MARLBOROUGH DISTRICT COUNCIL
15 SEYMOUR STREET
PO BOX 443, BLENHEIM 7240
NEW ZEALAND

TELEPHONE (0064) 3 520 7400
FACSIMILE (0064) 3 520 7496
EMAIL mdc@marlborough.govt.nz
WEB www.marlborough.govt.nz

27 September 2024

Record No: 24227725
File Ref: D050-001-E01
Ask For: Nicole Chauval

Notice of Committee Meeting – Thursday 3 October 2024

A meeting of the Environment & Planning Committee will be held in the Council Chambers, 15 Seymour Street, Blenheim on **Thursday, 3 October 2024 commencing at 9.00 am.**

BUSINESS

As per Agenda attached.

JOHN BOSWELL
CHIEF EXECUTIVE

MARLBOROUGH DISTRICT COUNCIL

Meeting of the ENVIRONMENT & PLANNING COMMITTEE
to be held in the Council Chambers, District Administration Building, Seymour Street,
on THURSDAY, 3 OCTOBER 2024 commencing at 9.00 am

Committee	Clr G A Hope (Chairperson) Clr B A Faulls (Deputy) Clr S J Arbuckle Clr A R Burgess Clr R J Innes Clr B J Minehan Clr T P Sowman Mayor N P Taylor Mr S Harvey (Rural Representative) Mr R Smith (Iwi Representative)
Departmental Head	Mr H Versteegh (Environmental Science and Policy Group Manager) and Ms G Ferguson (Consents and Compliance Group Manager)
Staff	Ms N Chauval (Committee Secretary)

In Public

Page

1. Apologies

No apologies received.

2. Declaration of Interests

Members are reminded of the need to be vigilant to stand aside from decision making when a conflict arises between their role as a member and any private or other external interest they might have.

3. Adapting and Growing Uptake of Remote/Virtual Building Inspections

(Clr Innes) (Report prepared by Dhyanom Gala) **R450-001-038-01**

Purpose of Report

1. To update the Committee on growing uptake of remote/virtual Building Inspections in the building industry and how the Building Control Group has adapted remote inspections into its workflow.

Executive Summary

2. The New Zealand government has announced plans to make remote inspections the default approach for Building Consent Authorities (BCA) with further details to be announced later in the year.

3. This initiative is expected to streamline the building consent process, reduce costs, and improve efficiency. However, it also presents several challenges, including technological requirements, training needs, liability sharing, and potential concerns from the building industry and council.

4. This report explores these aspects and provides update on the Remote Inspection Programme currently implemented by Building Control group using the Artisan remote inspection technology.

RECOMMENDATION

That the information be received.

Background/Context

5. In July 2024, the New Zealand government announced that remote inspections would become the default method for undertaking building inspections associated with building consents. This decision is part of a broader effort to enhance the efficiency and consistency of the building consent processes across the country.

6. Remote inspections are when building inspection activities are conducted remotely using digital tools and technologies. Instead of visiting the site in-person inspectors may, at their discretion, use live video streaming or review photographic evidence to assess the building work from their office, with the builder following their instructions on-site.

7. The two most commonly used remote inspection approaches in New Zealand are Live Stream (Video) and evidence based (Photo). However, technologies continue to evolve and other options may become more prevalent, such as drone inspections, fixed site camera monitoring and 360° reality capture systems.

8. Council's Building Control Group currently undertakes 4500-5000 building inspections every year and the group continually explore ways to promote efficiencies and improve overall performance.

9. Well before the government's recent announcement on uptake of remote inspections, the group decided to use BRANZ Artisan (in August 2021) as a piece of evidence based remote/virtual technology that allowed inspections to be photographed by builders and reviewed off-site by Council inspectors.

10. The goal at the time of adoption of this tool was to improve the building consent process, provide business continuity and see how effective remote inspection might be in certain situations, for example use in some of the more remote parts of the district or when faced with pandemic type situations.

11. An evidence based type of remote inspection tool provides a good option for both lower risk inspection types and inspections with builders that have consistently demonstrated compliant work.

12. When using an evidence-based approach, a greater focus on the quality of information is needed, with clear requirements on what the BCA will accept as evidence of compliance. The inspector sets clear expectations (shortlists/checklists) in advance, and it provides added flexibility for builders to record evidence at different stages of the build at their own convenience taking more control of their own quality.

13. The building industry is adapting at a fast pace. As the building industry changes, Building Consent Authority's tools and solutions must change with it. The uptake of Artisan by the Building Control Group demonstrates that there's an appetite for change within council, for doing things differently and for doing things better.

Incorporation of BRANZ Artisan Technology into Building Control Workflow

14. Artisan is a state-of-the-art mobile phone application and web solution developed by BRANZ optimising both the building Quality Assurance processes and consent compliance inspection.

15. The digital solution enables each key step in the build process to be prescribed, seen, assessed, and verified, then saved to Council files.

16. This digital remote inspection app (Artisan) allows tradespeople to photograph key compliance elements of a building project against predefined checklists using their smartphones for remote verification by the BCA. Inspectors can view the images in real time, assess and approve the work, or make recommendations without leaving their desks.

17. Artisan also has a full in-built video screen-sharing facility to be used in a live stream way, but it is fundamentally a Quality Assurance (QA) and digital record-keeping system and not a full remote inspection tool. Building Control Group uses Artisan in its hybrid inspection model alongside on-site inspection.

18. A detailed operational process flow on how Artisan inspection process works for a customer/builder has been appended to this report in Attachment 1.

19. Since starting the pilot programme to evaluate Artisans feasibility in August 2021 to subsequently rolling out Artisans implementation into its workflow in August 2022, Building Control Group has undertaken approximately 1085 inspections remotely using Artisan technology (up until 13th September 2024).

20. Over this period Marlborough District Council has saved over 32,400 kms in travel to building sites and have saved over 1,030 (129 full working days) hours from inspection and travel times for building inspectors. The use of remote inspection technology has helped reduce the inspection times by an average of 1 hour per inspection for council over this period.

21. In addition, Artisan provides a sense of security in terms of compliance, as it's not just about the council, but also about the homeowners and future owners, that there's a good record of what's been done, and that as a consenting authority, the council, is comfortable that the work meets the building code requirements.

22. Currently Building Control Group undertakes approximately 15% of all its inspections remotely using Artisan technology and is gradually increasing its uptake in the Marlborough's building industry.

23. Building Control Group has developed thorough policies and procedures to strike the appropriate balance between increased efficiency and maintaining the rigour of the inspection process.

Remote Inspection Opportunities and Benefits

24. Remote inspections offer several opportunities and benefits for council and the building industry:

a) *Efficiency*: Reduces travel time and delays by enabling more inspections per day. Particularly helpful for Marlborough having large travel distances between building sites.

b) *Cost Savings*: Lowers transportation and vehicle maintenance costs for undertaking inspections and reduces the need for physical presence at inspection sites. Building Control Group also refunds the travel component of building consent fees back to the consent fee payer effectively resulting in cost savings for builders.

c) *Environmental Impact*: Decreases carbon emissions associated with travel, contributing to Council's sustainability goals.

d) *Flexibility*: Provides greater flexibility for inspectors and building professionals, enabling inspections to be scheduled more conveniently. Builders get more-timely inspections that are undertaken at a time that suits them, rather than relying on the inspector's availability.

e) *Record Keeping*: Enhances documentation and record-keeping through digital tools which are geographically stamped, providing quality assurance.

f) *Health and Safety*: Minimise exposure of building inspectors to hazards on-site and as there will be fewer people on-site reduces the likelihood of accidents.

g) *Improved Knowledge of Building Code*: Builders are being incentivised to build better quality homes through increasing their knowledge of the requirements of the building code. Builders learn more and gain an in-depth understanding of what's required for the council building inspections through early provision of checklists, enabling them to get it right faster the first time.

h) *Resilience:* Provide Business Continuity and resilience in times of pandemic-related challenges or natural disasters.

i) *Faster Builds*: Shorter building process by reducing down-time for builders waiting for a council inspection.

j) *Build Trust and Connectivity*: Building industry is one built on relationships. Whether you're a builder, inspector, tradesperson or homeowner, we all know the best relationships are underpinned by trust, and remote inspections support that trust, enhance reputation and collaboration between stakeholders.

Challenges for Council with Administering Remote Inspections

25. Despite the benefits, there are several challenges associated with the shift to remote inspections that will have significant impacts on BCAs:

a) *Operational Changes*: BCAs will need to update their policies, procedures, and systems to accommodate remote inspections to align with regulatory proposals and accreditation regulations.

b) *Financial and Staff Resourcing:* The financial cost of investing in the necessary remote inspection technology, integration with existing systems and its upkeep has an additional burden on operational expenditure. Also, there are increased costs associated with training staff to support the transition and upskill in remote inspections.

c) *Technological and Training Requirements*: Ensuring all parties have access to the necessary technology and reliable internet/satellite connections. Building practitioners may also require training on the new technology, a consideration is who should be responsible for this, and whether there would be any centralised support.

d) *Resistance to Change*: The uptake has been sporadic across the country, with some councils reluctant to adopt remote technology instead of in person inspections due to various operational reasons. Overcoming reluctance from different stakeholders who are accustomed to traditional inspection methods is a challenge. Some builders in the building industry have been historically averse on use of technology.

e) *Consistency and Quality Control*: While remote inspections are available at some councils, their approaches are inconsistent. This can be frustrating for builders, particularly those operating across different regions. Introducing and maintaining a nationally consistent approach for high-quality remote inspections would therefore be desirable for both councils and building industry.

f) *Risk Management*: When using remote inspections councils have to ensure that the quality and reliability of information sourced from these inspections does not suffer. Building practitioners could mislead inspectors (even unintentionally) by sending inaccurate or incomplete visual records of building work. There is room for error if the onus is placed on inspectors to identify at risk inspection records and carry out further verification.

g) *Liability Settings*: A key concern for councils is the liability settings and liability sharing in the use of remote inspections. Councils owe a duty of care to ensure their inspections are accurate, and that houses built under their watch comply with the Building Code. If that duty is breached, they could be liable. Addressing liability related concerns at policy level are required to ensure there is robust regulatory framework.

h) *Regulatory Framework*: Councils have a duty to exercise reasonable care when carrying out the relevant regulatory functions, including when inspecting building work to ensure compliance with a building consent and certifying compliance with the building code. Regulatory framework specific for remote inspection must be developed to ensure robust verification processes.

