Dry_VL_AM1      | 22                                | 218                                   |
| Ar_BD_DPD_Fert_GMP  | 118                               | 1,724                                 |
| Ar_BD_L_Fert_GMP    | 118                               | 1,729                                 |
| Ar_BD_MH_Fert_GMP   | 120                               | 1,724                                 |
| Ar_BD_VL_Fert_GMP   | 117                               | 1,733                                 |
| Ar_Piv_DPD_Fert_GMP | 32                                | 518                                   |
| Ar_Piv_L_Fert_GMP   | 48                                | 550                                   |
| Ar_Piv_MH_Fert_GMP  | 42                                | 547                                   |
| Ar_Piv_VL_Fert_GMP  | 50                                | 554                                   |
| Ar_RR_DPD_Fert_GMP  | 37                                | 584                                   |
| Ar_RR_L_Fert_GMP    | 56                                | 676                                   |
| Ar_RR_MH_Fert_GMP   | 48                                | 617                                   |
| Ar_RR_VL_Fert_GMP   | 58                                | 675                                   |
| Ar_Dry_DPD_Fert_GMP | 20                                | 201                                   |
| Ar_Dry_L_Fert_GMP   | 31                                | 269                                   |
| Ar_Dry_MH_Fert_GMP  | 25                                | 246                                   |
| Ar_Dry_VL_Fert_GMP  | 32                                | 275                                   |
| D1_BD_DPD_Fert_GMP  | 140                               | 1,373                                 |
| D1_BD_L_Fert_GMP    | 174                               | 1,620                                 |
| D1_BD_MH_Fert_GMP   | 154                               | 1,620                                 |
| D1_BD_VL_Fert_GMP   | 183                               | 1,621                                 |
| D1_Piv_DPD_Fert_GMP | 78                                | 422                                   |
| D1_Piv_L_Fert_GMP   | 111                               | 501                                   |
| D1_Piv_MH_Fert_GMP  | 89                                | 501                                   |
| D1_Piv_VL_Fert_GMP  | 118                               | 501                                   |
| D1_RR_DPD_Fert_GMP  | 76                                | 419                                   |
| D1_RR_L_Fert_GMP    | 115                               | 625                                   |
| D1_RR_MH_Fert_GMP   | 92                                | 563                                   |
| D1_RR_VL_Fert_GMP   | 123                               | 605                                   |
| D1_Dry_DPD_Fert_GMP | 22                                | 195                                   |
| D1_Dry_L_Fert_GMP   | 37                                | 246                                   |

| Matrix code          | Nitrogen loss v6.5.2<br>(kg N/yr) | Soil water drainage<br>v6.5.2 (mm/yr) |
|----------------------|-----------------------------------|---------------------------------------|
| D1_Dry_MH_Fert_GMP   | 29                                | 230                                   |
| D1_Dry_VL_Fert_GMP   | 40                                | 250                                   |
| D2_BD_DPD_Fert_GMP   | 140                               | 1,373                                 |
| D2_BD_L_Fert_GMP     | 174                               | 1,620                                 |
| D2_BD_MH_Fert_GMP    | 154                               | 1,620                                 |
| D2_BD_VL_Fert_GMP    | 183                               | 1,621                                 |
| D2_Piv_DPD_Fert_GMP  | 71                                | 422                                   |
| D2_Piv_L_Fert_GMP    | 102                               | 501                                   |
| D2_Piv_MH_Fert_GMP   | 82                                | 501                                   |
| D2_Piv_VL_Fert_GMP   | 109                               | 501                                   |
| D2_RR_DPD_Fert_GMP   | 76                                | 419                                   |
| D2_RR_L_Fert_GMP     | 115                               | 625                                   |
| D2_RR_MH_Fert_GMP    | 92                                | 563                                   |
| D2_RR_VL_Fert_GMP    | 123                               | 605                                   |
| D2_Dry_DPD_Fert_GMP  | 22                                | 195                                   |
| D2_Dry_L_Fert_GMP    | 37                                | 246                                   |
| D2_Dry_MH_Fert_GMP   | 29                                | 230                                   |
| D2_Dry_VL_Fert_GMP   | 40                                | 250                                   |
| DS_BD_DPD_Fert_GMP   | 113                               | 1,570                                 |
| DS_BD_L_Fert_GMP     | 132                               | 1,680                                 |
| DS_BD_MH_Fert_GMP    | 122                               | 1,676                                 |
| DS_BD_VL_Fert_GMP    | 135                               | 1,682                                 |
| DS_Piv_DPD_Fert_GMP  | 60                                | 503                                   |
| DS_Piv_L_Fert_GMP    | 82                                | 538                                   |
| DS_Piv_MH_Fert_GMP   | 70                                | 538                                   |
| DS_Piv_VL_Fert_GMP   | 84                                | 539                                   |
| DS_RR_DPD_Fert_GMP   | 60                                | 513                                   |
| DS_RR_L_Fert_GMP     | 88                                | 666                                   |
| DS_RR_MH_Fert_GMP    | 73                                | 601                                   |
| DS_RR_VL_Fert_GMP    | 92                                | 656                                   |
| DS_Dry_DPD_Fert_GMP  | 22                                | 195                                   |
| DS_Dry_L_Fert_GMP    | 37                                | 246                                   |
| DS_Dry_MH_Fert_GMP   | 29                                | 230                                   |
| DS_Dry_VL_Fert_GMP   | 40                                | 250                                   |
| WIN_BD_DPD_Fert_GMP  | 155                               | 1,712                                 |
| WIN_BD_L_Fert_GMP    | 178                               | 1,723                                 |
| WIN_BD_MH_Fert_GMP   | 167                               | 1,716                                 |
| WIN_BD_VL_Fert_GMP   | 181                               | 1,726                                 |
| WIN_Piv_DPD_Fert_GMP | 86                                | 563                                   |
| WIN_Piv_L_Fert_GMP   | 115                               | 566                                   |

| Matrix code          | Nitrogen loss v6.5.2<br>(kg N/yr) | Soil water drainage<br>v6.5.2 (mm/yr) |
|----------------------|-----------------------------------|---------------------------------------|
| WIN_Piv_MH_Fert_GMP  | 101                               | 566                                   |
| WIN_Piv_VL_Fert_GMP  | 118                               | 567                                   |
| WIN_RR_DPD_Fert_GMP  | 88                                | 581                                   |
| WIN_RR_L_Fert_GMP    | 126                               | 697                                   |
| WIN_RR_MH_Fert_GMP   | 106                               | 629                                   |
| WIN_RR_VL_Fert_GMP   | 131                               | 693                                   |
| WIN_Dry_DPD_Fert_GMP | 29                                | 226                                   |
| WIN_Dry_L_Fert_GMP   | 51                                | 266                                   |
| WIN_Dry_MH_Fert_GMP  | 40                                | 249                                   |
| WIN_Dry_VL_Fert_GMP  | 55                                | 270                                   |
| S&B_BD_DPD_Fert_GMP  | 80                                | 1,428                                 |
| S&B_BD_L_Fert_GMP    | 94                                | 1,635                                 |
| S&B_BD_MH_Fert_GMP   | 87                                | 1,633                                 |
| S&B_BD_VL_Fert_GMP   | 97                                | 1,636                                 |
| S&B_Piv_DPD_Fert_GMP | 37                                | 443                                   |
| S&B_Piv_L_Fert_GMP   | 52                                | 509                                   |
| S&B_Piv_MH_Fert_GMP  | 44                                | 509                                   |
| S&B_Piv_VL_Fert_GMP  | 55                                | 509                                   |
| S&B_RR_DPD_Fert_GMP  | 39                                | 442                                   |
| S&B_RR_L_Fert_GMP    | 57                                | 634                                   |
| S&B_RR_MH_Fert_GMP   | 47                                | 570                                   |
| S&B_RR_VL_Fert_GMP   | 60                                | 617                                   |
| S&B_Dry_DPD_Fert_GMP | 15                                | 156                                   |
| S&B_Dry_L_Fert_GMP   | 27                                | 214                                   |
| S&B_Dry_MH_Fert_GMP  | 21                                | 199                                   |
| S&B_Dry_VL_Fert_GMP  | 29                                | 218                                   |
| Ar_BD_DPD_Irr_GMP    | 115                               | 1,778                                 |
| Ar_BD_L_Irr_GMP      | 113                               | 1,784                                 |
| Ar_BD_MH_Irr_GMP     | 115                               | 1,779                                 |
| Ar_BD_VL_Irr_GMP     | 112                               | 1,787                                 |
| Ar_Piv_DPD_Irr_GMP   | 22                                | 256                                   |
| Ar_Piv_L_Irr_GMP     | 36                                | 319                                   |
| Ar_Piv_MH_Irr_GMP    | 28                                | 298                                   |
| Ar_Piv_VL_Irr_GMP    | 37                                | 320                                   |
| Ar_RR_DPD_Irr_GMP    | 22                                | 277                                   |
| Ar_RR_L_Irr_GMP      | 36                                | 336                                   |
| Ar_RR_MH_Irr_GMP     | 30                                | 324                                   |
| Ar_RR_VL_Irr_GMP     | 38                                | 339                                   |
| Ar_Dry_DPD_Irr_GMP   | 20                                | 201                                   |
| Ar_Dry_L_Irr_GMP     | 31                                | 269                                   |

| Matrix code        | Nitrogen loss v6.5.2<br>(kg N/yr) | Soil water drainage<br>v6.5.2 (mm/yr) |
|--------------------|-----------------------------------|---------------------------------------|
| Ar_Dry_MH_Irr_GMP  | 25                                | 246                                   |
| Ar_Dry_VL_Irr_GMP  | 32                                | 275                                   |
| D1_BD_DPD_Irr_GMP  | 148                               | 1,418                                 |
| D1_BD_L_Irr_GMP    | 186                               | 1,675                                 |
| D1_BD_MH_Irr_GMP   | 161                               | 1,674                                 |
| D1_BD_VL_Irr_GMP   | 194                               | 1,675                                 |
| D1_Piv_DPD_Irr_GMP | 37                                | 195                                   |
| D1_Piv_L_Irr_GMP   | 60                                | 297                                   |
| D1_Piv_MH_Irr_GMP  | 46                                | 272                                   |
| D1_Piv_VL_Irr_GMP  | 63                                | 289                                   |
| D1_RR_DPD_Irr_GMP  | 31                                | 213                                   |
| D1_RR_L_Irr_GMP    | 50                                | 299                                   |
| D1_RR_MH_Irr_GMP   | 37                                | 274                                   |
| D1_RR_VL_Irr_GMP   | 54                                | 299                                   |
| D1_Dry_DPD_Irr_GMP | 24                                | 195                                   |
| D1_Dry_L_Irr_GMP   | 41                                | 246                                   |
| D1_Dry_MH_Irr_GMP  | 32                                | 230                                   |
| D1_Dry_VL_Irr_GMP  | 44                                | 250                                   |
| D2_BD_DPD_Irr_GMP  | 148                               | 1,418                                 |
| D2_BD_L_Irr_GMP    | 186                               | 1,675                                 |
| D2_BD_MH_Irr_GMP   | 161                               | 1,674                                 |
| D2_BD_VL_Irr_GMP   | 194                               | 1,675                                 |
| D2_Piv_DPD_Irr_GMP | 29                                | 195                                   |
| D2_Piv_L_Irr_GMP   | 48                                | 297                                   |
| D2_Piv_MH_Irr_GMP  | 36                                | 272                                   |
| D2_Piv_VL_Irr_GMP  | 51                                | 289                                   |
| D2_RR_DPD_Irr_GMP  | 31                                | 213                                   |
| D2_RR_L_Irr_GMP    | 50                                | 299                                   |
| D2_RR_MH_Irr_GMP   | 37                                | 274                                   |
| D2_RR_VL_Irr_GMP   | 54                                | 299                                   |
| D2_Dry_DPD_Irr_GMP | 24                                | 195                                   |
| D2_Dry_L_Irr_GMP   | 41                                | 246                                   |
| D2_Dry_MH_Irr_GMP  | 32                                | 230                                   |
| D2_Dry_VL_Irr_GMP  | 44                                | 250                                   |
| DS_BD_DPD_Irr_GMP  | 115                               | 1,621                                 |
| DS_BD_L_Irr_GMP    | 135                               | 1,735                                 |
| DS_BD_MH_Irr_GMP   | 125                               | 1,730                                 |
| DS_BD_VL_Irr_GMP   | 138                               | 1,736                                 |
| DS_Piv_DPD_Irr_GMP | 35                                | 240                                   |
| DS_Piv_L_Irr_GMP   | 57                                | 314                                   |

| Matrix code         | Nitrogen loss v6.5.2<br>(kg N/yr) | Soil water drainage<br>v6.5.2 (mm/yr) |
|---------------------|-----------------------------------|---------------------------------------|
| DS_Piv_MH_Irr_GMP   | 44                                | 283                                   |
| DS_Piv_VL_Irr_GMP   | 58                                | 305                                   |
| DS_RR_DPD_Irr_GMP   | 35                                | 258                                   |
| DS_RR_L_Irr_GMP     | 58                                | 323                                   |
| DS_RR_MH_Irr_GMP    | 45                                | 294                                   |
| DS_RR_VL_Irr_GMP    | 62                                | 324                                   |
| DS_Dry_DPD_Irr_GMP  | 24                                | 195                                   |
| DS_Dry_L_Irr_GMP    | 41                                | 246                                   |
| DS_Dry_MH_Irr_GMP   | 32                                | 230                                   |
| DS_Dry_VL_Irr_GMP   | 44                                | 250                                   |
| WIN_BD_DPD_Irr_GMP  | 162                               | 1,767                                 |
| WIN_BD_L_Irr_GMP    | 187                               | 1,778                                 |
| WIN_BD_MH_Irr_GMP   | 175                               | 1,771                                 |
| WIN_BD_VL_Irr_GMP   | 190                               | 1,780                                 |
| WIN_Piv_DPD_Irr_GMP | 49                                | 274                                   |
| WIN_Piv_L_Irr_GMP   | 81                                | 327                                   |
| WIN_Piv_MH_Irr_GMP  | 63                                | 291                                   |
| WIN_Piv_VL_Irr_GMP  | 82                                | 317                                   |
| WIN_RR_DPD_Irr_GMP  | 51                                | 290                                   |
| WIN_RR_L_Irr_GMP    | 85                                | 340                                   |
| WIN_RR_MH_Irr_GMP   | 66                                | 308                                   |
| WIN_RR_VL_Irr_GMP   | 90                                | 342                                   |
| WIN_Dry_DPD_Irr_GMP | 33                                | 226                                   |
| WIN_Dry_L_Irr_GMP   | 57                                | 266                                   |
| WIN_Dry_MH_Irr_GMP  | 45                                | 249                                   |
| WIN_Dry_VL_Irr_GMP  | 62                                | 270                                   |
| S&B_BD_DPD_Irr_GMP  | 76                                | 1,474                                 |
| S&B_BD_L_Irr_GMP    | 90                                | 1,689                                 |
| S&B_BD_MH_Irr_GMP   | 83                                | 1,687                                 |
| S&B_BD_VL_Irr_GMP   | 93                                | 1,690                                 |
| S&B_Piv_DPD_Irr_GMP | 18                                | 205                                   |
| S&B_Piv_L_Irr_GMP   | 30                                | 303                                   |
| S&B_Piv_MH_Irr_GMP  | 23                                | 274                                   |
| S&B_Piv_VL_Irr_GMP  | 31                                | 293                                   |
| S&B_RR_DPD_Irr_GMP  | 18                                | 222                                   |
| S&B_RR_L_Irr_GMP    | 30                                | 305                                   |
| S&B_RR_MH_Irr_GMP   | 23                                | 278                                   |
| S&B_RR_VL_Irr_GMP   | 32                                | 305                                   |
| S&B_Dry_DPD_Irr_GMP | 15                                | 156                                   |
| S&B_Dry_L_Irr_GMP   | 27                                | 214                                   |