Next steps

26. Drawing on our current experience with remote inspections, take the opportunity to provide feedback on the government’s discussion paper in the coming months. This paper will inform the development of proposed regulatory settings aimed at increasing the adoption of remote inspections in the building industry.

27. The consultation will seek feedback on the costs, risks, and benefits of various potential approaches. It will be an excellent opportunity for the Council to express its views and concerns regarding the use of remote inspections. The success of remote inspections will depend on perfecting the finer details of the process.

28. Monitor and evaluate assess the effectiveness of current remote inspections setting and make adjustments as needed to adapt to new challenges and regulatory changes.

29. *Investment in Technology and Staff Training*: It is important for council to ensure that they invest and have access to the necessary technology and staff training to further grow use of remote inspections and explore future technological advancements.

Presentation

A short presentation will be given by Dhyanom Gala (10 minutes).

Attachment

Attachment 1 – Artisan process flow Page [6]

Author	Dhyanom Gala, Building Control Group Manager
Authoriser	Gina Ferguson, Consents and Compliance Group Manager

Attachment 1

Artisan - Process Flow

MARLBOROUGH DISTRICT COUNCIL

Builder Notifies MDC with Building Consent Number

- E-mail MDC with the Live Building Consent Number and the Inspection Type(s) you wish to be arranged with Artisan. Please ensure that you provide this notification at least 1 week before undertaking the First Inspection on Artisan.
  E-mail Address: build.artisan@marlborough.govt.nz
- MDC will evaluate the inspection types requested and notify Building Participant of final inspection types permitted to be carried out remotely/virtually on Artisan.

MDC Sets up Projects with Tailored Shotlists

- MDC will create a Building Consent Project in Artisan Web Console for requested Building Consent.
- Each of the Shotlist/Checklist will be best tailored to meet the Individual Project needs.
- 1 weeks' notice for set-up the Project Shotlist is best Suited at this stage for MDC.

Builder Invites Participants

- Once the Project set-up is completed by MDC, a notification will be sent to the Building Firm that the Project is Live.
- Building Firm can then choose to Invite other Participants to the Project in Artisan. (May include – Owner, Project Manager, LBP Builders, Sub-contractors, etc.).
- The MDC can provide Training to Participants in use of Artisan App and Taking Photos for Shotlist with Demo Project.

Build Team Takes Photos & Submits them for Review

- Build Team Starts Work and Trained Participants (Shot taker) will complete Tasks in Shotlist as they complete work.
- Shot taker should notify MDC by E-mail atleast 24 hours prior before they are ready to 'Submit' the Shot-list so that MDC can provide review result within one working day. If this notification is not provided, then review period will be 2 working days. (Specify: Building Consent Number, Inspection Type and Time they the Shot-taker will Submit Shotlist).
- The Shot taker then Submits the Shotlist to MDC for Review in Artisan App. An automated notification is sent to MDC.

MDC Reviews the Shotlist and Determines Result

- MDC Inspector will best try to review the Shotlist as they are taken on notified time (*BCO Workload Permitted*).
  In such instances, the inspector may choose to call the shot taker via Artisan App and discuss any issues seen or any further clarification required during the Shot taking process.
- However, in most cases, the inspector will review the shots at later time after a Shotlist has been submitted for Review and send feedback or inspection result (Pass or Fail with comments) via the Artisan App.

For Incomplete/Failed Items: Shotlist Unlocks to Submit Evidence of Rework

- All Re-check shots for the Failed Items need to be sent for Review to MDC and Passed before the Work is covered over.
- The Shot taker again notifies MDC that Shotlist has been submitted for further review.
- MDC will assess the updated Shotlist for Passing the Inspection. MDC can arrange to e-mail the completed inspection record on request, or this can be viewed by participant on MDC Online Property Files.

4. Compliance Monitoring Summary 2023-24

(Clr Minehan) (Report prepared by Claire Frooms) **E360-006-02**

Purpose of Report

1. To provide Council with an overview of the activity undertaken by Council's Compliance Monitoring Team during the 2023-24 monitoring period.

Executive Summary

2. The Compliance Monitoring team operate under a strategic monitoring programme to prioritise resources, activities for proactive monitoring are prioritised and ranked based on risk of harm to the environment; state of environment trends; previous compliance issues; Iwi interest; and public interest.

3. The Compliance Monitoring Team monitored 3,329 separate resource consents or permitted activities, in the 2023-2024 year. This included 4,558 individual monitoring events.

4. Compliance levels overall for each instance of monitoring during the monitoring period were: 69% compliance, 11% technically non-compliant, 12% non-compliant and no significant non-compliance. 8% of monitoring was unable to determine a compliance rating, for example further information had to be requested.

5. The Compliance Monitoring Team issued 19 formal enforcement notices in response to non-compliance identified during the monitoring period.

RECOMMENDATION

That the information be received.

Background/Context

6. Council's Compliance Monitoring Team is responsible for monitoring a range of activities undertaken in the Marlborough region, both those undertaken as permitted activities and those governed by resource consents.

7. The team's objectives are:

    a) Objective 1: To provide an active compliance monitoring and enforcement regime to sustainably manage Marlborough's natural and physical resources.

    b) Objective 2: To provide feedback and information on resource use and sufficient environmental information to enable other objectives to be met.

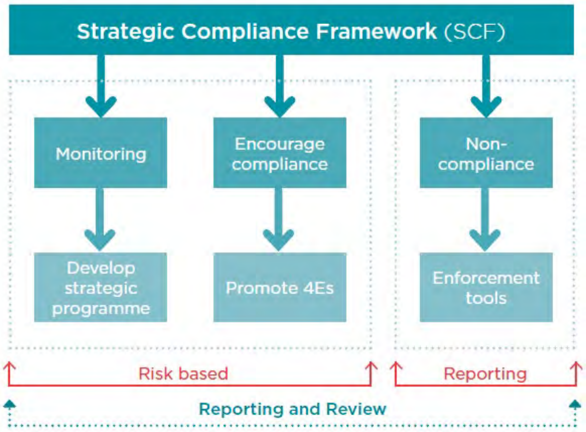
8. During the 2023-24 monitoring period there were 36,925 active resource consents. Of these, many have been previously monitored and do not require further monitoring or have no conditions requiring active monitoring for example where the activity is complete.

9. In addition to resource consents there are a number of activities undertaken as permitted activities either under the Proposed Marlborough Environment Plan (PMEP) rules or under National Environmental Standards (NES) regulations. Many of these activities are also monitored by the Compliance Monitoring Team. These include discharge to land of dairy effluent and winery wastewater, forestry harvesting and earthworks, and application of synthetic nitrogen.

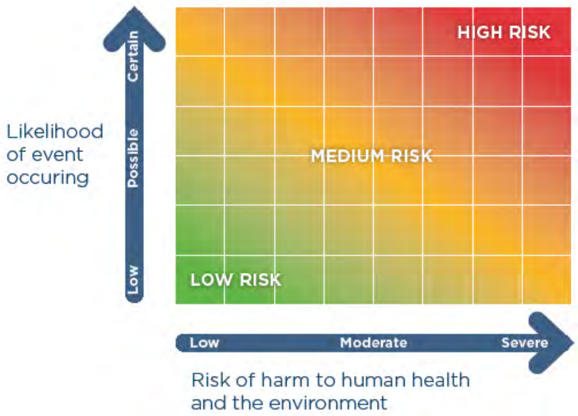
10. The Compliance Monitoring team consists of one Team Leader (0.5 FTE), four Environmental Protection Officers (EPO) (4 FTE), one Water Monitoring Administration Officer who shares an EPO and Administration Officer role (1 FTE) and one Monitoring Administration Officer (1 FTE).

11. Two of these FTE's were new to Council during the 2023-24 monitoring period.

12. The Regional Sector Compliance and Enforcement Special Interest Group (CESIG) have created a Regional Sector Strategic Compliance Framework. The framework outlines the purpose of strategic compliance monitoring, the principles to guide compliance, guidelines for developing a strategic compliance monitoring program, how to encourage compliance and how to deal with non-compliance.



Elements of a Strategic Compliance Framework (CESIG)



Generic Environmental Risk Matrix (CESIG)

13. Given the large number of active consents and the relatively small number of monitoring officers it is important the group undertakes a risk-based monitoring approach utilising efficient monitoring methods to achieve maximum benefit.

14. The team's strategic monitoring programme identifies which activities will be proactively monitored and which will be monitored by complaint. Those identified as requiring proactive monitoring include:

i) Forestry
ii) Water takes
iii) Winery waste
iv) Dairy effluent disposal
v) New Zealand King Salmon
vi) Marine farms
vii) Industrial discharges
viii) Commercial wastewater
ix) Large earthworks
x) River diversion and disturbance
xi) MDC resource consents
xii) Moorings
xiii) Coastal structures
xiv) Domestic wastewater
xv) Quarries and cleanfills

15. Those activities which are monitored on a complaint basis include:

i) Second dwellings
ii) Bird scaring devices
iii) Frost fans

iv) Odour discharges

v) Signs

vi) Small earthworks

16. The majority of our monitoring activities are cost recoverable, either through direct cost recovery for time taken conducting monitoring or through annual monitoring charges for water and mooring resource consents. This is in accordance with the user pays model in which the resource consent holder pays for the monitoring costs associated with their own resource consent.

17. The annual charges for moorings and water take consent holders cover the costs of most anticipated monitoring however, when non-compliance is identified the officer’s time spent dealing with the non-compliance is chargeable in addition to the annual fixed charge.

18. Most other resource consent types receive an annual admin charge which covers the maintenance of monitoring systems and other overheads, but officer’s time spent monitoring the consent is chargeable in addition, regardless of the compliance status.

19. Monitoring of permitted activities under plan rules is not chargeable, this includes discharge of dairy effluent and winery wastewater where resource consent is not required. Therefore, the cost of monitoring of these activities is absorbed by the general rate payer.

20. Some activities under NES permitted activity regulations do provide the ability for Council to charge for the monitoring of these activities. These include forestry earthworks and harvesting (National Environmental Standards for Commercial Forestry 2023) and application of nitrogen (National Environmental Standards for Freshwater 2020).

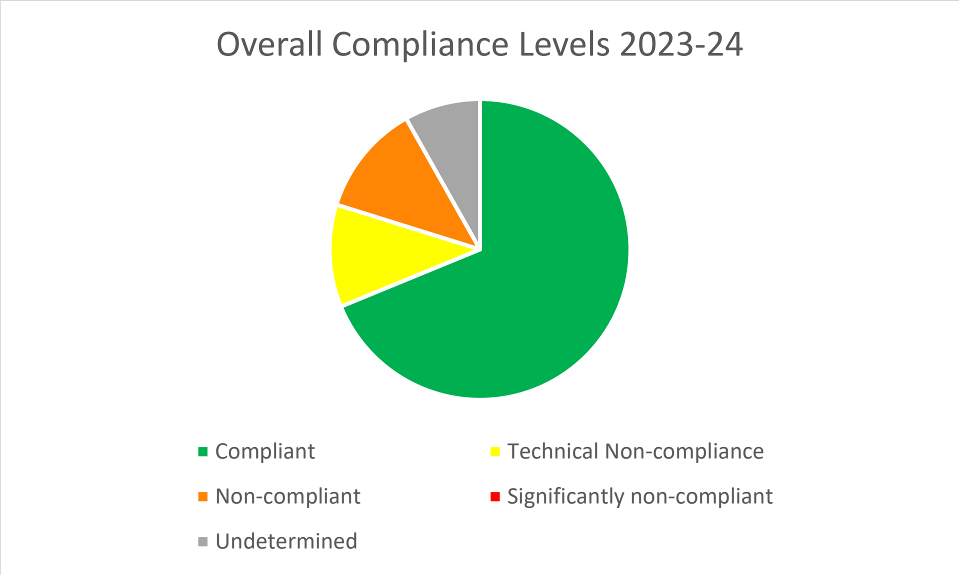
Monitoring Undertaken

21. Each activity requiring proactive monitoring has a project plan which identifies the extent of the monitoring required. The intensity and frequency of the monitoring undertaken is outlined in the project specific strategies which have been developed in accordance with information about the activity undertaken. For example, dairy farm inspections are undertaken annually in accordance with the National Dairy Farm Audit protocols.

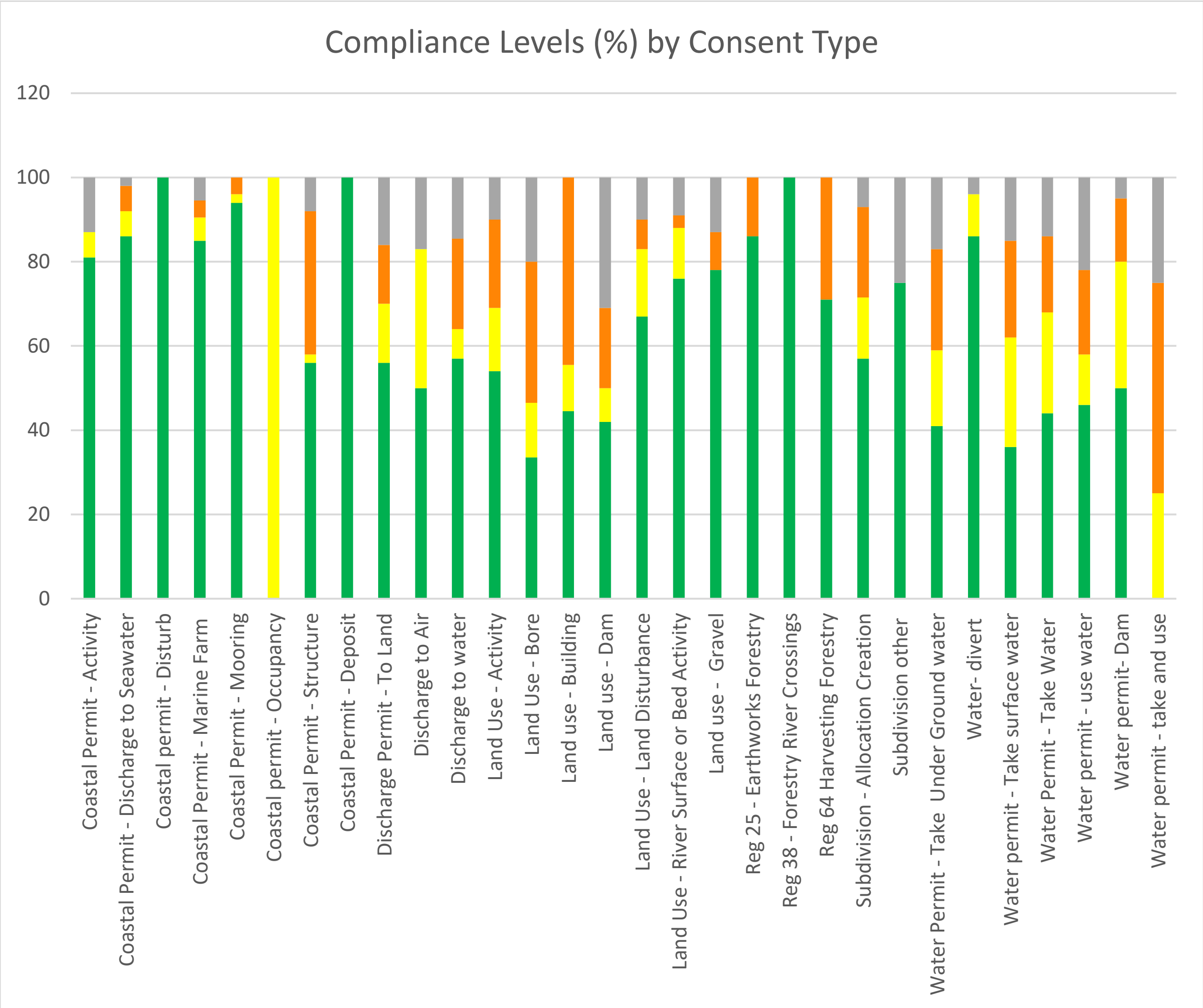
22. Some activities require monitoring in the form of a site visit, for example forestry earthworks and harvesting. Whilst other activities generally require more desktop monitoring, for example water takes which largely provide telemetry data of the water abstraction.

23. The monitoring period ran from 1 July 2023 to 30 June 2024. There were 4,558 individual records of monitoring undertaken during the 2023-24 monitoring period. This includes monitoring of 3,329 separate resource consents or permitted activities.

24. Compliance levels overall for each instance of monitoring during the monitoring period were: 69% compliance, 11% technically non-compliant, 12% non-compliant and no significant non-compliance. 8% of monitoring was unable to determine a compliance rating, for example further information had to be requested.



25. Monitoring is recorded against the category of resource consent and a summary of compliance by consent type is shown in the graph below:



Priority Programmes

26. For the 2023-24 reporting period, MDC had approximately 36,925 active resource consents. Of these, 3,555 required monitoring under MDC's priority monitoring programmes. 1,889 were water take consents and 1,666 consents predominantly for land use or discharges to land, air, and water.