| Matrix code        | Nitrogen loss v6.5.2<br>(kg N/yr) | Soil water drainage<br>v6.5.2 (mm/yr) |
|--------------------|-----------------------------------|---------------------------------------|
| S&B_Dry_MH_Irr_GMP | 21                                | 199                                   |
| S&B_Dry_VL_Irr_GMP | 29                                | 218                                   |
| Ar_BD_DPD_GMP      | 115                               | 1,778                                 |
| Ar_BD_L_GMP        | 113                               | 1,784                                 |
| Ar_BD_MH_GMP       | 115                               | 1,779                                 |
| Ar_BD_VL_GMP       | 112                               | 1,787                                 |
| Ar_Piv_DPD_GMP     | 22                                | 256                                   |
| Ar_Piv_L_GMP       | 36                                | 319                                   |
| Ar_Piv_MH_GMP      | 28                                | 298                                   |
| Ar_Piv_VL_GMP      | 37                                | 320                                   |
| Ar_RR_DPD_GMP      | 22                                | 277                                   |
| Ar_RR_L_GMP        | 36                                | 336                                   |
| Ar_RR_MH_GMP       | 30                                | 324                                   |
| Ar_RR_VL_GMP       | 38                                | 339                                   |
| Ar_Dry_DPD_GMP     | 20                                | 201                                   |
| Ar_Dry_L_GMP       | 31                                | 269                                   |
| Ar_Dry_MH_GMP      | 25                                | 246                                   |
| Ar_Dry_VL_GMP      | 32                                | 275                                   |
| D1_BD_DPD_GMP      | 141                               | 1,418                                 |
| D1_BD_L_GMP        | 177                               | 1,675                                 |
| D1_BD_MH_GMP       | 153                               | 1,674                                 |
| D1_BD_VL_GMP       | 185                               | 1,675                                 |
| D1_Piv_DPD_GMP     | 35                                | 195                                   |
| D1_Piv_L_GMP       | 57                                | 297                                   |
| D1_Piv_MH_GMP      | 43                                | 272                                   |
| D1_Piv_VL_GMP      | 60                                | 289                                   |
| D1_RR_DPD_GMP      | 32                                | 213                                   |
| D1_RR_L_GMP        | 52                                | 299                                   |
| D1_RR_MH_GMP       | 38                                | 274                                   |
| D1_RR_VL_GMP       | 56                                | 299                                   |
| D1_Dry_DPD_GMP     | 22                                | 195                                   |
| D1_Dry_L_GMP       | 37                                | 246                                   |
| D1_Dry_MH_GMP      | 29                                | 230                                   |
| D1_Dry_VL_GMP      | 40                                | 250                                   |
| D2_BD_DPD_GMP      | 141                               | 1,418                                 |
| D2_BD_L_GMP        | 177                               | 1,675                                 |
| D2_BD_MH_GMP       | 153                               | 1,674                                 |
| D2_BD_VL_GMP       | 185                               | 1,675                                 |
| D2_Piv_DPD_GMP     | 30                                | 195                                   |
| D2_Piv_L_GMP       | 51                                | 297                                   |

| Matrix code     | Nitrogen loss v6.5.2<br>(kg N/yr) | Soil water drainage<br>v6.5.2 (mm/yr) |
|-----------------|-----------------------------------|---------------------------------------|
| D2_Piv_MH_GMP   | 38                                | 272                                   |
| D2_Piv_VL_GMP   | 54                                | 289                                   |
| D2_RR_DPD_GMP   | 32                                | 213                                   |
| D2_RR_L_GMP     | 52                                | 299                                   |
| D2_RR_MH_GMP    | 38                                | 274                                   |
| D2_RR_VL_GMP    | 56                                | 299                                   |
| D2_Dry_DPD_GMP  | 22                                | 195                                   |
| D2_Dry_L_GMP    | 37                                | 246                                   |
| D2_Dry_MH_GMP   | 29                                | 230                                   |
| D2_Dry_VL_GMP   | 40                                | 250                                   |
| DS_BD_DPD_GMP   | 108                               | 1,621                                 |
| DS_BD_L_GMP     | 127                               | 1,735                                 |
| DS_BD_MH_GMP    | 118                               | 1,730                                 |
| DS_BD_VL_GMP    | 130                               | 1,736                                 |
| DS_Piv_DPD_GMP  | 33                                | 240                                   |
| DS_Piv_L_GMP    | 54                                | 314                                   |
| DS_Piv_MH_GMP   | 42                                | 283                                   |
| DS_Piv_VL_GMP   | 55                                | 305                                   |
| DS_RR_DPD_GMP   | 33                                | 258                                   |
| DS_RR_L_GMP     | 55                                | 323                                   |
| DS_RR_MH_GMP    | 42                                | 294                                   |
| DS_RR_VL_GMP    | 58                                | 324                                   |
| DS_Dry_DPD_GMP  | 22                                | 195                                   |
| DS_Dry_L_GMP    | 37                                | 246                                   |
| DS_Dry_MH_GMP   | 29                                | 230                                   |
| DS_Dry_VL_GMP   | 40                                | 250                                   |
| WIN_BD_DPD_GMP  | 151                               | 1,767                                 |
| WIN_BD_L_GMP    | 173                               | 1,778                                 |
| WIN_BD_MH_GMP   | 163                               | 1,771                                 |
| WIN_BD_VL_GMP   | 176                               | 1,780                                 |
| WIN_Piv_DPD_GMP | 46                                | 274                                   |
| WIN_Piv_L_GMP   | 76                                | 327                                   |
| WIN_Piv_MH_GMP  | 59                                | 291                                   |
| WIN_Piv_VL_GMP  | 77                                | 317                                   |
| WIN_RR_DPD_GMP  | 47                                | 290                                   |
| WIN_RR_L_GMP    | 79                                | 340                                   |
| WIN_RR_MH_GMP   | 62                                | 308                                   |
| WIN_RR_VL_GMP   | 84                                | 342                                   |
| WIN_Dry_DPD_GMP | 29                                | 226                                   |
| WIN_Dry_L_GMP   | 51                                | 266                                   |

| Matrix code     | Nitrogen loss v6.5.2<br>(kg N/yr) | Soil water drainage<br>v6.5.2 (mm/yr) |
|-----------------|-----------------------------------|---------------------------------------|
| WIN_Dry_MH_GMP  | 40                                | 249                                   |
| WIN_Dry_VL_GMP  | 55                                | 270                                   |
| S&B_BD_DPD_GMP  | 76                                | 1,474                                 |
| S&B_BD_L_GMP    | 90                                | 1,689                                 |
| S&B_BD_MH_GMP   | 83                                | 1,687                                 |
| S&B_BD_VL_GMP   | 93                                | 1,690                                 |
| S&B_Piv_DPD_GMP | 18                                | 205                                   |
| S&B_Piv_L_GMP   | 30                                | 303                                   |
| S&B_Piv_MH_GMP  | 23                                | 274                                   |
| S&B_Piv_VL_GMP  | 31                                | 293                                   |
| S&B_RR_DPD_GMP  | 18                                | 222                                   |
| S&B_RR_L_GMP    | 30                                | 305                                   |
| S&B_RR_MH_GMP   | 23                                | 278                                   |
| S&B_RR_VL_GMP   | 32                                | 305                                   |
| S&B_Dry_DPD_GMP | 15                                | 156                                   |
| S&B_Dry_L_GMP   | 27                                | 214                                   |
| S&B_Dry_MH_GMP  | 21                                | 199                                   |
| S&B_Dry_VL_GMP  | 29                                | 218                                   |



# **Environmental Management Strategy review**

## **Barrhill Chertsey Irrigation Limited**

28<sup>th</sup> November 2023

|                 |                                         |
|-----------------|-----------------------------------------|
| Client          | <b>Barrhill Chertsey Irrigation Ltd</b> |
| Matai Reference | J000304                                 |
| Prepared by     | Paul Reese                              |
| Date            | 27 <sup>th</sup> November 2023          |

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## EMS Review

### Review requirement

Barrhill Chertsey Irrigation Limited (BCI) hold a consent CRC184159 and CRC211511 permitting nutrient discharge from the farming activities the supply of water enables. BCI lease water to the Acton Farmers Irrigation Co-Operative and their farming activities are managed under the BCI consents.

In the consents an external EMS review required. This consists of an initial full review followed by an annual review of at least one third of the EMS (to be rotated annually to ensure the full EMS is reviewed at least once every three years).

This review is the starting component and reviews the EMS as a whole.

### Methodology

This review has 4 parts.

1. Program review. The program review tests the EMS against quality management principles.
2. Consent review. The consent review tests the EMS against the consent conditions.
3. Document review. The document review has investigated the connectivity, completeness and appropriateness of the content and documentation that makes up the EMS.
4. Process review. The process review selected examples of the processes outlined with in the documents and followed the outcomes to ensure consistency with the EMS.

### Aim

The aim of the EMS review as set out in the document is “The aim of the EMS review is to identify and discuss improvements in the documentation and implementation of the EMS to ensure the following:

1. Resource consents CRC184159 and CRC211511 are complied with
2. Properties achieve applicable N loss reduction targets
3. Properties with a Farm Environment Plan are achieving or working towards an “A” audit grade.”

## Findings

### **1. The Resource consent CRC184159 and CRC211511 are complied with**

The EMS has all the elements required within the consent conditions.

### **2. Properties achieve applicable N loss reduction targets**

The nitrogen loss targets are detailed within consent conditions. The reduction targets in CRC184159 (from HPZgmp<sup>1</sup>) are set into the future as

- a) from 1<sup>st</sup> January 2025, by 15% and
  - b) from 1<sup>st</sup> January 2030 by 25%
- and CRC211511 (from GMP)
- a) 15% of Properties that require a Farm Environment Plan at Advanced Mitigation (representing at least 15% of the total land area)
  - b) 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)

As the target dates are in the future the achievement of them cannot be confirmed by this review. However, the 2022 compliance report states the scheme wide nitrogen losses are 85% and 89% of the current consented N load limit for CRC184159 and CRC211511 respectively which meets and exceeds the 2025 reduction target.

### **3. Properties with a Farm Environment Plan are achieving or working towards an “A” audit grade.**

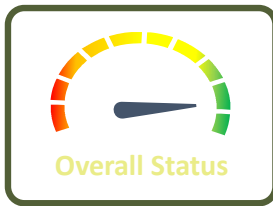
The EMS has very thorough processes and the BCI scheme provides strong support to enable properties to achieve A grades. The analysis of the data provided from the audits and subsequent actions has played a strong part in A grade achievement. The achievement, and progression of achievement, to A and AM grades is evident in the results reported.

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<sup>1</sup> Hinds Plains Zone Good Management Practice

## Program review

### Status



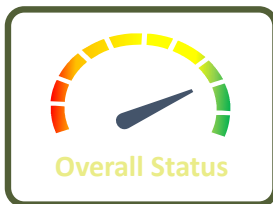
**The program review concludes the EMS is a comprehensive and effective program that meets the consent conditions and successfully manages the land use of the scheme shareholders**

### Findings

- The principles of a good QA scheme are all in place with many good aspects in each.
- There are some areas of improvement suggested but none are critical issues.
- The QA program has very clear standards that are set with rigid and enforceable actions to attain the standards.
- The processes are comprehensive with internal and external checks that include regulatory and EMS requirements.

## Consent and policy review

### Status



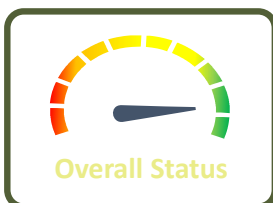
**The consent review shows all requirements are included in the EMS program.  
The EMS is consistent with the nutrient management policy.**

### Findings

- Work is ongoing with stakeholders to complete the risk assessment module.

## Document review

### Status



**The document review concludes the detailed and comprehensive processes provide an excellent platform to implement the EMS program.**

### Findings

- The document review has confirmed that the content within the EMS is fit for purpose to meet the consent and EMS objectives.
- The documents purpose and subject matter are identified with version control and review protocols in place.

## Process review

### Status



**The process review concludes the processes are well managed and provide high levels of confidence that the objectives of the EMS will be met.**

### Findings

- The systems in place are ordered, follow a repeatable and understandable pattern and can be followed by shareholders/farmers and their agents.
- There are internal and external checks and balances throughout the processes with thorough coverage of risks and regulatory considerations. Final approvals are confirmed at CE level.
- The examples reviewed all had followed correct processes and had considered the range of environmental and regulatory considerations.
- The examples reviewed found some areas for improvement but no critical issues.



# Annual Monitoring Report for Barrhill Chertsey Irrigation Limited: July 2022 – June 2023

✦ Prepared for

Barrhill Chertsey Irrigation Limited

✦ November 2023



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## Quality Control Sheet

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Appendix A: Groundwater Figures

Appendix B: Surface Water Figure and Tables

## 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 are 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, starting May 2023, as agreed with ECan groundwater scientist Mark Trewartha.

| 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       | 9.1              | 9.3    | 9.8  | 4              |
| BY22/0067                                                                                                                                                                | 36        | 12.3             | 13.8   | 15.7 | 20             |
| K36/0033                                                                                                                                                                 | 8         | 1.6              | 7.5    | 14.0 | 104            |
| K36/0088                                                                                                                                                                 | 17        | 0.1              | 3.7    | 6.8  | 60             |
| K36/0145                                                                                                                                                                 | 7         | 3.3              | 3.9    | 4.3  | 4              |
| K36/0172                                                                                                                                                                 | 10        | 1.6              | 3.9    | 10.3 | 43             |
| K36/0244                                                                                                                                                                 | 12        | 0.0              | 0.0    | 0.1  | 39             |
| L36/1242                                                                                                                                                                 | 83        | 2.4              | 12.7   | 17.5 | 63             |
| L36/2414                                                                                                                                                                 | 115       | 5.8              | 8.0    | 10.2 | 29             |
| L37/0010                                                                                                                                                                 | 74        | 3.5              | 3.9    | 8.1  | 3 <sup>1</sup> |
| L37/0016                                                                                                                                                                 | 72        | 10.8             | 11.5   | 12.0 | 4              |
| L37/0020                                                                                                                                                                 | 68        | 5.8              | 7.8    | 17.5 | 70             |
| L37/0197                                                                                                                                                                 | 41        | 7.2              | 9.7    | 11.5 | 59             |
| L37/0297                                                                                                                                                                 | 25        | 15.0             | 21.2   | 26.0 | 57             |
| L37/0556                                                                                                                                                                 | 44        | 5.3              | 7.0    | 16.2 | 23             |
| L37/0867                                                                                                                                                                 | 30        | 0.2              | 9.8    | 14.9 | 69             |
| L37/1566                                                                                                                                                                 | 21        | 6.6              | 12.6   | 16.7 | 10             |
| L37/1595                                                                                                                                                                 | 95        | 7.5              | 7.8    | 8.1  | 2 <sup>1</sup> |
| Notes:<br>1. Bores L37/0010 and L37/1595 were chosen as replacement monitoring bores, starting May 2023. This was agreed with ECan groundwater scientist Mark Trewartha. |           |                  |        |      |                |

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 ten of the 18 bores (56%) have exceeded the maximum acceptable value (MAV) for nitrate-nitrogen 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. 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 10.0 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.

| Table 2: Time Trends (v10.0) Results |             |       |                     |                       |                                |                   |
|--------------------------------------|-------------|-------|---------------------|-----------------------|--------------------------------|-------------------|
| Well                                 | Sample size | P     | Median annual slope | Percent annual change | 95% confidence limits on slope | Long-term Trend   |
| BX21/0001                            | 4           | -     | -                   | -                     | -                              | Insufficient data |
| BY22/0067                            | 20          | 0.672 | 0.111               | 0.807                 | -0.350 to 0.607                | Stable            |
| K36/0033                             | 104         | 0.000 | -0.140              | -1.878                | -0.201 to -0.076               | Decreasing        |
| K36/0088                             | 60          | 0.153 | 0.025               | 0.663                 | -0.010 to 0.055                | Stable            |
| K36/0145                             | 4           | -     | -                   | -                     | -                              | Insufficient data |
| K36/0172                             | 43          | 0.834 | -0.011              | -0.289                | -0.154 to 0.100                | Stable            |

| Well     | Sample size | P     | Median annual slope | Percent annual change | 95% confidence limits on slope | Long-term Trend   |
|----------|-------------|-------|---------------------|-----------------------|--------------------------------|-------------------|
| K36/0244 | 39          | 0.763 | 0.000               | 0.000                 | 0.000 to 0.000                 | Stable            |
| L36/1242 | 63          | 0.000 | 0.334               | 2.629                 | 0.187 to 0.516                 | Increasing        |
| L36/2414 | 29          | 0.019 | 0.151               | 1.887                 | 0.021 to 0.298                 | Increasing        |
| L37/0010 | 3           | -     | -                   | -                     | -                              | Insufficient data |
| L37/0016 | 4           | -     | -                   | -                     | -                              | Insufficient data |
| L37/0020 | 70          | 0.000 | 0.205               | 2.645                 | 0.185 to 0.235                 | Increasing        |
| L37/0197 | 59          | 0.001 | 0.037               | 0.386                 | 0.014 to 0.057                 | Increasing        |
| L37/0297 | 57          | 0.000 | 0.199               | 0.938                 | 0.081 to 0.286                 | Increasing        |
| L37/0556 | 23          | 0.411 | 0.046               | 0.659                 | -0.050 to 0.095                | Stable            |
| L37/0867 | 69          | 0.017 | 0.160               | 1.633                 | 0.027 to 0.304                 | Increasing        |
| L37/1566 | 10          | 0.592 | 0.271               | 2.157                 | -1.188 to 0.661                | Stable            |
| L37/1595 | 2           | -     | -                   | -                     | -                              | 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)<sup>1</sup>. BCIL staff underwent a field training day with PDP Ecologist, Tim Green, on 28 October 2022 to ensure staff were competent with the required sampling methodology. Regular auditing of BCIL sampling methodology is required, as specified in the BCIL Environmental Monitoring Plan. Auditing is yet to be undertaken. The location of the monitoring sites is shown in Figure B1 (Appendix B).

Surface water quality and ecological monitoring results to date are presented in full in Appendix B. Summary results for the first nine months of monitoring (within the hydrological year: 1 July 2022 to 30 June 2023) are presented below, including comparisons with relevant national and regional standards for surface water quality and ecology (Table 3).

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<sup>1</sup> Green, T., Nicol, R. (2022) *BCIL environmental monitoring plan*. Pattle Delamore Partners Limited.

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

| Parameter                                  | NPS-FM 2020 <sup>1</sup> Bottom-Line                                                                                                                                       | LWRP <sup>2</sup> Freshwater Outcome<br>(Hill-fed Lower) | LWRP <sup>2</sup> Freshwater Outcome<br>(Alpine Lower) |
|--------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------|--------------------------------------------------------|
| Temperature                                | -                                                                                                                                                                          | > 20°C                                                   | > 20°C                                                 |
| Dissolved Oxygen                           | -                                                                                                                                                                          | < 90%                                                    | < 90%                                                  |
| Nitrate-Nitrogen                           | Annual median $\geq 2.4$ mg/L<br>Annual 95th Percentile $\geq 3.5$ mg/L                                                                                                    | -                                                        |                                                        |
| Dissolved Reactive Phosphorus <sup>3</sup> | Five-year median > 0.018 mg/L<br>Five-year 95th percentile > 0.054 mg/L                                                                                                    | -                                                        |                                                        |
| <i>Escherichia coli</i>                    | Five-year median > 260 n/100 mL<br>Five-year 95th percentile > 1200 n/100 mL<br>> 30% of records > 540 n/100 mL (five-year)<br>> 50% of records > 260 n/100 mL (five-year) | -                                                        |                                                        |
| Long Filamentous Periphyton                | -                                                                                                                                                                          | > 30% cover                                              | > 20% cover                                            |
| Cyanobacteria Mat Cover                    | -                                                                                                                                                                          | > 50% cover                                              | > 30% cover                                            |
| Periphyton Biomass                         | 200 mg chl-a/m <sup>2</sup> exceeded by no more than 8% of samples over minimum 3 years                                                                                    | > 200 mg chl-a/m <sup>2</sup>                            | > 120 mg chl-a/m <sup>2</sup>                          |
| Macroinvertebrates                         | QMCI < 4.5<br>MCI < 90                                                                                                                                                     | QMCI < 3.5                                               | QMCI < 6                                               |

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

| Parameter               | NPS-FM 2020 <sup>1</sup> Bottom-Line | LWRP <sup>2</sup> Freshwater Outcome<br>(Hill-fed Lower) | LWRP <sup>2</sup> Freshwater Outcome<br>(Alpine Lower) |
|-------------------------|--------------------------------------|----------------------------------------------------------|--------------------------------------------------------|
| Deposited Fine Sediment | > 27%                                | > 20%                                                    | > 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. 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/>).
3. NPS-FM 2020 lowest Attribute Band presented as dissolved reactive phosphorus does not currently have a national bottom line.

“-“ indicates no value set



## 4.1 Surface Water Quality

### 4.1.1 Physicochemical Surface Water Quality

Summary physicochemical surface water quality monitoring results are presented in Table 4. There was typically minimal variation in median physicochemical surface water quality values across the monitoring sites. Electrical conductivity (EC) was the most notably variable parameter recorded from the assessment sites, with the highest median EC recorded from the Taylors Stream monitoring site (70.8  $\mu\text{S}/\text{cm}$ ) and the lowest recorded from the Ashburton River South monitoring site (48.6  $\mu\text{S}/\text{cm}$ ). However, values were generally consistent with 'reference conditions' (i.e., minimally impacted by land use) for waterways sharing the same River Environment Classification (REC)<sup>2</sup>.

Maximum and 95<sup>th</sup> percentile temperatures measured from the Ashburton River South and Rakaia River South Braid sites exceeded the upper limit specified within the Canterbury Land and Water Regional Plan (LWRP) Freshwater Outcomes (Table 3).

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<sup>2</sup> ANZG 2018. Australian and New Zealand Guidelines for Fresh and Marine Water Quality. Australian and New Zealand Governments and Australian state and territory governments, Canberra ACT, Australia. Available at [www.waterquality.gov.au/anz-guidelines](http://www.waterquality.gov.au/anz-guidelines)

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            | 5.8            | 6.2                   | 8.7                      |
|                                                                                                                                                                                                     | Median          | 12.3           | 11.1           | 12.3                  | 14.7                     |
|                                                                                                                                                                                                     | 95th Percentile | 17.8           | 17.9           | <b>21.2</b>           | <b>22.4</b>              |
|                                                                                                                                                                                                     | Maximum         | 19.2           | 19.9           | <b>23.1</b>           | <b>22.8</b>              |
|                                                                                                                                                                                                     | n               | 10             | 10             | 10                    | 10                       |
| Conductivity (µs/cm)                                                                                                                                                                                | Minimum         | 49.3           | 39.9           | 23.7                  | 28                       |
|                                                                                                                                                                                                     | Median          | 60.6           | 70.8           | 48.6                  | 53.6                     |
|                                                                                                                                                                                                     | 95th Percentile | 88.7           | 89.6           | 72.1                  | 73.1                     |
|                                                                                                                                                                                                     | Maximum         | 91.8           | 92.8           | 76.4                  | 77.1                     |
|                                                                                                                                                                                                     | n               | 10             | 10             | 10                    | 10                       |
| pH                                                                                                                                                                                                  | Minimum         | 7.14           | 7.34           | 7.29                  | 7.79                     |
|                                                                                                                                                                                                     | Median          | 7.28           | 7.57           | 7.72                  | 7.98                     |
|                                                                                                                                                                                                     | 95th Percentile | 7.88           | 7.9            | 8.11                  | 8.29                     |
|                                                                                                                                                                                                     | Maximum         | 7.9            | 7.95           | 8.15                  | 8.3                      |
|                                                                                                                                                                                                     | n               | 10             | 10             | 10                    | 10                       |
| Notes<br>1. <b>Bold</b> 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

Summary nutrient and microbial surface water quality monitoring results are presented in Table 5.

Concentrations of both total ammoniacal-nitrogen (TAN) and nitrite-nitrogen were consistently recorded below laboratory detection limits, from all monitoring sites. Nitrate-nitrogen (nitrate-N) concentrations were variable across monitoring sites, with the highest median concentration measured from Bowyers Stream (1.16 mg/L) and the lowest median concentration recorded from the Rakaia River South Braid (0.08 mg/L), representing an approximate 15-fold difference. There was minimal variation in dissolved reactive phosphorus (DRP) across monitoring sites, with concentrations recorded from three sites consistently measuring below laboratory detection limits, and low concentrations detected from Bowyers Stream only (median 0.005 mg/L).

Median *Escherichia coli* counts were similar across the monitoring sites. However, occasionally elevated *E. coli* counts were recorded from the Rakaia River South Braid site, as indicated by high 95<sup>th</sup> percentile and maximum concentrations (339 n/100 mL and 450 n/100 mL respectively) when compared to the remaining sites (105-219 n/100 mL and 148-236 n/100 mL, respectively).

All parameters were compliant with national and regional nutrient and microbial surface water quality standards (Table 3). Summary nitrate-N concentrations were consistent with the National Policy Statement – Freshwater Management (NPS-FM 2020) 'A' Attribute Band at all sites except for Bowyers Stream, which was consistent with the 'B' Attribute Band. The 'A' Attribute Band for nitrate-N indicates that toxicity effects on sensitive species are unlikely, while the 'B' Attribute Band indicates some growth effects on up to 5% of species. All monitoring sites were consistent with the 'A' Attribute Band for TAN, DRP, and *E. coli*; the highest category of surface water quality.

| 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 | 0.005          | 0.005          | 0.005                 | 0.005                    |
|                                                        | Maximum         | 0.005          | 0.005          | 0.005                 | 0.005                    |
|                                                        | n               | 11             | 11             | 11                    | 11                       |
| 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          | 0.001                 | 0.001                    |
|                                                        | Maximum         | 0.001          | 0.001          | 0.001                 | 0.001                    |
|                                                        | n               | 11             | 11             | 11                    | 11                       |
| Nitrate-Nitrogen (mg/L)                                | Minimum         | 0.61           | 0.23           | 0.11                  | 0.04                     |
|                                                        | Median          | 1.16           | 0.81           | 0.19                  | 0.08                     |
|                                                        | 95th percentile | 1.84           | 1.36           | 0.44                  | 0.10                     |
|                                                        | Maximum         | 1.95           | 1.39           | 0.59                  | 0.11                     |
|                                                        | n               | 11             | 11             | 11                    | 11                       |
|                                                        | Minimum         | 0.61           | 0.23           | 0.11                  | 0.04                     |

| Table 5: Nutrients and microbial surface water quality                                                                                                                                                                                                                                                                                                                                                                                |                 |                |                |                       |                          |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------|----------------|----------------|-----------------------|--------------------------|
| Parameter                                                                                                                                                                                                                                                                                                                                                                                                                             | Statistic       | Bowyers Stream | Taylors Stream | Ashburton River South | Rakaia River South Braid |
| Total Oxidised Nitrogen (mg/L)                                                                                                                                                                                                                                                                                                                                                                                                        | Median          | 1.16           | 0.81           | 0.19                  | 0.08                     |
|                                                                                                                                                                                                                                                                                                                                                                                                                                       | 95th percentile | 1.84           | 1.36           | 0.44                  | 0.10                     |
|                                                                                                                                                                                                                                                                                                                                                                                                                                       | Maximum         | 1.95           | 1.39           | 0.59                  | 0.11                     |
|                                                                                                                                                                                                                                                                                                                                                                                                                                       | n               | 11             | 11             | 11                    | 11                       |
| Dissolved Reactive Phosphorus (mg/L)                                                                                                                                                                                                                                                                                                                                                                                                  | Minimum         | 0.002          | 0.002          | 0.002                 | 0.002                    |
|                                                                                                                                                                                                                                                                                                                                                                                                                                       | Median          | 0.005          | 0.002          | 0.002                 | 0.002                    |
|                                                                                                                                                                                                                                                                                                                                                                                                                                       | 95th percentile | 0.0065         | 0.002          | 0.002                 | 0.002                    |
|                                                                                                                                                                                                                                                                                                                                                                                                                                       | Maximum         | 0.007          | 0.002          | 0.002                 | 0.002                    |
|                                                                                                                                                                                                                                                                                                                                                                                                                                       | n               | 11             | 11             | 11                    | 11                       |
| Escherichia coli (n/100 mL)                                                                                                                                                                                                                                                                                                                                                                                                           | Minimum         | 2              | 2              | 6                     | 2                        |
|                                                                                                                                                                                                                                                                                                                                                                                                                                       | Median          | 29             | 39             | 15                    | 41                       |
|                                                                                                                                                                                                                                                                                                                                                                                                                                       | 95th percentile | 105            | 127            | 219                   | 339                      |
|                                                                                                                                                                                                                                                                                                                                                                                                                                       | Maximum         | 148            | 160            | 236                   | 450                      |
|                                                                                                                                                                                                                                                                                                                                                                                                                                       | n               | 11             | 11             | 11                    | 11                       |
| Notes<br>1. <b>Bold</b> 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.<br>2. <b>Shaded</b> values indicate exceedance of NPS—FM (2020) national 'bottom-line' values for surface water quality.<br>3. Data recorded below laboratory detection limit reported at 0.5-fold 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 58.5% (Rakaia River South Braid) and 78.25% (Taylors Stream). Median periphyton 'sludge' percentage cover was recorded at marginally elevated cover levels when compared to the other periphyton categories, with 6% and 8.8% cover recorded from the Ashburton River South and Rakaia River South Branch sites, respectively. Median cover levels of all other periphyton categories did not exceed 3% cover.

Occasionally elevated cover of levels of all periphyton categories, except for the 'thick mat' and 'cyanobacteria mat' categories (consistently < 3% cover), were recorded across the monitoring sites. However, periphyton cover levels were consistently in accordance with the LWRP Freshwater Outcomes (Table 3).

Median periphyton biomass (chlorophyll-*a*) varied minimally across monitoring sites (0.6-2.5 mg/m<sup>2</sup>). The maximum periphyton biomass values recorded across the monitoring sites (7.6-17.3 mg/m<sup>2</sup>) were consistently below both the upper limit specified as both LWRP Freshwater Outcome and NPS-FM (2020) national 'bottom-line' (Table 3). Notably, periphyton biomass was consistent with the NPS-FM (2020) 'A' Attribute Band across all sites, indicating negligible nutrient enrichment and/or alteration of the natural flow regime or habitat.