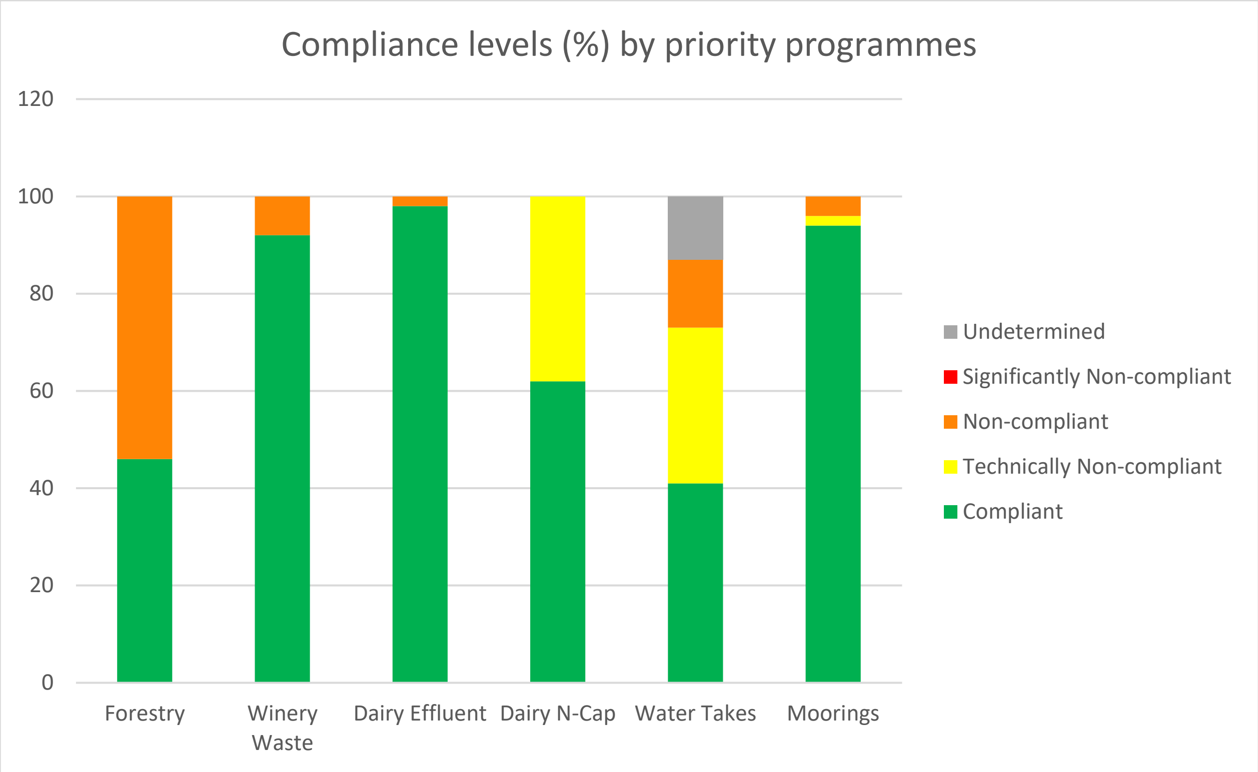
27. During the 2023-24 period, MDC monitored 76.23% of the resource consents that required monitoring (2,710 of the 3,555). In addition, a further 619 resource consent were monitored, due to receipt of a report or notification as a condition of consent.

28. Most of the highest priority portfolios achieved the monitoring levels required. There were challenges associated with monitoring the large numbers of water take permits in the district, the compliance levels with data receival and the extent of water shut offs during the exceptionally dry irrigation period put extra demands on the team. Dealing with non-compliance is more time consuming and therefore when low compliance levels are identified, the ability to monitor all consents is compromised.

29. All compliance reports have the consent condition, a comment regarding the compliance and the compliance status colour coded using the traffic light system.

- **Green** are compliant and no action is required;
- **Yellow** are technically non-compliant with no-adverse environmental effects;
- **Orange** are assigned for relatively minor breaches requiring some corrective action;
- **Red** are significantly non-compliant;

30. A summary of overall compliance for the main priority programmes is shown in the graph below:



31. The highest priority monitoring programmes have been or will be reported on in more detail throughout the year by the officers responsible for each of those programmes.

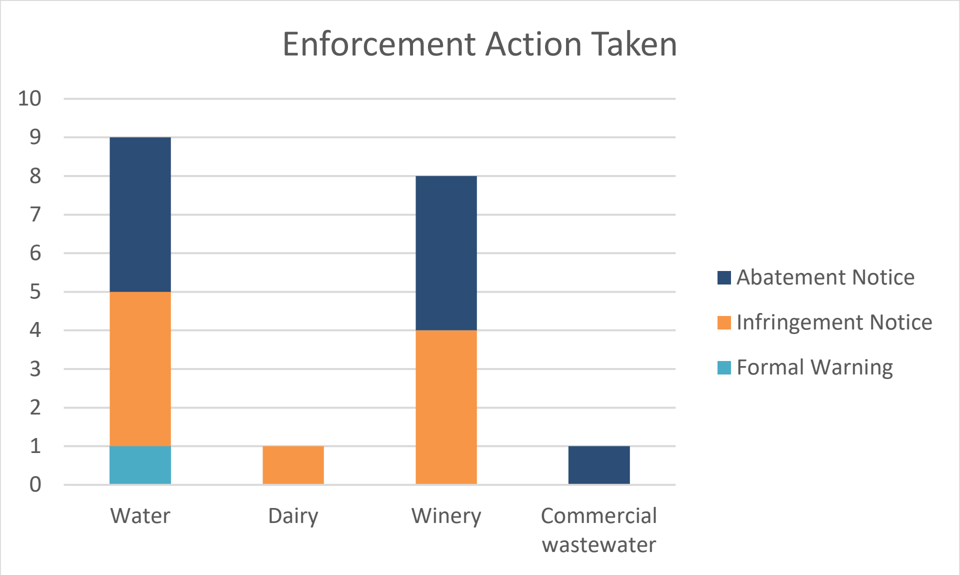
Compliance Snapshots

32. The Environmental Protection Team has created Compliance Snapshots, for each monitoring program as they are completed for the reported year. These are completed to get key information to the public

in an easy-to-read format and provide background information regarding how compliance is carried out and how compliance is assessed.

Enforcement Action Taken

33. As a result of monitoring activities, a range of enforcement tools are used to address non-compliance in accordance with Council's Enforcement Policy. During the 2023-24 monitoring period 1 formal warning, 10 infringements and 9 abatement notices were issued as part of strategic monitoring programmes. Other actions taken included letters of direction and letters of education.



Changes made during 2023-24

34. The introduction of strategic QA's enabled officers to make decisions about appropriate enforcement action to take in a more efficient manner.

35. Strategic QAs take into consideration all of the usual facts of a case and ensure consistency by providing a pre-determined outcome without the need for the officer to write a QA report in each case and have a panel review meeting to determine the outcome.

36. These have been implemented for forestry, water takes, winery waste disposal, moorings and dairy effluent disposal. These strategic QAs have been introduced throughout the year as they have been developed and more will continue to be added as they are developed.

37. The consistent approaches taken by all officers enables a clear message to be passed to the relevant industries to ensure they can improve their practices and achieve better environmental outcomes.

38. Our Water Monitoring Administration Officer and Monitoring Administration Officer became warranted towards the end of the 2023-24 monitoring period. This is another initiative to ensure more efficient monitoring. Our Monitoring Administration Officers have been provided with strategic QAs to allow them to make informed and consistent compliance decisions regarding matters to which they are dealing with, without the need to pass files to EPO's.

Upcoming changes

39. A review of the overall monitoring strategy will be undertaken this year to ensure our monitoring priorities align with the current priorities for the community and the environment. This will flow down into reviews of the individual monitoring programmes.

40. The current compliance monitoring database is limited in functionality and not considered fit for purpose, this impacts efficiency of administration tasks when carrying out monitoring functions.

Council is investigating replacement databases in order to make changes and further improve the team’s performance and assist resource consent holders with meeting their resource consent obligations.

Presentation

A short presentation will be given by Claire Frooms (15 minutes).

Author	Claire Frooms, Team Leader Compliance Monitoring Programme Coordinator
Authoriser	Rachael Williams, Compliance Manager

5. Gravel Bed Rivers (GBR) National Project Wairau River Case Study Final Report

(Clr Burgess) (Report prepared by Peter Davidson) **E345-007-001**

Purpose of Report

1. To present the report Wairau River Study: Subsurface Processes in Braided Rivers MBIE Programme.

Executive Summary

2. The main findings of the report were:

   a) Braided rivers should be considered as a “river system”, comprising their river channels, gravel beds and the water stored within those gravel beds.

   b) Braided rivers have their own distinct aquifer (braidplain aquifer) formed by movement of bed sediments during flooding, and which temporarily store water which is exchanged with river channels.

   c) Braided river systems can be hydraulically perched above the regional groundwater table or hydraulically connected as is the case for the Wairau River system.

   d) Recharge to the Wairau Aquifer from the Wairau River system is dynamic and depends on channel-aquifer head differences. The Wairau River provides recharge at an average rate of 6.65 m^3/s to the Wairau Aquifer (range 4 to 26 m^3/s).

   e) The most permeable gravel layer beneath the Wairau River and forming the Wairau Aquifer on the river berms is very thin (<8 metres) and sensitive to changes in levels in either water body.

   f) Braiding distributes water more evenly across the braidplain aquifer and promotes higher groundwater levels. Channelisation increases water level fluctuations and scoring compounds it, allowing groundwater levels to fall to very low levels during low flow periods.

   g) Wairau River flood protection works have reduced the degree of braiding since 1960 leading inadvertently to lower channel levels relative to the Wairau Aquifer and reduced exchange with groundwater, all other factors being equal.

   h) Continued lowering of the Wairau River bed would reduce security of supply for irrigators and cause further spring recession. Bed raising would increase cost of gravel, increase security of supply for irrigators and reduce spring recession.

   i) Widening of the Wairau River bed would potentially provide a one-off gravel source, decrease the depth of scouring, and promote braiding.