Table 6: Periphyton cover monitoring results

| Site                        | Statistic | No Algae<br>(% Cover) | Sludge<br>(% Cover) | Thin Film<br>(% Cover) | Medium Mat<br>(% Cover) | Thick Mat<br>(% Cover) | Cyanobacteria<br>Mat<br>(% Cover) | Short Filaments<br>(% Cover) | Long<br>Filaments<br>(% Cover) | Chlorophyll-<br>a<br>(mg/m <sup>2</sup> ) |
|-----------------------------|-----------|-----------------------|---------------------|------------------------|-------------------------|------------------------|-----------------------------------|------------------------------|--------------------------------|-------------------------------------------|
| Ashburton<br>River South    | Minimum   | 56.3                  | 0.0                 | 0.0                    | 0.0                     | 0.0                    | 0.0                               | 0.0                          | 0.0                            | 0.0                                       |
|                             | Median    | 69.0                  | 6.1                 | 0.0                    | 0.0                     | 0.0                    | 0.0                               | 2.0                          | 0.9                            | 1.0                                       |
|                             | Maximum   | 87.5                  | 10.5                | 19.8                   | 18.8                    | 0.0                    | 0.0                               | 12.0                         | 7.8                            | 8.0                                       |
|                             | n         | 9                     | 9                   | 9                      | 9                       | 9                      | 9                                 | 9                            | 9                              | 11                                        |
| Bowyers<br>Stream           | Minimum   | 58.8                  | 0.0                 | 0.0                    | 0.0                     | 0.0                    | 0.0                               | 0.0                          | 0.0                            | 0.0                                       |
|                             | Median    | 76.8                  | 2.3                 | 0.8                    | 0.0                     | 0.0                    | 0.0                               | 2.9                          | 1.0                            | 0.7                                       |
|                             | Maximum   | 95.1                  | 5.8                 | 14.0                   | 9.8                     | 2.5                    | 0.5                               | 10.5                         | 9.8                            | 16.0                                      |
|                             | n         | 9                     | 9                   | 9                      | 9                       | 9                      | 9                                 | 9                            | 9                              | 11                                        |
| Rakaia River<br>South Braid | Minimum   | 41.3                  | 0.0                 | 0.0                    | 0.0                     | 0.0                    | 0.0                               | 0.0                          | 0.0                            | 0.2                                       |
|                             | Median    | 58.5                  | 8.8                 | 0.0                    | 0.0                     | 0.0                    | 0.0                               | 0.4                          | 1.1                            | 2.5                                       |
|                             | Maximum   | 97.2                  | 30.8                | 13.8                   | 4.8                     | 0.5                    | 0.0                               | 15.3                         | 18.0                           | 7.6                                       |
|                             | n         | 9                     | 9                   | 9                      | 9                       | 9                      | 9                                 | 9                            | 9                              | 11                                        |
|                             | Minimum   | 32.0                  | 0.0                 | 0.0                    | 0.0                     | 0.0                    | 0.0                               | 0.0                          | 0.0                            | 0.0                                       |

Table 6: Periphyton cover monitoring results

| Site              | Statistic | No Algae<br>(% Cover) | Sludge<br>(% Cover) | Thin Film<br>(% Cover) | Medium Mat<br>(% Cover) | Thick Mat<br>(% Cover) | Cyanobacteria<br>Mat<br>(% Cover) | Short Filaments<br>(% Cover) | Long<br>Filaments<br>(% Cover) | Chlorophyll-<br><i>a</i><br>(mg/m <sup>2</sup> ) |
|-------------------|-----------|-----------------------|---------------------|------------------------|-------------------------|------------------------|-----------------------------------|------------------------------|--------------------------------|--------------------------------------------------|
| Taylors<br>Stream | Median    | 78.3                  | 0.8                 | 0.8                    | 0.0                     | 0.0                    | 0.0                               | 0.3                          | 0.5                            | 0.6                                              |
|                   | Maximum   | 93.2                  | 29.7                | 37.8                   | 0.0                     | 1.8                    | 0.0                               | 14.8                         | 7.5                            | 17.3                                             |
|                   | n         | 9                     | 9                   | 9                      | 9                       | 9                      | 9                                 | 9                            | 9                              | 11                                               |

## Notes:

- Bold** 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.
- Shaded** values indicate exceedance of NPS—FM (2020) national 'bottom-line' values.



### 4.3 Macrophyte Cover Assessments

Across all sampling dates, macrophyte cover was assessed on 28 October 2022 only. For this sampling occasion, 0% macrophyte cover was recorded from all sites. All results are therefore consistent with regional and national standards (Table 3).

### 4.4 Deposited Sediment

Summary results for deposited fine sediment cover are shown in Table 7.

Median deposited fine sediment cover was variable across monitoring sites, ranging between 1.5% (Taylors Stream) and 9.1% (Rakaia River South Branch).

Records from both the Bowyers Stream and the Ashburton River South sites were consistently in accordance with the national and regional standards (Table 3). 95<sup>th</sup> percentile and maximum values measured from both Taylors Stream and the Rakaia River South Branch exceeded the upper limit specified within the LWRP Freshwater Outcomes (Table 3). No sites had median values exceeding NPS-FM (2020) national 'bottom-line'. Notably, the median deposited sediment cover levels measured across all assessment sites were consistent with the NPS-FM (2020) 'A' Attribute Band, indicating minimal impact from deposited fine sediment on instream biota.

| Table 7: Deposited fine sediment monitoring results                                                                                                                                                                                                                                                |                |                |                       |                          |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------|----------------|-----------------------|--------------------------|
| Statistic                                                                                                                                                                                                                                                                                          | Bowyers Stream | Taylors Stream | Ashburton River South | Rakaia River South Braid |
| Minimum                                                                                                                                                                                                                                                                                            | 0              | 0              | 2                     | 0.3                      |
| Median                                                                                                                                                                                                                                                                                             | 2.7            | 1.5            | 5.5                   | 9.1                      |
| 95 <sup>th</sup> Percentile                                                                                                                                                                                                                                                                        | 5.2            | <b>15.6</b>    | 9.5                   | <b>27.3</b>              |
| Maximum                                                                                                                                                                                                                                                                                            | 5.8            | <b>23.6</b>    | 10.5                  | <b>33.8</b>              |
| n                                                                                                                                                                                                                                                                                                  | 10             | 10             | 10                    | 10                       |
| Notes:<br>1. <b>Bold</b> 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.<br>2. <b>Shaded</b> values indicate exceedance of NPS—FM (2020) national 'bottom-line' values. |                |                |                       |                          |

#### **4.5 Macroinvertebrates**

Macroinvertebrate monitoring data was not provided to PDP prior to preparing this report. It is understood that the first round of macroinvertebrate monitoring will be completed during the summer of 2023/2024 (December-March (inclusive)).