RECOMMENDATION

That the report be received.

Background/Context

3. The long-term declining trend in Wairau Aquifer levels generated a series of work streams to understand the causes. These included the five-year Gravel Bed Rivers (GBR) national project, analysis of climate/hydrological patterns since 1960 and a review of metered water use. The results showed Wairau River summer flows were lower in recent times due principally to consented abstraction from the Wairau River channel and climate patterns, while the long-term declining trend is

caused by falling Wairau River channel bed levels relative to the most permeable Wairau Aquifer layers due to unintentional changes from river management and catchment sediment supply.

Methodology

4. The GBR project involved a combination of field work and computer modelling to understand the mechanics of braided rivers and the impact of their management on the water exchange process with groundwater. Case studies were carried out on the Ngaruroro River in central Hawkes Bay, Waikirikiri/Selwyn River south of Christchurch and the local Wairau River. The project team consisted of a multi-disciplinary group from New Zealand and overseas which included river engineers from NIWA. This report is output from the GBR project for the Wairau River case study.

Next steps

5. Once adopted by MDC the report and associated presentation to the September MDC workshop, will be publicly available via the Council website. The document has been identified by MDC Assets & Services as a valuable piece of work for the upcoming review of the Lower Wairau River Scheme and sustainability of MEP gravel extraction policy.

Presentation

A short presentation will be given by Peter Davidson and Andy White (15 minutes).

Attachment

Attachment 1 – Wairau River Study Page [16]

Author	Peter Davidson, Environmental Scientist Groundwater Quantity & Quality and Andy White, MDC Rivers & Drainage Group Manager
Authoriser	Alan Johnson, Environmental Science & Monitoring Manager

Attachment 1

MEASURE. MODEL. MANAGE.

Wairau River Study

Subsurface Processes in Braided Rivers

MBIE Programme

Report 1003-28 R3

Scott Wilson, Linda Robb and Thomas Wöhling
Lincoln Agritech

17th September 2024

LINCOLN AGRITECH

LINCOLN AGRITECH LOCATIONS

Lincoln Agritech is a 100% subsidiary of Lincoln University and is based on campus at Lincoln University, near Christchurch, New Zealand. Our North Island office is located on the Ruakura Research Campus in Hamilton, New Zealand.

Lincoln/Head Office

Lincoln Agritech Limited / Engineering Drive / Lincoln University
PO Box 69133 / Lincoln / Christchurch 7640 / New Zealand

P +64 3 325 3700 / **F** +64 3 325 3725

Hamilton/Regional Office

Ruakura Research Centre / 10 Bisley Road
Hamilton 3214 / New Zealand

P +64 7 858 4840

CONFLICTS OF INTEREST, CONFIDENTIALITY & COPYRIGHT

Conflicts of Interest

We are not aware of any circumstance where a conflict of interest could arise. However, should a potential conflict of interest become evident, we would immediately bring this to the attention of our client and discuss appropriate action and mutually acceptable ways to move forward.

DOCUMENT ACCEPTANCE

ACTION	NAME	SIGNED	DATE
Prepared By	Scott Wilson, Linda Robb and Thomas Wöhling	[signature]	17 September 2024
Approved By	Simon Pollock Group Manager Environmental Research	[signature]	17 September 2024
BD Manager	Anya Hornsey	[signature]	17 September 2024

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

1. INTRODUCTION

This report summarises the work and findings of a five-year MBIE-funded research programme "Subsurface Processes in Braided Rivers" (contract LVLX1901). Additional funding was provided by Marlborough District Council as well as our other council partners Hawkes Bay Regional Council and Environment Canterbury Regional Council. We provide a list of outputs from this programme in the form of reports and published papers in Appendix 1. Detailed information on data collection for this work is included in Appendix 2.

While this report is written by Lincoln Agritech, we acknowledge the substantive contribution made by braided river geomorphologists Jo Hoyle and Richard Measures of NIWA, and hydrological modeller Moritz Kraft of TU Dresden. This research programme used a multidisciplinary approach to understand a problem which crosses several fields of expertise. As such, the report includes contributions from Lincoln Agritech, Lincoln University, NIWA, University of Canterbury, TU Dresden (Germany), Flinders University (Australia), and Aarhus University (Denmark).

In New Zealand we have inherited conceptual ideas and terminology from overseas studies carried out in relatively passive river environments. Our braided and gravel bed rivers differ from the traditional conceptualisation in that they have a significant water reservoir in the river bed. This requires a different way of thinking about what constitutes a river, and the terminology that is used. Throughout the text we refer to "riverbed" as a topographic surface, and "river bed" as the bed sediments of the river system. Local exchange of flow across the riverbed surface is commonly known in the literature as hyporheic flow or exchange. We refer to flow within the river bed sediments as parafluvial flow or parafluvial exchange.

2. SCOPE

The five-year research programme began in October 2019 and focussed on the main flow-losing sections of three rivers, the Ngaruroro, Wairau, and Waikirikiri Selwyn. Flow-losing sections of the respective rivers were chosen for this study to potentially maximise the difference between water elevation in the river system and the underlying regional aquifer system, thereby revealing any structural control on river leakage. The research programme focussed on three key questions:

- How do braided rivers work beneath the riverbed?
- How can we represent such a complex river system in a regional scale model?
- What impact is river management having on river losses?

Included in the third research question is an economic analysis to get an indication of the value of management trade-offs e.g. gravel extraction versus security of supply for irrigators. The economic evaluation was focussed on the Ngaruroro and Wairau River sites, which are engineered for flood protection and have a high demand for gravel extraction.

3. THE STUDY SITE

The Wairau study site was established between Jeffries and Giffords roads (Fig. 1). This river reach provides the majority of recharge to groundwater that sustains the Spring Creek catchment.

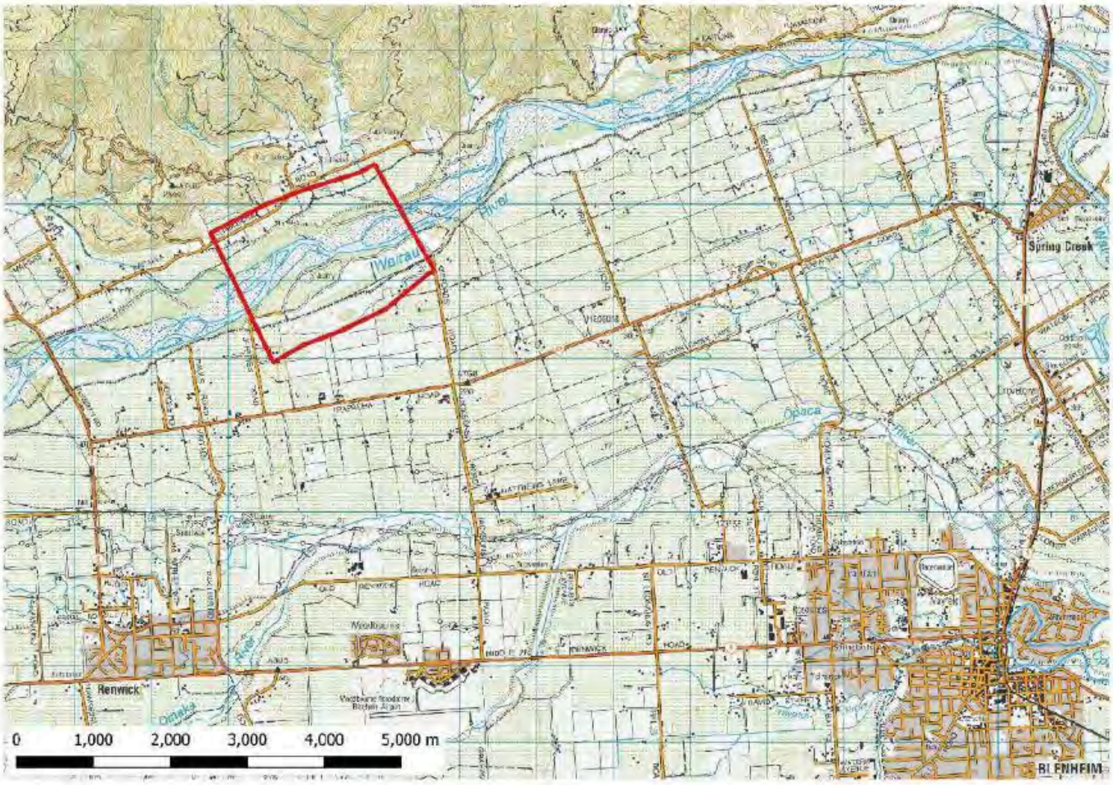


Figure 1. Wairau field site location

4. DATA COLLECTION

Subsurface Investigations

Fieldwork within a braided river bed is challenging due to the coarseness of the sediments and the dynamic nature of the river environment. To investigate recharge to the Wairau Aquifer we first installed a reconnaissance network of twenty-two shallow piezometers in August 2020 using rotary drilling (w01-w22). Six of these were located on the north bank, three were installed in the active braidplain, and the remainder were located on the south bank. We found that there is a hydraulic gradient from northwest to southeast across the river, with north bank water flowing into the active braidplain gravels and being captured by the river system. Stable isotope sampling along the north bank of the river and piezometers along the river edge confirmed very little river water recharges groundwater on the north bank, at least in the study area. North bank groundwater is hydraulically connected to the river, with groundwater level fluctuations on the north bank responding to fluctuations in the river stage. It is likely that flux between the north bank and river may reverse during river floods, when considerable flow into the north bank may occur.