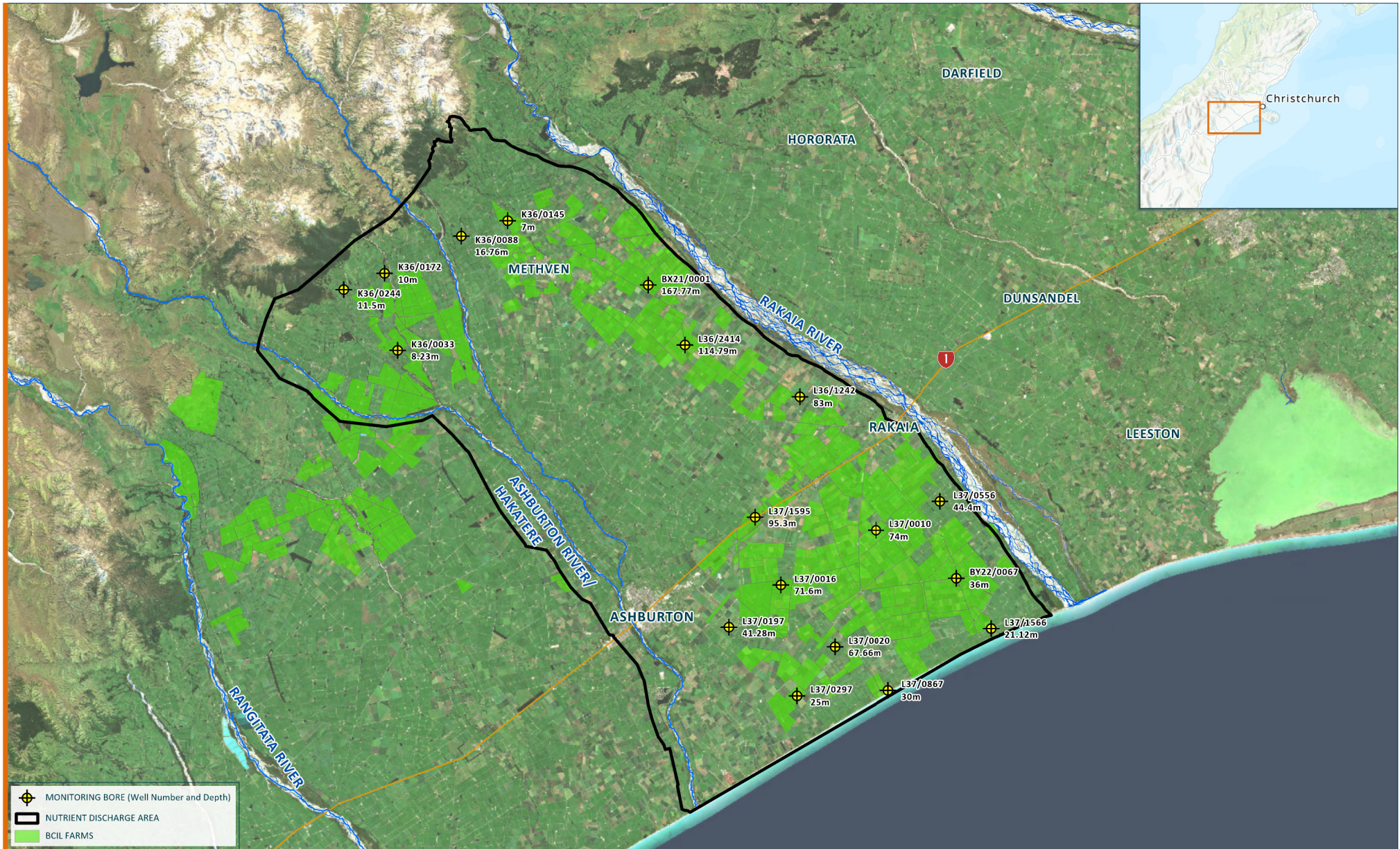


FIGURE A1: LOCATION OF MONITORING BORES



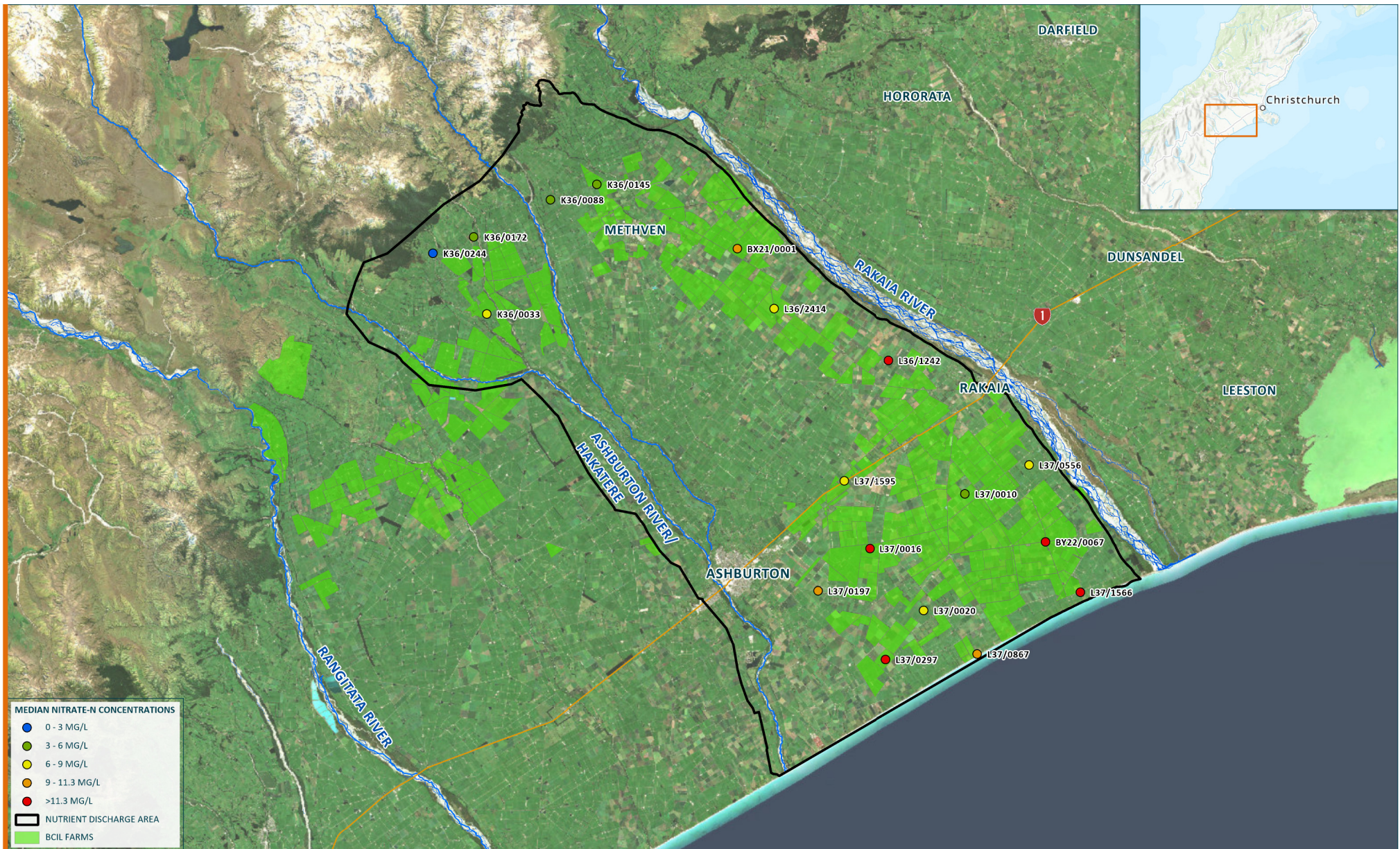


FIGURE A2: MEDIAN NITRATE-N CONCENTRATIONS



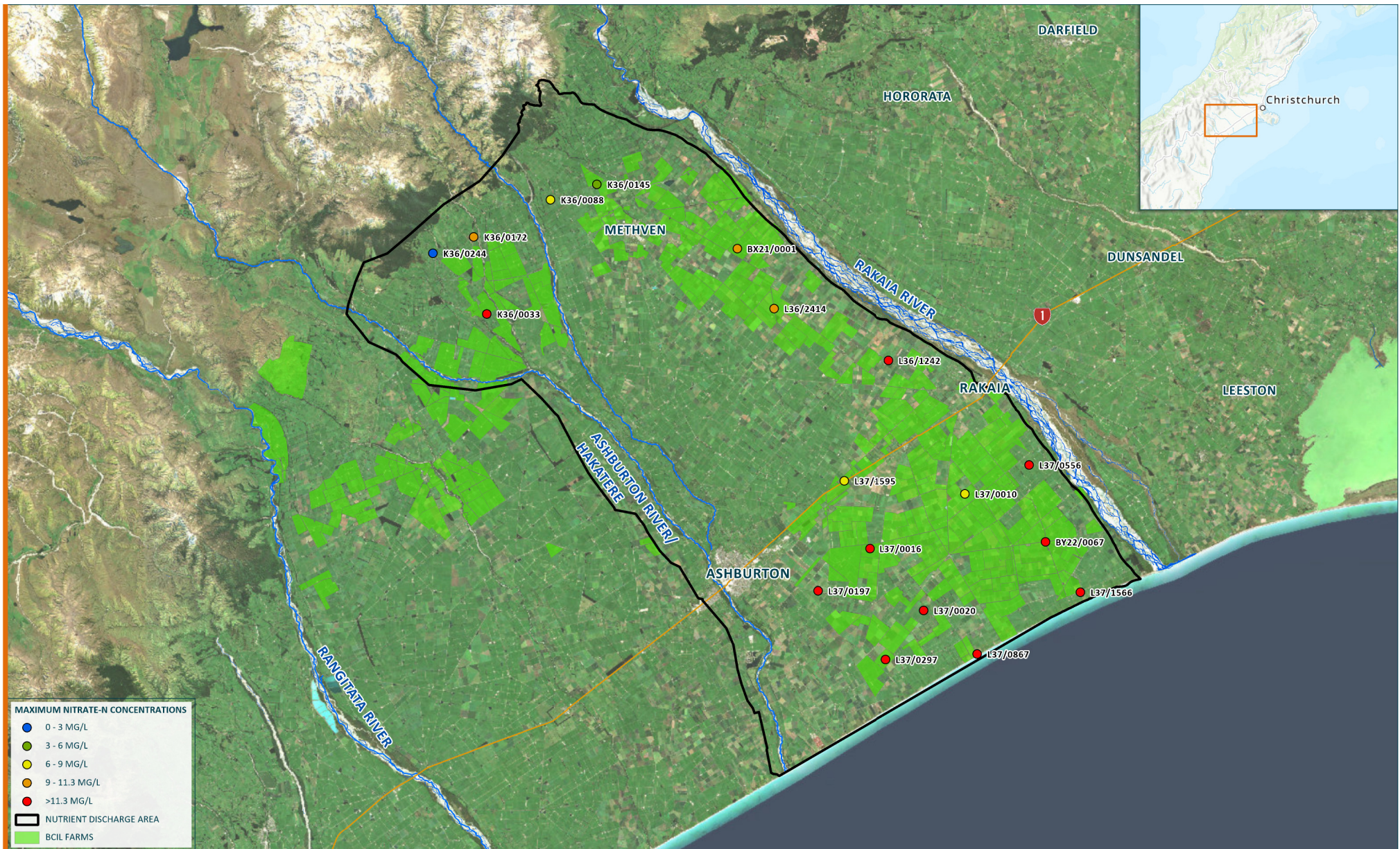


FIGURE A3: MAXIMUM NITRATE-N CONCENTRATIONS



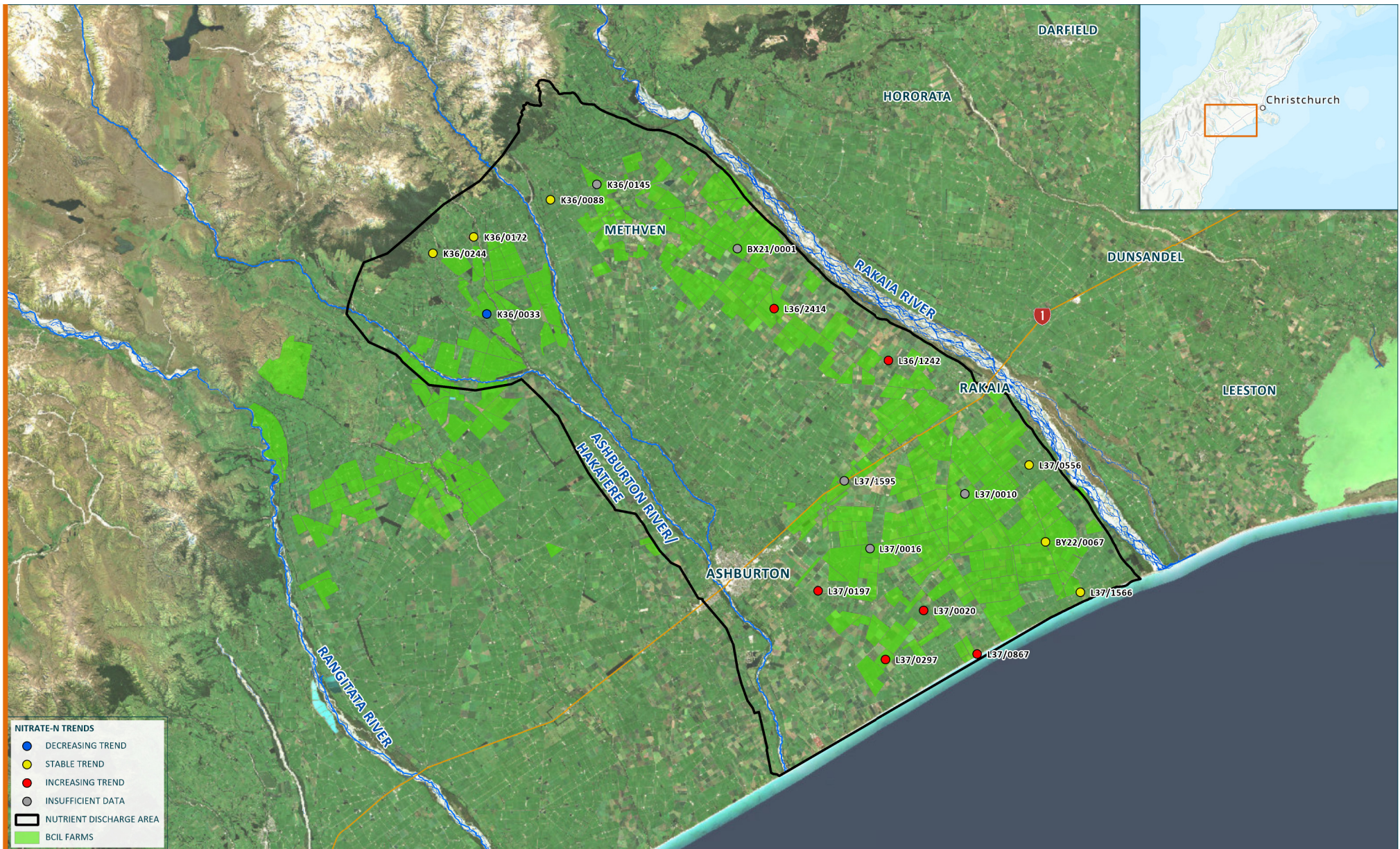
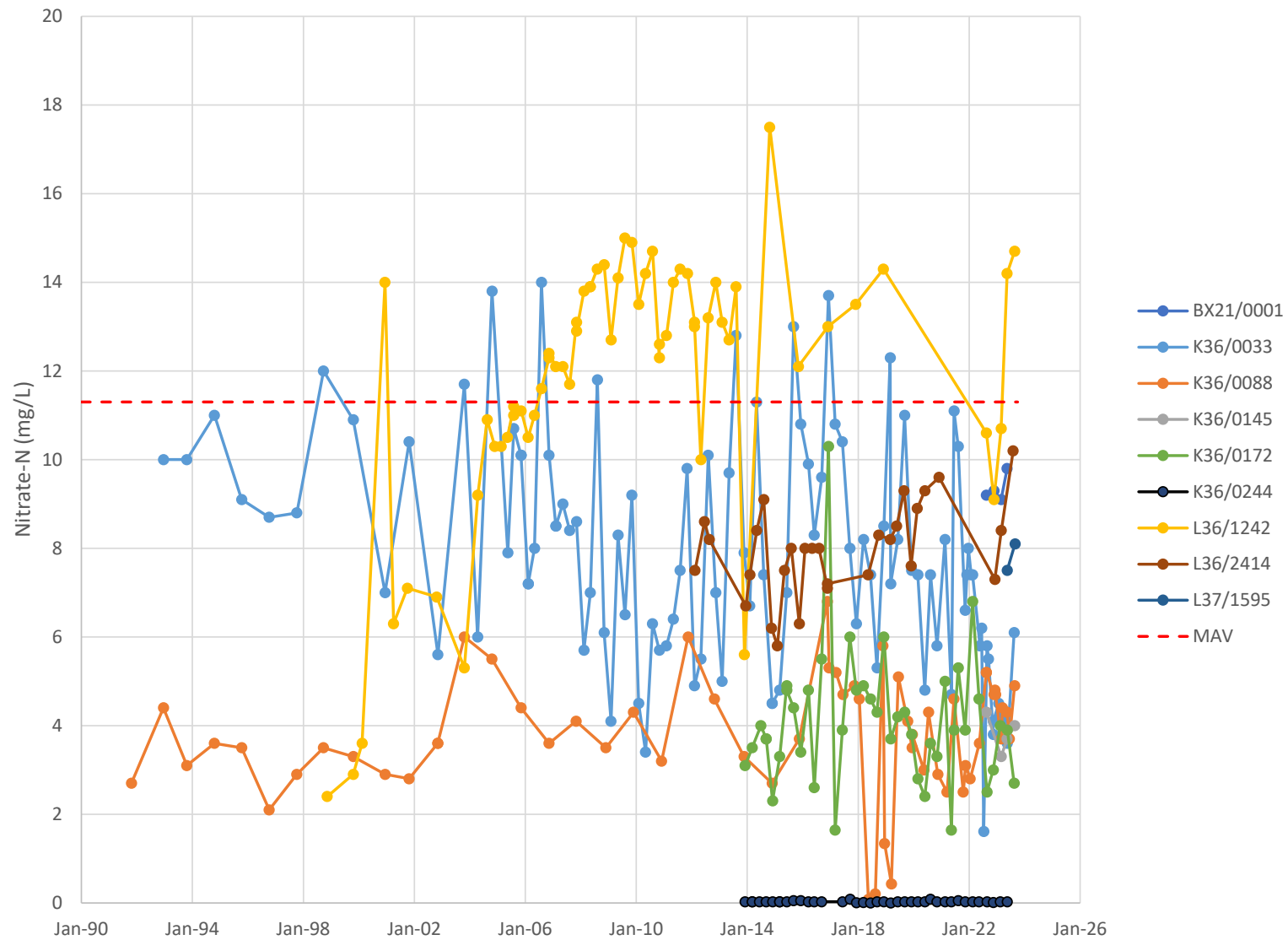


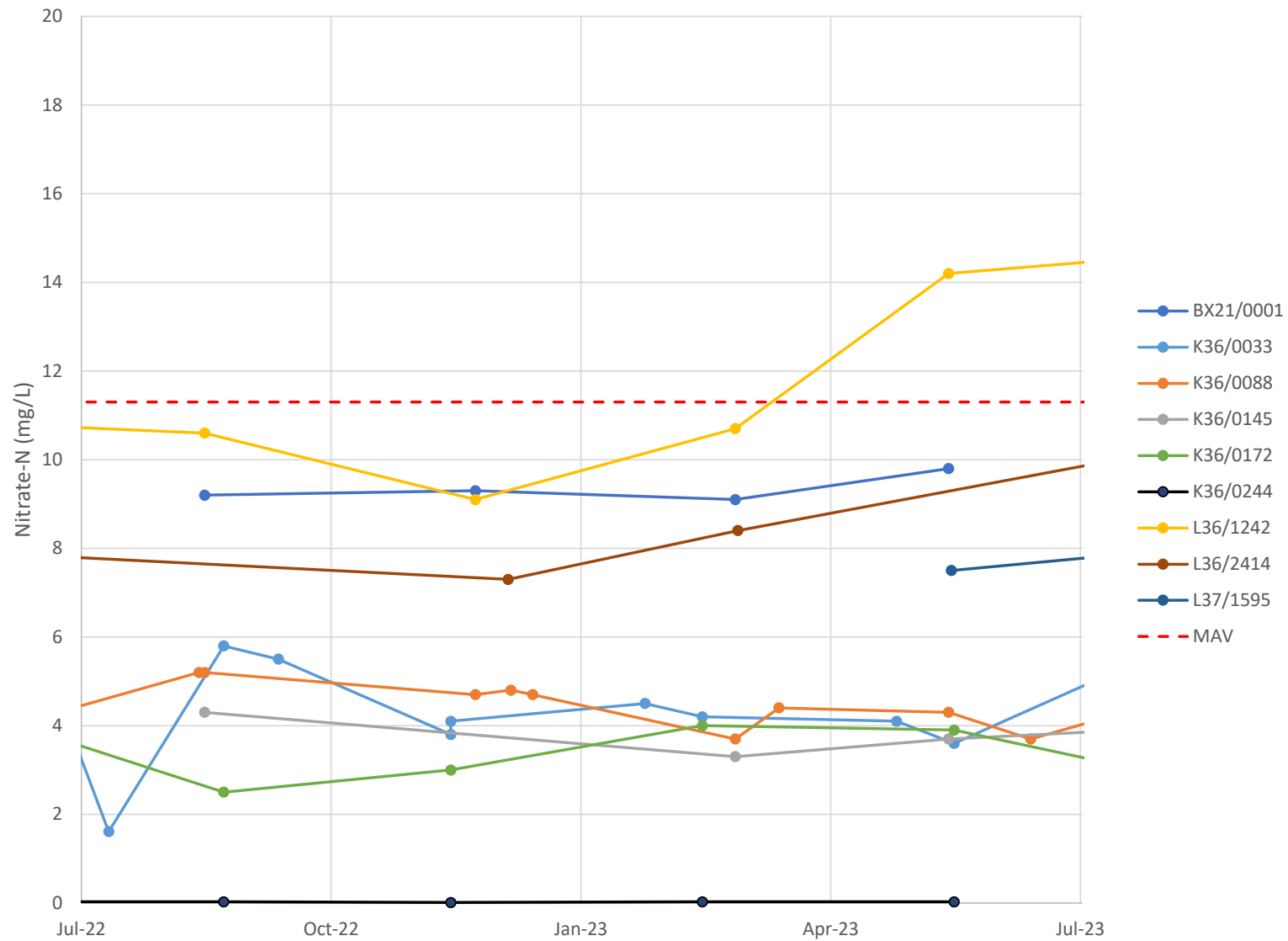
FIGURE A4: NITRATE-N TRENDS





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



**FIGURE A6: 2022-23 NITRATE-N DATA IN BORES NORTH OF STATE HIGHWAY 1**

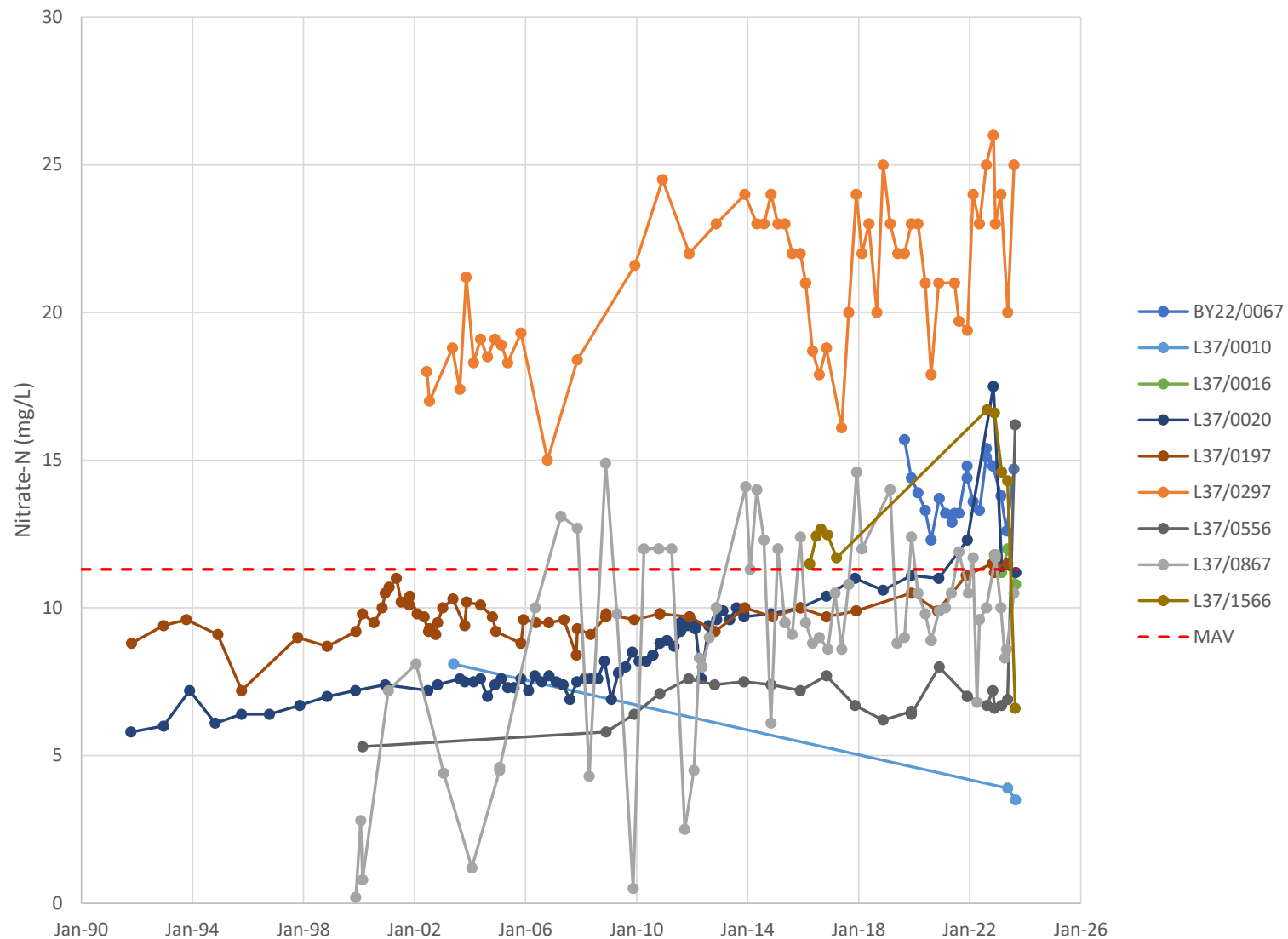
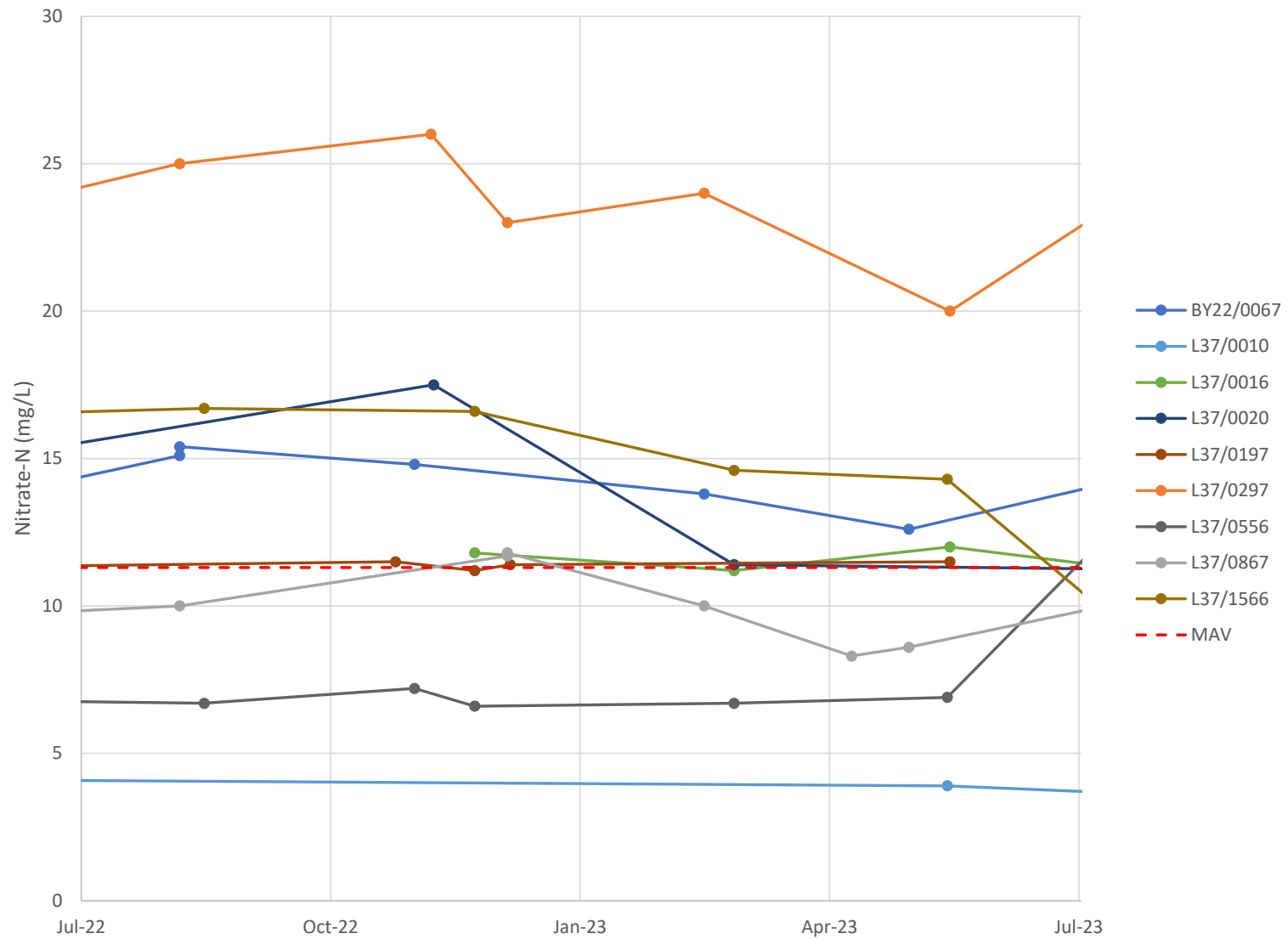


FIGURE A7: LONG-TERM NITRATE-N DATA IN BORES SOUTH OF STATE HIGHWAY 1

**FIGURE A8: 2022-23 NITRATE-N DATA IN BORES SOUTH OF STATE HIGHWAY 1**

## **Appendix B: Surface Water Figure and Tables**



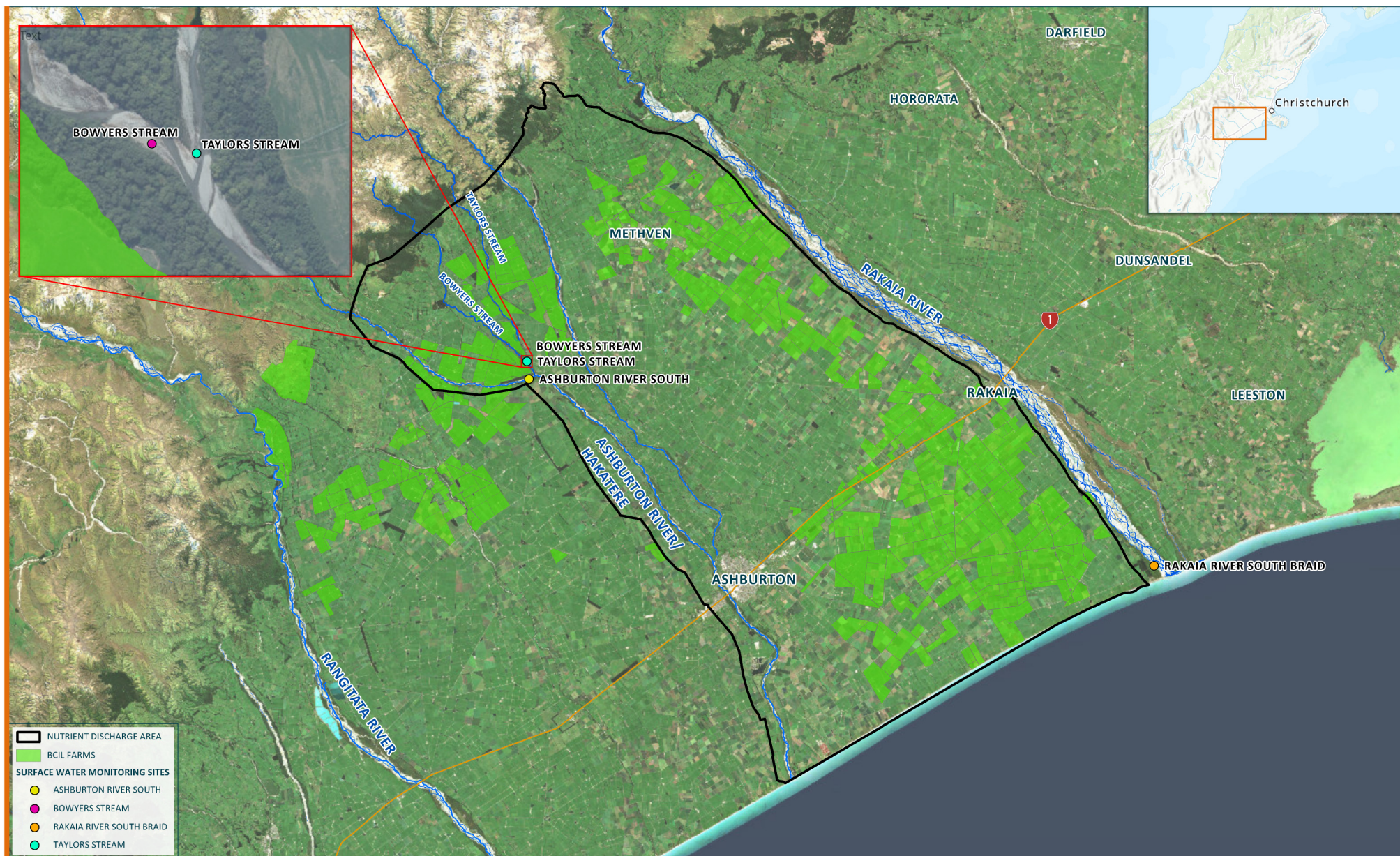


FIGURE B1: LOCATION OF SURFACE WATER MONITORING SITES

**SOURCE:**  
1. AERIAL IMAGERY: EAGLE TECHNOLOGY, LINZ, STATS NZ, NIWA, NATURAL EARTH, © OPENSTREETMAP CONTRIBUTORS, EAGLE TECHNOLOGY, LAND INFORMATION NEW ZEALAND, EAGLE TECHNOLOGY, LAND INFORMATION NEW ZEALAND, GEBCO, COMMUNITY MAPS CONTRIBUTORS.

0 5 10  
Kilometers  
SCALE : 1:300,000 (A3)

REVISION: 01 | DATE: OCT 23 | BY: BR  
CLIENT: BARRHILL CHERTSEY IRRIGATION LTD (BCIL)

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| Table B1: Physicochemical surface water quality monitoring results |                      |                |                |                       |                          |
|--------------------------------------------------------------------|----------------------|----------------|----------------|-----------------------|--------------------------|
| Date                                                               | Parameter            | Bowyers Stream | Taylors Stream | Ashburton River South | Rakaia River South Braid |
| 28/10/2022                                                         | Temperature (°C)     | 11.5           | 10.4           | 12.0                  | 13.0                     |
| 30/11/2022                                                         |                      | 13.0           | 11.8           | 12.6                  | 14.6                     |
| 14/12/2022                                                         |                      | 15.7           | 14.2           | 17.5                  | 20.7                     |
| 18/01/2023                                                         |                      | 15.8           | 14.8           | 17.3                  | 20.4                     |
| 31/01/2023                                                         |                      | 16.0           | 15.5           | 18.8                  | 22.8                     |
| 21/02/2023                                                         |                      | 19.2           | 19.9           | 23.1                  | 21.8                     |
| 27/04/2023                                                         |                      | 10.1           | 8.4            | 11.2                  | 14.8                     |
| 16/05/2023                                                         |                      | 8.6            | 7.2            | 8.9                   | 9.6                      |
| 27/06/2023                                                         |                      | 7.4            | 7.0            | 7.3                   | 9.3                      |
| 31/07/2023                                                         |                      | 5.5            | 5.8            | 6.2                   | 8.7                      |
| 28/10/2022                                                         | Conductivity (µS/cm) | 84.9           | 79.5           | 63.4                  | 66.4                     |
| 30/11/2022                                                         |                      | 91.8           | 92.8           | 76.4                  | 77.1                     |
| 14/12/2022                                                         |                      | 66.6           | 66.7           | 42.3                  | 52.5                     |
| 18/01/2023                                                         |                      | 68.3           | 74.9           | 54.5                  | 54.7                     |
| 31/01/2023                                                         |                      | 64.3           | 77.0           | 57.9                  | 60.9                     |
| 21/02/2023                                                         |                      | 49.3           | 85.6           | 66.7                  | 68.1                     |
| 27/04/2023                                                         |                      | 53.7           | 50.8           | 42.6                  | 44.5                     |
| 16/05/2023                                                         |                      | 56.9           | 51.7           | 40.7                  | 28.0                     |
| 27/06/2023                                                         |                      | 55.0           | 39.9           | 39.6                  | 35.0                     |
| 31/07/2023                                                         |                      | 55.4           | 58.5           | 23.7                  | 41.6                     |
| 28/10/2022                                                         | pH                   | 7.14           | 7.76           | 7.61                  | 8.08                     |
| 30/11/2022                                                         |                      | 7.29           | 7.42           | 7.36                  | 7.85                     |
| 14/12/2022                                                         |                      | 7.26           | 7.59           | 7.83                  | 8.28                     |
| 18/01/2023                                                         |                      | 7.20           | 7.49           | 7.29                  | 7.90                     |
| 31/01/2023                                                         |                      | 7.22           | 7.54           | 7.83                  | 7.79                     |
| 21/02/2023                                                         |                      | 7.39           | 7.77           | 8.07                  | 7.82                     |
| 27/04/2023                                                         |                      | 7.32           | 7.53           | 7.58                  | 8.26                     |
| 16/05/2023                                                         |                      | 7.86           | 7.84           | 8.06                  | 8.05                     |
| 27/06/2023                                                         |                      | 7.90           | 7.95           | 8.15                  | 8.30                     |

| 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                                                         |                                 | 7.27           | 7.34            | 7.42                  | 7.87                     |
| 28/10/2022                                                         | Dissolved Oxygen Saturation (%) | 92.3           | 97.7            | 96.4                  | 103.6                    |
| 30/11/2022                                                         |                                 | 96.6           | 97.5            | 98.6                  | 106.7                    |
| 14/12/2022                                                         |                                 | -              | -               | -                     | -                        |
| 18/01/2023                                                         |                                 | -              | -               | -                     | -                        |
| 31/01/2023                                                         |                                 | -              | -               | -                     | -                        |
| 21/02/2023                                                         |                                 | -              | -               | -                     | -                        |
| 27/04/2023                                                         |                                 | -              | -               | -                     | -                        |
| 16/05/2023                                                         |                                 | -              | -               | -                     | -                        |
| 27/06/2023                                                         |                                 | -              | -               | -                     | -                        |
| 31/07/2023                                                         |                                 | -              | -               | -                     | -                        |
| 28/10/2022                                                         | Dissolved Oxygen (mg/L)         | 10.06          | 10.93           | 10.39                 | 10.91                    |
| 30/11/2022                                                         |                                 | 10.17          | 10.54           | 10.48                 | 10.85                    |
| 14/12/2022                                                         |                                 | -              | -               | -                     | -                        |
| 18/01/2023                                                         |                                 | -              | -               | -                     | -                        |
| 31/01/2023                                                         |                                 | -              | -               | -                     | -                        |
| 21/02/2023                                                         |                                 | -              | -               | -                     | -                        |
| 27/04/2023                                                         |                                 | -              | -               | -                     | -                        |
| 16/05/2023                                                         |                                 | -              | -               | -                     | -                        |
| 27/06/2023                                                         |                                 | -              | -               | -                     | -                        |
| 31/07/2023                                                         |                                 | -              | -               | -                     | -                        |
| 28/10/2022                                                         | Turbidity (NTU)                 | 0.1            | 3.0             | 0.6                   | 0.8                      |
| 30/11/2022                                                         |                                 | -              | -               | -                     | -                        |
| 14/12/2022                                                         |                                 | -              | -               | -                     | -                        |
| 18/01/2023                                                         |                                 | -              | -               | -                     | -                        |
| 31/01/2023                                                         |                                 | -              | -               | -                     | -                        |
| 21/02/2023                                                         |                                 | -              | -               | -                     | -                        |
| 27/04/2023                                                         |                                 | -              | -               | -                     | -                        |
| 16/05/2023                                                         |                                 | -              | -               | -                     | -                        |