Figure 2. Wairau field site showing location of drilled piezometers (w01-w32), river stage and temperature recorders (r04, r08, r17), flow gauging sites (G1-G4), electrical resistivity tomography survey (ERT), and vertical digital temperature sensing (VDTS) cables.

A further eight holes were drilled in December 2021 using a sonic drilling rig to extract drill core (w23-w30). This drilling was strategically focussed to obtain more detailed information on the subsurface sediment structure, and to install two vertical fibre optic cables at w23 and w27. A final six holes were cored in February 2023, two beneath the active braidplain, and the remaining four at locations outside of the field area for MDC (w20184-w20187).

We also installed river stage and temperature recorders at three sites (r04, r08, and r17). All sites drilled were instrumented with sensors to measure water level and temperature apart from w23, w27, w31, and w32 which were drilled for core only. Sites within the active braidplain were destroyed by the floods that occurred on 17 July 2021 (w06, w15, w08, r08) and 20 August 2022 (w09, w16, w27, r17), while w14 on the south berm was flattened by road works.

Following our initial drilling investigation, we conducted towed transient electromagnetic surveys (tTEM) with the assistance of Aarhus University, Denmark. These were unsuccessful as the tTEM could not define any structure in such electrically resistive subsurface sediments. Nine electrical resistivity tomography (ERT) surveys were subsequently carried out in the active braidplain and on south bank berms using equipment from Flinders University, Australia. The majority of these surveys also did not reveal any clear subsurface sediment structure. However, ERT surveys which were conducted across the river channel were successful. The additional conductance provided by water in the channel appears to have improved the signal response and revealed sediment horizons which match sediment changes in our drill core. A relatively new geophysical method, magnetic resonance imaging (MRI), was also successful in characterising subsurface sediment structure, and we carried out 33 MRI soundings at the Wairau field site with the help of Aarhus University (REF).

The sediment structure revealed by the drill core, MRI, and ERT surveys (Figure 3) is that of a thin layer of loose grey sandy gravels, approximately 4m thick immediately underlying the active braidplain surface. Drill core recovery from these sediments is typically poor. Underlying these gravels is an older thin layer of more poorly sorted brown consolidated gravel with a significant silt and clay sized matrix. These gravels are more cohesive and provide better core recovery.

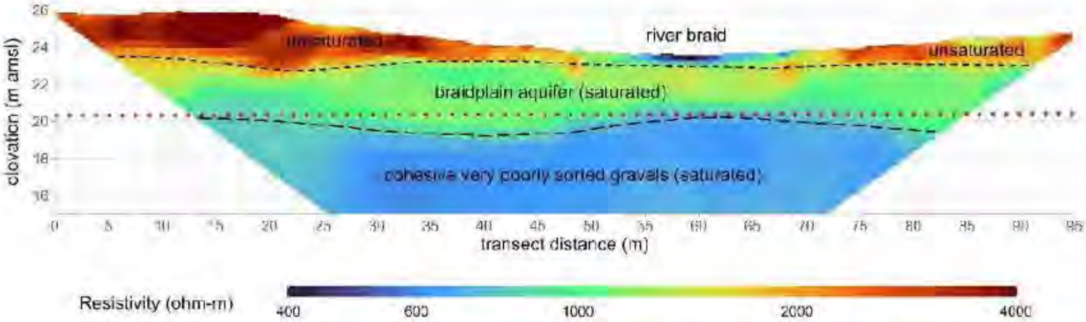


Figure 3. Subsurface resistivity collected by Electrical Resistivity Tomography (ERT) across a Wairau River braid showing the near-surface sediment structure. The profile location is shown on Figure 2, and is looking down-river, so north is on the left. The red dotted line is the base of the braidplain gravels predicted by drillhole contacts.

At a depth below 8-9 m on the south berm is a distinctive yellow-brown silt and clay rich sediment (which looks like peanut butter). These sediments were also found at shallow depths in cores drilled in the Conders area (w20184, w20186, w20187), and are interpreted to underlie the terrace of the north bank beneath Tuamarina Road. They are laterally extensive within the field area, so much so that we can model the depositional surface, which slopes southwards away from the Richmond Range. This sediment is interpreted to represent buried fan sediments deposited by north bank streams and is very low permeability compared to the shallower gravels deposited by the Wairau River. A review of existing well log data in the Conders area indicates that the river bed lies within these low permeability sediments in this area. Groundwater levels at the shallow Conders recharge well (w20184) show that recharge to the Wairau aquifer via the historical Ōpaoa channel becomes limited when water levels fall below the surface of the lower permeability north bank fan deposits at 39.8m elevation (6.1m below ground level). However, some reduction in the groundwater recharge rate will occur when water levels are above this depth, since the bed of the river, and braidplain gravels, have eroded into and are sitting within these clay-rich deposits in this area.

Some of the core samples were used to determine porosity and grainsize distribution of the three main sediment horizons encountered. Porosity was also determined at nine near-surface locations using a photogrammetry technique. The porosity of the braidplain sediments was found to be 0.09-0.46 from nine samples (median 0.18).

Temperature

Water temperature can be used as a tracer for estimating groundwater flow rates in contrast to water levels which only describe the potential for flow. River temperature cycles vary on a daily and annual basis, and in aquifers recharged from rivers, these signals move through the groundwater system and can be measured with sensors. The degree to which a temperature signal becomes attenuated and delayed with distance from the recharge source is used to determine flow velocity. However, attenuation and delay also depend on the thermal properties of the sediment, and uncertainty about these properties has hampered the use of temperature as a tracer in New Zealand. For this reason, we used a Tempos thermal analyser to measure thermal conductivity and specific heat capacity of aquifer host sediments from our three river field sites.

The dominant source rock for gravel clasts in the Wairau catchment is greywacke, which potentially comes from different greywacke terranes. The dominant greywacke source is of Torlesse or Rakaia terrane in origin, although younger Waipapa terrane also occurs in the eastern Richmond Range as semi-schist. Previous measurements of greywacke in the Taupo area by Mielke et al. (2016) found that the thermal conductivity of Torlesse and Waipapa greywackes differ slightly at 2.5 and 1.7 W/m.K respectively, while specific heat capacities were very similar at 0.8 and 0.7 kJ/kg.K.

In the lab, we made 58 measurements of thermal conductivity and 46 measurements of heat capacity from saturated Wairau sediment core, which was corrected for the packed sample porosity and bulk density. This process gave a mean and standard deviation of 2.65 ± 0.22 W/m.K for thermal conductivity, and 618 ± 156 J/kg.K for specific heat capacity, and 2.53 ± 0.17 for grain density (see Appendix 2, Table 5). These thermal conductivity values are consistent with those previously measured for Taupo Torlesse. Our measured heat capacity and grain density values were slightly lower than those reported by Mielke et al. (2016). We hope that these measured thermal properties will help guide further modelling of temperature to determine groundwater flow velocities.

Estimates of groundwater velocity were modelled using daily temperature fluctuations observed in three of our piezometers (w05, w08, and w17). The model we used was an analytical model equation which solves the 1D heat transport (conduction-advection-dispersion) equation for periodic variations in surface temperature (Hatch et al., 2006). Rather than setting fixed parameter values, we used a probabilistic approach by setting ranges of values for thermal conductivity, dispersity, volumetric heat capacity and travel distance. This approach provides estimates of the most likely parameter and velocity values. Most likely values and standard deviations derived by the model were thermal conductivity (2.35 ± 0.4 W/m.K), volumetric heat capacity (990 ± 160 J/kg.K), and thermal dispersity (8.6 ±2.7 m). These estimates can be compared with our lab measured values if we assume a field porosity of 0.18 and bulk density of 2.65 g/cm^3. The most likely sediment thermal conductivity derived by the model (2.65 ± 0.4 W/m.K) compares well with our values measured in the laboratory. However, volumetric heat capacity was poorly resolved by the model, which reflects its poor estimate of 843 ± 160 J/kg.K compared to our measured values. Fluid velocities estimated by the model varied with flow and channel position and are within our expected ranges (w08: 18-30 m/d, w05: 20-50 m/d, w17: 20-200 m/d).

Temperature fluctuations outside of the active braidplain gravels tend to lack daily fluctuation, but they do show a clear annual cycle. Temporary changes in temperature also occur in pulses when large flow events increase the recharge rate and temperature. Groundwater flow estimates are highly uncertain when the lag time of the signal between the river and receiving groundwater is small. However, we see benefit in using recharge temperatures for calculating flows in the Wairau Aquifer and elsewhere at greater distances from the recharge source where lag times are longer.

To understand the influence of sediment structure on groundwater flow we also installed two fibre optic cables, at sites w23 and w27 to carry out vertical digital temperature sensing (VDTS). The fibre optic cables can measure temperature at 25cm increments down the cable. By taking measurements over the course of the year we can see how temperature signals from the river system are lagged and attenuated with depth. Figure 4 shows vertical profiles for these two cables, and the main geological layers encountered in the drill core. We can interpret from these profiles that most of the recharge from the river is conveyed by more permeable gravels within 8m of the surface. While the hydraulic conductivity of these sediments is very high, their saturated thickness is very thin, only 6-7m. This means that flow through these sediments will be sensitive to changes in river elevation.