**Table B1: Physicochemical surface water quality monitoring results**

| Date                   | Parameter | Bowyers Stream | Taylors Stream | Ashburton River South | Rakaia River South Braid |
|------------------------|-----------|----------------|----------------|-----------------------|--------------------------|
| 27/06/2023             |           | -              | -              | -                     | -                        |
| 31/07/2023             |           | -              | -              | -                     | -                        |
| 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 |
| 28/10/2022                              | 0.61                    | 0.23           | 0.11                  | 0.04                     |
| 30/11/2022                              | 0.86                    | 0.45           | 0.19                  | 0.07                     |
| 14/12/2022                              | 1.19                    | 0.81           | 0.19                  | 0.04                     |
| 18/01/2023                              | 1.02                    | 1.25           | 0.19                  | 0.05                     |
| 31/01/2023                              | 1.15                    | 0.86           | 0.13                  | 0.11                     |
| 21/02/2023                              | -                       | -              | -                     | -                        |
| 27/04/2023                              | 1.13                    | 0.56           | 0.18                  | 0.05                     |
| 16/05/2023                              | 1.16                    | 0.54           | 0.16                  | 0.09                     |
| 27/06/2023                              | 1.19                    | 0.52           | 0.16                  | 0.08                     |
| 31/07/2023                              | 1.95                    | 1.30           | 0.59                  | 0.09                     |
| <i>Notes:</i><br>“-” 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 |
| 28/10/2022                                         | 0.002                                | 0.002          | 0.002                 | 0.002                    |
| 30/11/2022                                         | 0.007                                | 0.002          | 0.002                 | 0.002                    |
| 14/12/2022                                         | 0.006                                | 0.002          | 0.002                 | 0.002                    |
| 18/01/2023                                         | 0.005                                | 0.002          | 0.002                 | 0.002                    |
| 31/01/2023                                         | 0.006                                | 0.002          | 0.002                 | 0.002                    |
| 21/02/2023                                         | -                                    | -              | -                     | -                        |
| 27/04/2023                                         | 0.006                                | 0.002          | 0.002                 | 0.002                    |
| 16/05/2023                                         | 0.002                                | 0.002          | 0.002                 | 0.002                    |
| 27/06/2023                                         | 0.002                                | 0.002          | 0.002                 | 0.002                    |
| 31/07/2023                                         | 0.005                                | 0.002          | 0.002                 | 0.002                    |
| <p><i>Notes:</i></p> <p>"-" indicates no data.</p> |                                      |                |                       |                          |

**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 |
| 28/10/2022                                                                                                                                                       | 18*                                | 160*           | 65*                   | 450*                     |
| 30/11/2022                                                                                                                                                       | 148                                | 93             | 236                   | 185                      |
| 14/12/2022                                                                                                                                                       | 56                                 | 45             | 144                   | 41                       |
| 18/01/2023                                                                                                                                                       | 61                                 | 64             | 201                   | 55                       |
| 31/01/2023                                                                                                                                                       | 29                                 | 39             | 56                    | 15                       |
| 21/02/2023                                                                                                                                                       | -                                  | -              | -                     | -                        |
| 27/04/2023                                                                                                                                                       | 35                                 | 43             | 15                    | 18                       |
| 16/05/2023                                                                                                                                                       | 28                                 | 13             | 6                     | 228                      |
| 27/06/2023                                                                                                                                                       | 11                                 | 9              | 14                    | 225                      |
| 31/07/2023                                                                                                                                                       | 47                                 | 13             | 13                    | 2                        |
| <p>Notes:</p> <p>"-" indicates no data.</p> <p>"*" indicates caution with interpretation as the sample was not analysed within 24 hours of sample collection</p> |                                    |                |                       |                          |

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    | 28/10/2022 | 85.1                 | 10.5   | 0.0            | 4.3            | 0.0                    | 0.0              | 0.0              | 0.0                      | 0.0             | 0.0             | 0.0                     | 0.0                  | 0.0                  | 0.2                 | 0.0                 |
|                          | 30/11/2022 | 74.1                 | 6.1    | 7.9            | 0.8            | 0.0                    | 0.0              | 0.0              | 0.0                      | 0.0             | 0.0             | 0.0                     | 6.3                  | 0.3                  | 4.8                 | 0.0                 |
|                          | 14/12/2022 | 60.3                 | 0.0    | 19.8           | 0.0            | 0.0                    | 0.0              | 0.0              | 0.0                      | 0.0             | 0.0             | 0.0                     | 5.0                  | 6.0                  | 7.8                 | 1.3                 |
|                          | 18/01/2023 | 65.1                 | 9.6    | 7.9            | 4.5            | 0.0                    | 0.0              | 0.0              | 0.0                      | 0.0             | 0.0             | 0.0                     | 5.7                  | 0.3                  | 7.0                 | 0.0                 |
|                          | 31/01/2023 | 56.3                 | 8.8    | 2.0            | 0.0            | 0.0                    | 0.0              | 18.8             | 0.0                      | 0.0             | 0.0             | 0.0                     | 6.8                  | 0.0                  | 7.5                 | 0.0                 |
|                          | 21/02/2023 | 66.3                 | 5.0    | 3.7            | 6.3            | 0.0                    | 0.0              | 0.0              | 0.0                      | 0.0             | 0.0             | 0.0                     | 3.8                  | 4.3                  | 4.5                 | 6.5                 |
|                          | 27/04/2023 | 87.5                 | 4.5    | 5.8            | 1.8            | 0.0                    | 0.0              | 0.0              | 0.0                      | 0.0             | 0.0             | 0.0                     | 0.0                  | 0.0                  | 0.0                 | 0.5                 |
|                          | 16/05/2023 | 69.0                 | 6.8    | 0.0            | 4.5            | 0.0                    | 0.0              | 0.5              | 0.0                      | 0.0             | 0.0             | 0.0                     | 12.0                 | 0.0                  | 7.3                 | 0.0                 |
|                          | 27/06/2023 | 79.3                 | 2.5    | 1.0            | 0.0            | 0.0                    | 0.0              | 0.0              | 0.0                      | 0.0             | 0.0             | 0.0                     | 10.3                 | 0.0                  | 7.0                 | 0.0                 |
| Bowyers Stream           | 28/10/2022 | 95.1                 | 0.0    | 3.0            | 0.0            | 0.1                    | 0.0              | 0.0              | 0.0                      | 0.0             | 0.0             | 0.5                     | 1.4                  | 0.0                  | 0.1                 | 0.1                 |
|                          | 30/11/2022 | 69.8                 | 2.0    | 14.0           | 0.8            | 0.0                    | 0.0              | 0.0              | 0.0                      | 0.0             | 0.0             | 0.0                     | 4.0                  | 6.0                  | 0.5                 | 3.0                 |
|                          | 14/12/2022 | 76.8                 | 0.0    | 6.5            | 5.8            | 0.0                    | 0.0              | 0.0              | 0.0                      | 0.0             | 0.0             | 0.0                     | 5.0                  | 2.3                  | 3.3                 | 0.5                 |
|                          | 18/01/2023 | 85.9                 | 3.4    | 4.0            | 1.9            | 0.0                    | 0.0              | 0.0              | 0.0                      | 0.0             | 0.0             | 0.0                     | 3.5                  | 0.0                  | 1.4                 | 0.0                 |
|                          | 31/01/2023 | 63.8                 | 4.8    | 12.0           | 0.3            | 0.0                    | 0.0              | 0.0              | 0.0                      | 0.0             | 0.0             | 0.0                     | 10.5                 | 0.0                  | 8.8                 | 0.0                 |
|                          | 21/02/2023 | 79.0                 | 2.3    | 5.6            | 2.0            | 0.0                    | 0.0              | 0.0              | 0.0                      | 0.0             | 0.0             | 0.0                     | 5.2                  | 0.8                  | 5.0                 | 0.2                 |
|                          | 27/04/2023 | 87.2                 | 0.0    | 9.0            | 3.3            | 0.0                    | 0.0              | 0.0              | 0.0                      | 0.0             | 0.0             | 0.0                     | 0.0                  | 0.0                  | 0.0                 | 0.6                 |
|                          | 16/05/2023 | 58.8                 | 5.8    | 1.0            | 0.0            | 0.0                    | 0.0              | 9.8              | 0.0                      | 0.0             | 2.5             | 0.0                     | 6.5                  | 0.0                  | 6.0                 | 9.8                 |
|                          | 27/06/2023 | 63.8                 | 4.3    | 0.5            | 3.8            | 0.0                    | 0.0              | 0.0              | 0.0                      | 0.0             | 0.0             | 0.0                     | 8.0                  | 10.5                 | 4.3                 | 5.0                 |
| Rakaia River South Braid | 28/10/2022 | 97.2                 | 0.3    | 0.0            | 1.0            | 0.0                    | 0.0              | 1.0              | 0.0                      | 0.0             | 0.5             | 0.0                     | 0.1                  | 0.0                  | 0.0                 | 0.0                 |
|                          | 30/11/2022 | 56.0                 | 9.0    | 12.5           | 0.0            | 0.0                    | 0.0              | 0.0              | 0.0                      | 0.0             | 0.0             | 0.0                     | 12.0                 | 0.0                  | 11.1                | 0.0                 |
|                          | 14/12/2022 | 52.8                 | 0.0    | 6.8            | 8.0            | 0.0                    | 2.5              | 1.5              | 0.0                      | 0.0             | 0.0             | 0.0                     | 13.8                 | 0.0                  | 13.3                | 1.5                 |
|                          | 18/01/2023 | 41.3                 | 30.8   | 0.0            | 0.0            | 0.0                    | 0.0              | 0.0              | 0.0                      | 0.0             | 0.0             | 0.0                     | 12.8                 | 1.0                  | 13.5                | 0.8                 |
|                          | 31/01/2023 | 79.0                 | 5.0    | 0.0            | 6.5            | 0.0                    | 4.8              | 0.0              | 0.0                      | 0.0             | 0.0             | 0.0                     | 3.3                  | 0.0                  | 1.5                 | 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 |
|                        | 21/02/2023 | 65.5                 | 8.8    | 0.0            | 13.8           | 0.0                    | 0.0              | 0.0              | 0.0                      | 0.0             | 0.0             | 0.0                     | 0.8                  | 6.0                  | 0.5                 | 4.8                 |
|                        | 27/04/2023 | 49.5                 | 20.0   | 12.5           | 0.0            | 0.0                    | 0.0              | 0.0              | 0.0                      | 0.0             | 0.0             | 0.0                     | 0.0                  | 0.0                  | 18.0                | 0.0                 |
|                        | 16/05/2023 | 77.3                 | 9.8    | 0.0            | 0.0            | 0.0                    | 0.0              | 0.0              | 0.0                      | 0.0             | 0.0             | 0.0                     | 7.5                  | 0.0                  | 5.5                 | 0.0                 |
|                        | 27/06/2023 | 58.5                 | 8.8    | 0.0            | 0.0            | 0.0                    | 0.0              | 0.0              | 0.0                      | 0.0             | 0.0             | 0.0                     | 15.3                 | 0.0                  | 17.5                | 0.0                 |
|                        |            |                      |        |                |                |                        |                  |                  |                          |                 |                 |                         |                      |                      |                     |                     |
| Taylors Stream         | 28/10/2022 | 32.0                 | 29.7   | 37.8           | 0.0            | 0.0                    | 0.0              | 0.0              | 0.0                      | 0.0             | 0.0             | 0.0                     | 0.1                  | 0.0                  | 0.5                 | 0.0                 |
|                        | 30/11/2022 | 87.5                 | 0.0    | 6.5            | 0.8            | 0.0                    | 0.0              | 0.0              | 0.0                      | 0.0             | 0.0             | 0.0                     | 3.3                  | 0.5                  | 0.5                 | 1.0                 |
|                        | 14/12/2022 | 66.3                 | 0.0    | 17.0           | 0.3            | 0.0                    | 0.0              | 0.0              | 0.0                      | 0.0             | 0.0             | 0.0                     | 13.3                 | 0.0                  | 3.3                 | 0.0                 |
|                        | 18/01/2023 | 83.4                 | 4.3    | 9.3            | 0.0            | 0.0                    | 0.0              | 0.0              | 0.0                      | 0.0             | 0.0             | 0.0                     | 1.8                  | 0.0                  | 0.6                 | 0.8                 |
|                        | 31/01/2023 | 78.3                 | 2.3    | 5.3            | 7.5            | 0.0                    | 0.0              | 0.0              | 0.0                      | 0.0             | 0.0             | 0.0                     | 4.0                  | 0.0                  | 2.8                 | 0.0                 |
|                        | 21/02/2023 | 51.8                 | 24.5   | 9.0            | 0.8            | 0.0                    | 0.0              | 0.0              | 0.0                      | 1.8             | 0.0             | 0.0                     | 7.5                  | 0.0                  | 4.8                 | 0.0                 |
|                        | 27/04/2023 | 93.2                 | 0.3    | 4.8            | 1.8            | 0.0                    | 0.0              | 0.0              | 0.0                      | 0.0             | 0.0             | 0.0                     | 0.0                  | 0.0                  | 0.0                 | 0.0                 |
|                        | 16/05/2023 | 76.3                 | 0.0    | 0.0            | 1.5            | 0.0                    | 0.0              | 0.0              | 0.0                      | 0.0             | 0.0             | 0.0                     | 14.8                 | 0.0                  | 7.5                 | 0.0                 |
|                        | 27/06/2023 | 84.3                 | 0.8    | 1.3            | 1.0            | 0.0                    | 0.0              | 0.0              | 0.0                      | 0.0             | 0.0             | 0.0                     | 5.5                  | 1.8                  | 4.5                 | 0.5                 |
| Notes:                 |            |                      |        |                |                |                        |                  |                  |                          |                 |                 |                         |                      |                      |                     |                     |
| “-“ indicates no data. |            |                      |        |                |                |                        |                  |                  |                          |                 |                 |                         |                      |                      |                     |                     |



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

| Date                                        | Chlorophyll- <i>a</i> (mg/m <sup>2</sup> ) |                |                       |                          |
|---------------------------------------------|--------------------------------------------|----------------|-----------------------|--------------------------|
|                                             | Bowyers Stream                             | Taylors Stream | Ashburton River South | Rakaia River South Braid |
| 28/10/2022                                  | 0.20                                       | 0.40           | 0.12                  | -                        |
| 30/11/2022                                  | 0.03                                       | 0.03           | 0.03                  | 0.20                     |
| 14/12/2022                                  | 0.03                                       | 0.02           | 0.57                  | 4.50                     |
| 18/01/2023                                  | 13.20                                      | 2.90           | 2.70                  | 0.15                     |
| 31/01/2023                                  | 2.10                                       | 2.00           | 0.80                  | 2.20                     |
| 21/02/2023                                  | -                                          | -              | -                     | -                        |
| 27/04/2023                                  | 0.58                                       | 0.30           | 1.04                  | 2.40                     |
| 16/05/2023                                  | 16.00                                      | 17.30          | 8.00                  | 0.30                     |
| 27/06/2023                                  | 4.70                                       | 0.79           | 2.30                  | 7.60                     |
| 31/07/2023                                  | 0.04                                       | 0.03           | 0.00                  | 2.60                     |
| <p>Notes:</p> <p>"-" indicates no data.</p> |                                            |                |                       |                          |

**Table B7: Macrophyte monitoring results**

| Parameter                       | Date       | Bowyers Stream | Taylors Stream | Ashburton River South | Rakaia River South Braid |
|---------------------------------|------------|----------------|----------------|-----------------------|--------------------------|
| Emergent Macrophytes (% cover)  | 28/10/2022 | 0              | 0              | 0                     | 0                        |
|                                 | 30/11/2022 | -              | -              | -                     | -                        |
|                                 | 14/12/2022 | -              | -              | -                     | -                        |
|                                 | 18/01/2023 | -              | -              | -                     | -                        |
|                                 | 31/01/2023 | -              | -              | -                     | -                        |
|                                 | 21/02/2023 | -              | -              | -                     | -                        |
|                                 | 27/04/2023 | -              | -              | -                     | -                        |
|                                 | 16/05/2023 | -              | -              | -                     | -                        |
|                                 | 27/06/2023 | -              | -              | -                     | -                        |
|                                 | 31/07/2023 | -              | -              | -                     | -                        |
| Submerged Macrophytes (% cover) | 28/10/2022 | 0              | 0              | 0                     | 0                        |
|                                 | 30/11/2022 | -              | -              | -                     | -                        |
|                                 | 14/12/2022 | -              | -              | -                     | -                        |
|                                 | 18/01/2023 | -              | -              | -                     | -                        |
|                                 | 31/01/2023 | -              | -              | -                     | -                        |
|                                 | 21/02/2023 | -              | -              | -                     | -                        |
|                                 | 27/04/2023 | -              | -              | -                     | -                        |
|                                 | 16/05/2023 | -              | -              | -                     | -                        |
|                                 | 27/06/2023 | -              | -              | -                     | -                        |
|                                 | 31/07/2023 | -              | -              | -                     | -                        |

Notes:

"-" indicates no data.

**Table B8: Deposited fine sediment cover monitoring results**

| Date       | Deposited Fine Sediment Cover (%) |                |                       |                          |
|------------|-----------------------------------|----------------|-----------------------|--------------------------|
|            | Bowyers Stream                    | Taylors Stream | Ashburton River South | Rakaia River South Braid |
| 28/10/2022 | 0.0                               | 23.6           | 10.5                  | 0.3                      |
| 30/11/2022 | 2.0                               | 0.0            | 6.1                   | 9.5                      |
| 14/12/2022 | 3.8                               | 5.8            | 3.8                   | 19.5                     |
| 18/01/2023 | 3.4                               | 4.3            | 6.9                   | 33.8                     |
| 31/01/2023 | 4.5                               | 2.3            | 8.3                   | 5.0                      |
| 21/02/2023 | 2.0                               | 0.6            | 5.0                   | 8.8                      |
| 27/04/2023 | 0.0                               | 0.3            | 4.5                   | 18.8                     |
| 16/05/2023 | 5.8                               | 0.0            | 6.8                   | 9.8                      |
| 27/06/2023 | 4.5                               | 0.8            | 2.0                   | 8.8                      |
| 31/07/2023 | 0.6                               | 5.0            | 2.5                   | 4.3                      |

## APPENDIX F – CRC184159 ENVIRONMENTAL MONITORING PLAN 2022-2023 REPORT (MHV WATER LIMITED)

# MEMORANDUM

|                 |                                                                      |
|-----------------|----------------------------------------------------------------------|
| <b>To</b>       | Eva Harris                                                           |
| <b>Company</b>  | EnviroCollective                                                     |
| <b>CC</b>       | Nicole Matheson - MHV                                                |
| <b>From</b>     | Justin Legg                                                          |
| <b>Date</b>     | 13 November 2023                                                     |
| <b>Subject</b>  | Groundwater Monitoring for CRC185857 Compliance Report December 2023 |
| <b>Doc. Ref</b> | CRC185857_2023_Hydro_Compliance_Report_EnviroCollective              |

## Background

This document is an excerpt of CRC185857 Compliance Report December 2023

## 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 December, March, June and September each year.

The data presented is for the reporting period 1 July 2022 to 30 June 2023. The specified monitoring bores are presented in Table 1.

**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 & Stock water  |
| K36/1072  | 1478173 | 5152240 | 2011    | 97.0  | 27.1 – 27.4      | Domestic & 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 & Stock water  |
| K37/2162  | 1473649 | 5137895 | 2004    | 48.16 | 21.9 - 32.5      | Domestic & 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 & Stock water  |
| K37/3155  | 1488759 | 5144768 | 2008    | 38.0  | 21.3 - 36.5      | Domestic & Stock water  |
| K37/3500  | 1480912 | 5128041 | 2010    | 42.0  | 29.7 - 35.1      | Irrigation              |

### Nitrate (NO<sub>3</sub>-N) groundwater monitoring results

- The nitrate (NO<sub>3</sub>-N) results for the specified monitoring bores for the reporting period are tabulated in Table 2.
- The nitrate (NO<sub>3</sub>-N) results for the specified monitoring bores are presented in Table 3

**Table 2** Nitrate results for specified monitoring bores for CRC185857

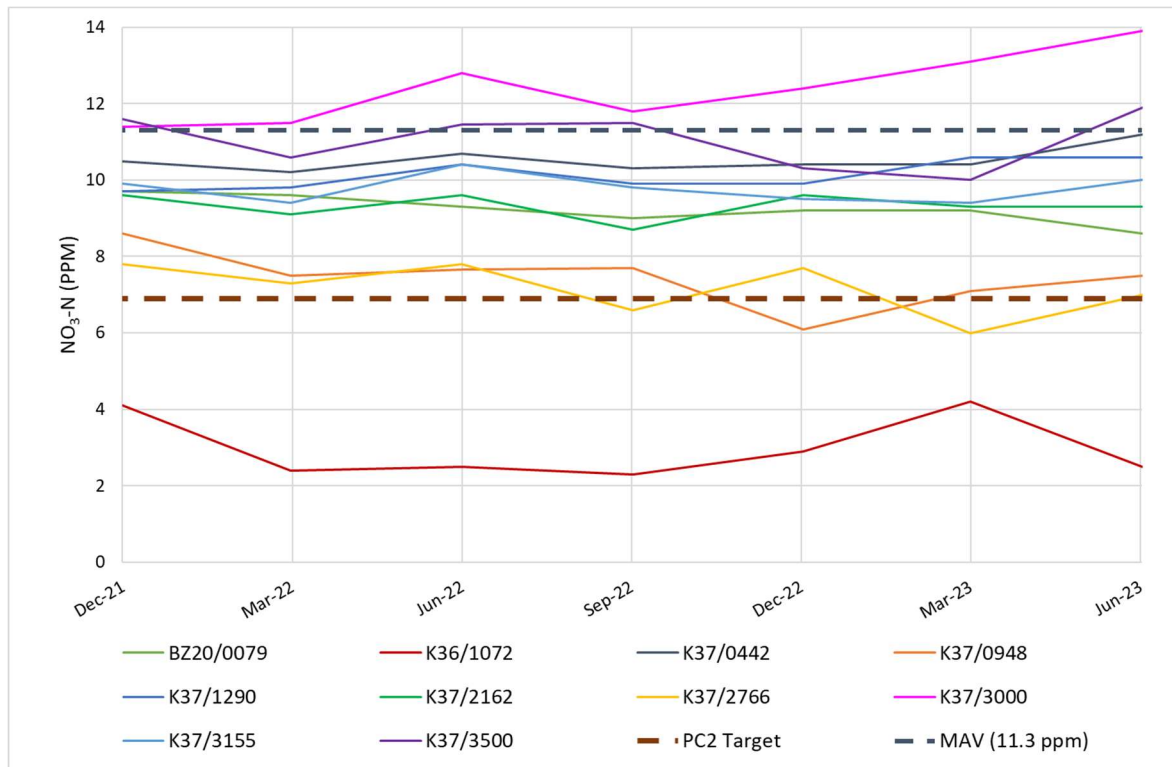
| WELL NO        | Sep-22      | Dec-22      | Mar-23      | Jun-23      | Average | Median |
|----------------|-------------|-------------|-------------|-------------|---------|--------|
| BZ20/0079      | 9.00        | 9.20        | 9.20        | 8.60        | 9.00    | 9.10   |
| K36/1072       | 2.30        | 2.90        | 4.20        | 2.50        | 2.98    | 2.70   |
| K37/0442       | 10.30       | 10.40       | 10.40       | 11.20       | 10.58   | 10.40  |
| K37/0948       | 7.70        | 6.10        | 7.10        | 7.50        | 7.10    | 7.30   |
| K37/1290       | 9.90        | 9.90        | 10.60       | 10.60       | 10.25   | 10.25  |
| K37/2162       | 8.70        | 9.60        | 9.30        | 9.30        | 9.23    | 9.30   |
| K37/2766       | 6.60        | 7.70        | 6.00        | 7.00        | 6.83    | 6.80   |
| K37/3000       | 11.80       | 12.40       | 13.10       | 13.90       | 12.80   | 12.75  |
| K37/3155       | 9.80        | 9.50        | 9.40        | 10.00       | 9.68    | 9.65   |
| K37/3500       | 11.50       | 10.30       | 10.00       | 11.90       | 10.93   | 10.90  |
| <b>Average</b> | <b>8.76</b> | <b>8.80</b> | <b>8.93</b> | <b>9.25</b> |         |        |
| <b>Mean</b>    | <b>9.40</b> | <b>9.55</b> | <b>9.35</b> | <b>9.65</b> |         |        |

For simplicity, Figure 2 presents the median NO<sub>3</sub>-N values with  $\pm 12\%$  error bars as specified by Hill Laboratories<sup>1</sup>.

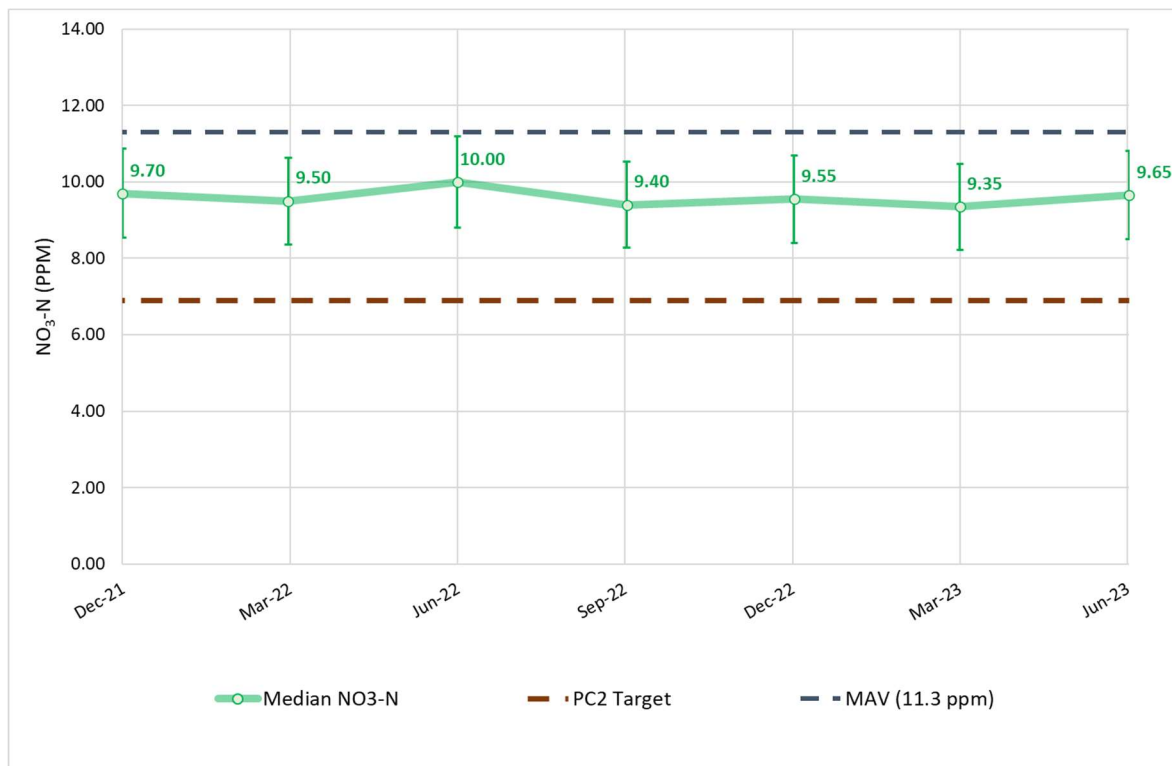
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<sup>1</sup> The reported uncertainty is an expanded uncertainty with a level of confidence of approximately 95 percent (i.e. two standard deviations, calculated using a coverage factor of 2). Reported uncertainties are calculated from the performance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





**Figure 1 Nitrate results for specified monitoring bores for CRC185857**



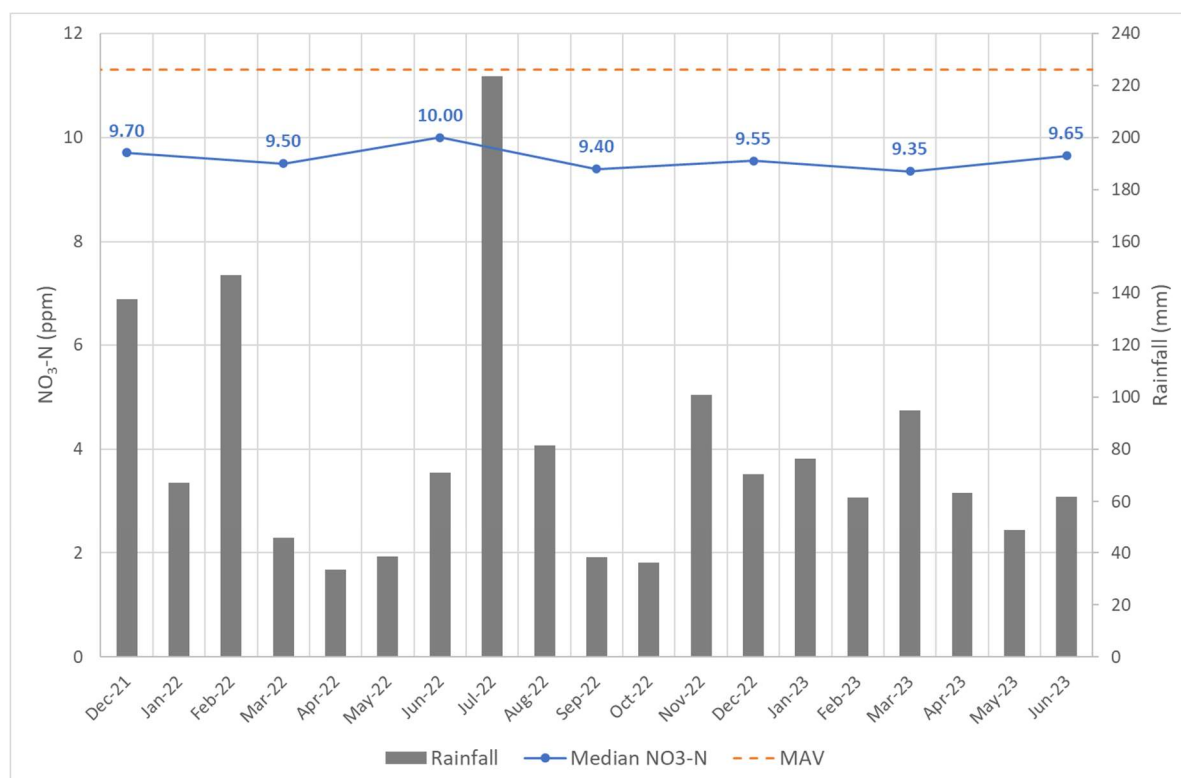
**Figure 2 Median NO<sub>3</sub>-N values with ±12% error bars as specified by Hill Laboratories**

Note, as the 2022-23 season was the second 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 (NO<sub>3</sub>-N) groundwater monitoring results

Figure 3 presents the arithmetic mean and median of the NO<sub>3</sub>-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).

The data indicates that all of the specified bores were consistently below the MAV of 11.3 ppm NO<sub>3</sub>-N for drinking water.



**Figure 3 Median NO<sub>3</sub>-N results for monitoring bores**

Note, as the 2022-23 season was the second 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).