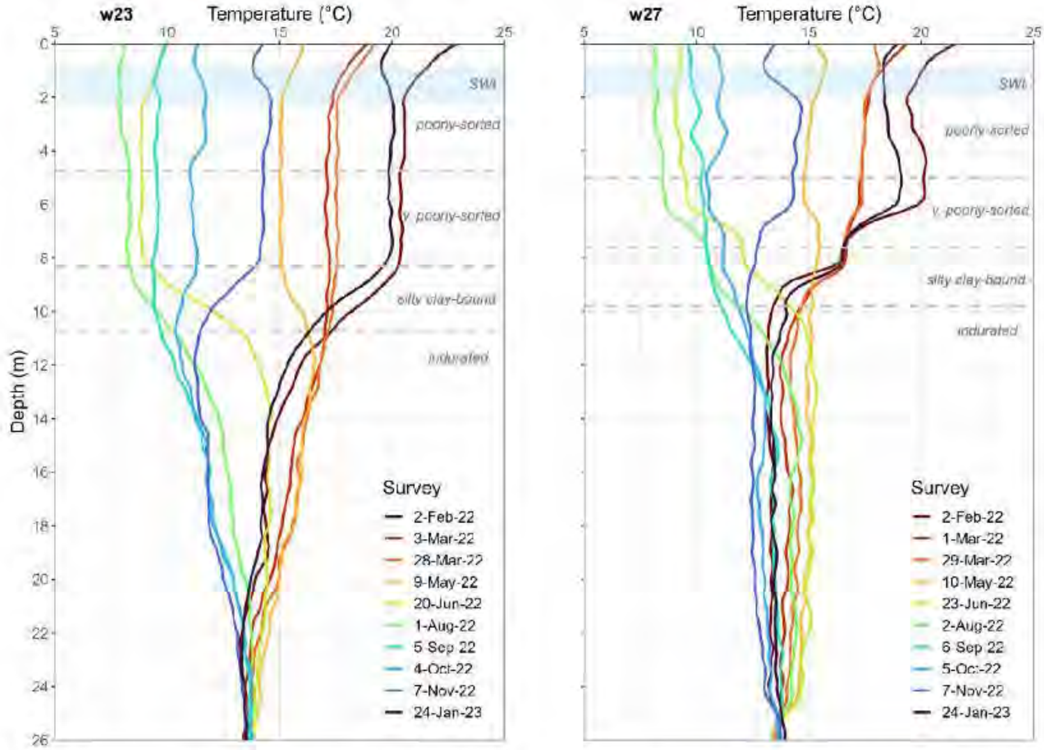


Figure 4. Vertical DTS surveys carried out on the south bank of the Wairau River on w23 (left) and w27 (right). SWL=static water level measurements over the survey period.

Surface Investigations

Concurrent flow gauging surveys were carried out by NIWA in the field area on 16 and 18 Feb 2021, which were corrected for flow recession (Appendix 2, Table 4). These surveys were supplemented with a whole river survey carried out by MDC at the same time. The results show that flow losses are greatest when the main channel lies against the south bank. In other positions the change in flow appears to reflect parafluvial exchange, and flow gains can occur. The data indicates that parafluvial exchange for these surveys could have been up to 500 l/s/km during a 20 m^3/s flow (~2.5% of flow). This exchange, combined with flow loss to the regional aquifer from the braidplain gravels indicates that river flow gaugings are only a rough guide for estimating river losses. Reliability can be increased if the gaugings are carried out several kilometres apart and measured at locations where parafluvial flow is minimal. Even then, loss estimates will have substantial uncertainties due to the position of the survey within the river, parafluvial exchange at that position, and the fact that flow measurement errors can exceed measured losses. Total losses for these surveys from SH6 to Selmes Road were estimated to be 4340 and 7020 l/s for 16 and 18 February 2021, at a rate of 382 and 618 l/s/km respectively. The flow at SH1 at the time of the two surveys was 19 and 14.7 m^3/s respectively.

To characterise the surface water system, the NIWA team carried out two remote sensing surveys on 18 February 2020 and 18-19 February 2021. Topographical data were captured in dry areas of riverbed using a LiDAR scanner deployed on a drone. Bathymetry and water surface elevation were mapped by wading or using a remote controlled jetboat equipped with a paired RTK GPS and echosounder. These LiDAR and bathymetry data were then combined to provide a complete digital elevation model (DEM) for the field site and each survey. We made use of additional topo-bathy surveys carried out by James Brasington's team on 31 March 2022 and 11 November 2023.

Differences between the LiDAR surveys show that the July 2021 flood event increased the gravel volume in the active braidplain of our field area by 45,000 m^3. This volume is only equivalent to a 4 cm rise in the mean bed level, which is within the accuracy error for the surveys. The August 2022 flood event increased the gravel volume in the active braidplain of our field area by 148,000 m^3. This is equivalent to a 13cm rise in the mean bed level, which is about the same magnitude as the survey accuracy error. The maximum bed change (range) was about 11.5m for both surveys. Both surveys show the migration of the main channels down-river, and a tendency for gravel to accumulate within the middle of the braidplain but erode at the braidplain margins.

Radon-222

Sampling for radon activity in water was carried out using 250 ml bottles which were analysed using a Durridge Rad-7 and adjusted for decay since the time of sampling. The 2σ uncertainties reported by this method are large, and impair it's use for estimating residence times. However, comparison with in-situ samples (Rad-Aqua method), which have much smaller uncertainties, indicates that sampling with bottles gives very similar results, suggesting that the 2σ uncertainties are unnecessarily large. Samples were taken from different source environments: river riffles/runs, pools, river seeps, and piezometers in the active and historical (pre-1960's river engineering) braidplain sediments within 500m of the river. The sample data are summarised in Appendix 2, Table 6.

The sampling results from the river system show that radon activity is strongly influenced by the sampling location. Samples from the river can be low or high, depending on whether the sample was from a run, riffle, pool or seep, which reflects the relative contribution of water from the active braidplain gravels (Figure 5). Samples from pools have a higher activity compared to seeps because the pools are capturing deeper flow paths, whereas seeps are only capturing the water from the water table. Pools are probably the most representative sample of the river systems, since they represent a good mix of river inflow and braidplain gravel inflow. The data indicate that once water has left the pool and entered a river run, there is significant degassing.

The equilibrium radon activity of current and historical braidplain gravels is estimated to be ~5100 Bq/m^3. Samples from the active braidplain tend to be lower than this (<3000 Bq/m^3) due to shorter residence times associated with parafluvial exchange (<5 days). Previous radon equilibrium estimates were made for the Wairau Aquifer by ESR (Close et al. 2014). By combining our data with the ESR samples we estimate the equilibrium for Wairau Aquifer gravels outside of the pre-1960's braidplain to be ~7000 Bq/m^3. Higher activities have been measured in deeper or more heterogeneous parts of the aquifer.

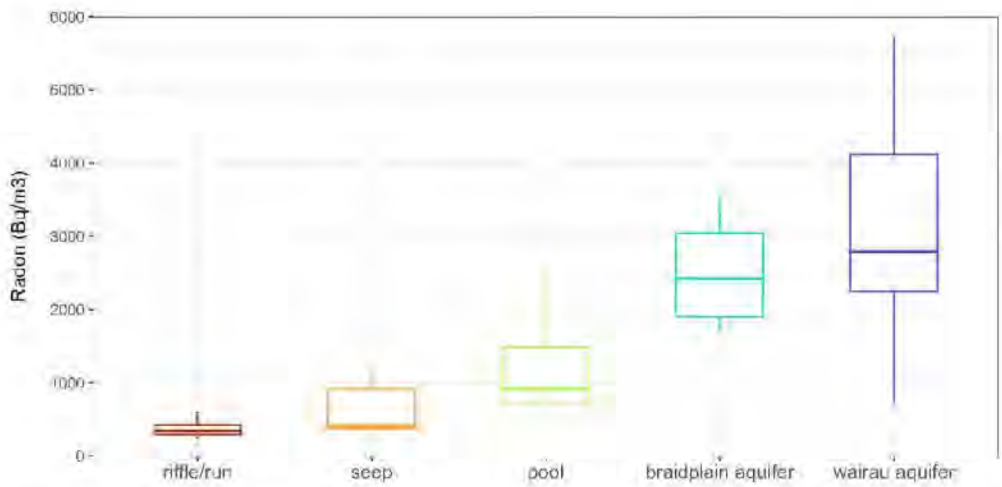


Figure 5. Radon results grouped by their sample sources. Note that Wairau aquifer samples are from the historical braidplain gravels.

5. CONCEPTUAL UNDERSTANDING

A conceptual model of how braided rivers function in the subsurface has been developed and published in an open access journal (Wilson et al. 2024). This paper summarises the work carried out in all three of the rivers studied, and presents additional information not included in this report. In summary, we found that the sediments within each of the three river beds studied consists of loose, high porosity sediments overlying more cohesive, poorly sorted sediments of lower porosity. These looser near-surface sediments are formed via the reworking of the riverbed during flood-flows. This process both loosens the sediments in the river bed and winnows out the fine fractions. Over time there is a tendency for fine sediments to be deposited on the adjacent berms and to infiltrate the pore spaces of the underlying sediments (through processes of colmation and depth filtration), thereby increasing their consolidation.

We have termed the groundwater system hosted by the loose near-surface sediments a "braidplain aquifer" (BPA). The relationship between the river, braidplain aquifer and regional aquifer is shown as a profile through the river system in Figure 6. In rivers which are controlled by flood engineering, the contemporary braidplain has essentially the same extent as the active braidplain due to the lateral restriction imposed by flood defences and lowering the riverbed through gravel extraction. In the Wairau, the river system (river channels and braidplain aquifer) is in direct hydraulic connection with the Wairau Aquifer. In other settings, for example on the upper Canterbury Plains, rivers can be perched above the regional aquifer, with water percolating vertically downwards to the water table. The nature of the hydraulic connection between the river system and regional aquifer influences how aquifers are recharged, and whether recharge is more sensitive to changes in riverbed level or braidplain width.

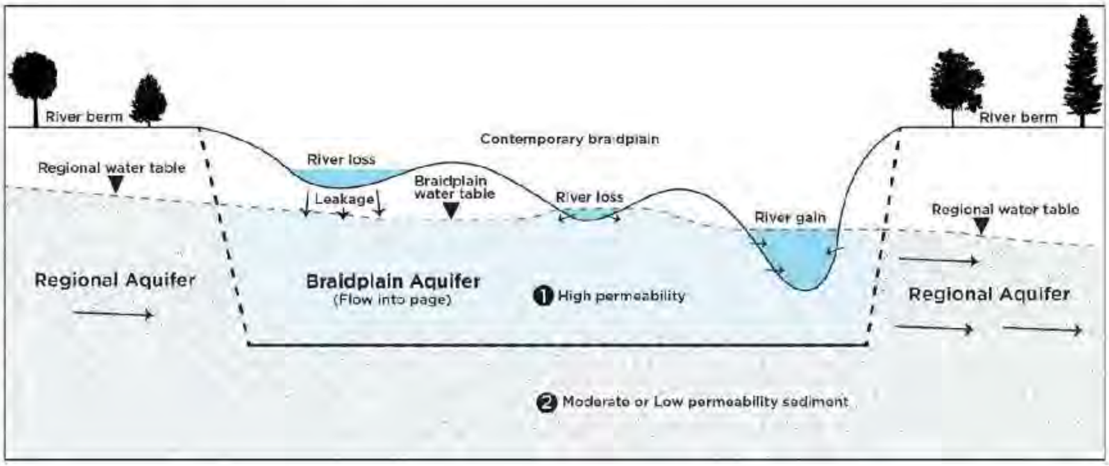


Figure 6. Conceptualisation of the Wairau Aquifer looking down-river. Very high permeability sediments of braidplain aquifer (1) sits within lower permeability sediments which host the Wairau Aquifer (2).

Distinctive features of the braidplain aquifer are a high transmissivity, flow that is sub-parallel to the river's longitudinal orientation, and considerable free exchange of water with river channels. As a result, temperatures and radon activities within the braidplain aquifer are similar to that of the river. Indeed, the water in the river gravels cannot be considered as a separate feature from the river itself, since the river uses the water stored within the braidplain aquifer reservoir to sustain surface flow and attenuate temperatures during summer conditions. This new conceptualisation highlights the marked difference between braided rivers (and other highly dynamic gravel-bed rivers) to other types of river system more common worldwide in which the volume and flux of water within the river bed is insignificant compared to channel flow.

Exchange between river channels and the braidplain aquifer depends on the interrelationship between the riverbed elevation and the braidplain water table elevation. River channels enter and emerge from the water table, looking visually like an eel with some parts visible and some parts submerged. Pools are the surface expression of the braidplain aquifer and are positions where the river is sitting within the water table gaining flow. At the end of a river run, at the very top of a riffle, the river has emerged above the water table. This is where the river loses the most flow to the braidplain aquifer. In a highly braided system these emergent channels will be in hydraulic connection with the braidplain aquifer. In a highly channelised river like the Wairau the riverbed can become perched above the water table and leak water vertically downwards. This exchange between the river and its braidplain aquifer is determined by bed morphology and is independent of the nature of the relationship between the braidplain and regional aquifers.

The new conceptualisation also has implications for how water is exchanged between the river and regional aquifer. Water does not pass directly from the river to the regional aquifer but is exchanged via the braidplain aquifer. An exception is where a river channel lies at the edge of the braidplain and is adjacent to the regional aquifer. In the case of the Wairau River, this occurs when a channel follows the south bank.

We found that the depth to the base of the braidplain aquifer can been estimated in two ways. The first is by observing the contact with postglacial outwash gravels in drill cores. The second approach provides a good estimate of the base, and simply involves measuring the elevation of the deepest pools in bathymetry survey data (Wilson et al. 2024). Although the braidplain aquifer sediments extend across the whole active braidplain, they are very thin, 2.5-5.5 m thick depending on topography. The braidplain aquifer sediments become fully saturated at high flow but have saturated thickness of 2m or less during low flow.

6. QUANTIFICATION

Modelling Losses to Regional Groundwater

A method was developed to determine transmission losses from satellite photos and flow data and published in an open access journal (Di Ciacca, 2023). This method is valid for ephemeral river systems and simply involves measuring the distance of wetted river from the drying front to the flow recorder, to derive a loss rate per kilometre. The advantages of this method over concurrent flow gauging are that the measurement is made over large distances, which lessens the effect of variable parafluvial exchange on the derived values, and a large number of values can be determined over time (loss rates can be determined for every day there is a clear sky). Application of the method on the Selwyn and Orari rivers showed a strong linear relationship between the distance to the drying front and the logarithm of river discharge which is stable over the long term. This enables a prediction of annual total recharge to be derived from long term flow data, without the need for additional satellite photo data.

The loss rates determined from the satellite photos enabled a method of implementing braided rivers in Modflow to be developed (Di Ciacca et al. 2024). What we found was that a braided river can be represented at a regional scale by using the SFR or RIVER package to represent the braidplain aquifer (not the river channels). This means that water levels used in those packages should represent the water level in the braidplain aquifer, and not in the individual channels, although the braidplain aquifer water level can be estimated from the water level of river pools.

Temperature Modelling

Temperature is now routinely included in environmental sensors, so if a pressure transducer is installed, we automatically get temperature data. Groundwater temperature measured within the braidplain aquifer can display a diurnal signal if the piezometer is located downstream of a losing river reach with a short groundwater travel time. All braidplain aquifer measurements show an annual fluctuation, although the time lag from river channels is too short to be of use for flux quantification. In losing rivers, this annual fluctuation propagates through to the regional groundwater system. If there is a sufficiently large time lag (the longer the better) the data can be used for flux quantification. For both diurnal and annual fluctuations, the time lag and attenuation observed in the groundwater system can be simulated using 1D equations, in 2D e.g. using Hydrus, or in 3D using Modflow.

Quantifying River Losses in Modflow

The river flow loss rates determined from the satellite photos enabled a method of implementing braided rivers in Modflow groundwater models to be developed (Di Ciacca et al. 2024). A braided river can be represented in a regional-scale Modflow model with the SFR or RIVER packages. To do this, the river stage should represent water levels in the braidplain aquifer (not the river channels).

Accordingly, we improved the way the Wairau River is represented in our Modflow groundwater model of the northern Wairau Plain (Wöhling et al. 2018). This involved some modifications to accommodate representation of the river system by the braidplain aquifer, and a re-calibration. To do this the bed width was fixed to the observed braidplain width, and the flow-width relationship was set to zero (to represent a braidplain aquifer with constant width for all flow conditions). The stage-flow relationship (defined by stage=C.flow^D) was revised by fitting the factor (C) and exponent (D) to the average stage discharge relationship calculated from one-dimensional normal-depth hydraulic calculations of all MDC surveyed cross section data within a given reach. The revised coefficients and widths were then implemented in the model over three reaches: Waihopai confluence - SH6 - Wratts - SH1. This new implementation increases our confidence in the model's predictions of groundwater recharge, and enables us to carry out scenarios to understand the effects of riverbed elevations and braidplain width on recharge rates. Recharge to the Wairau aquifer over the modelling period (3 May 2000 to 30 December 2023) was estimated to be from 4 m^3/s to 26 m^3/s, with a median of 6.1 m^3/s and mean of 6.65 m^3/s.

An approach to further improve estimates of groundwater recharge in Modflow is to combine the braidplain aquifer implementation with the simulation of temperature data. For the Ngaruroro River we successfully used temperature data to constrain fluxes to the Heretaunga Plains aquifer in a Modflow 6 model. To do this we used the transport module (GWT) with approximations for heat transport[1] (Durney & Wilson, 2024). We recommend that temperature data be collected from river systems, and groundwaters recharged by river systems as it is an invaluable tracer of groundwater recharge fluxes.

Hydrogeosphere modelling

The loss rates were also used to constrain a Hydrogeosphere model of our field site, covering a 2.5km length of the river system. Hydrogeosphere is an extremely complex 3D model which simulates fully coupled saturated and unsaturated flow and groundwater-surface water interaction on a triangular computational mesh. The objective of this modelling was to test different conceptualisations of subsurface sediment structure, and to understand the influence of river morphology on parafluvial exchange and recharge to the Wairau Aquifer.

To achieve these objectives, two Hydrogeosphere models were developed, covering the same area with the riverbed morphology represented at fine (sub-meter) scale. The first model was built using LiDAR data from the February 2020 survey to represent the riverbed. The major flood event of 17 July 2021 changed the morphology of the riverbed significantly. The second model was built using LiDAR data collected by James Brasington's team after that event (31 March 2022). This approach produced pre-flood and post-flood models with the same parameter values, which could be used to understand the influence of bed form on water exchanges.

Among the different model structures tested, the braidplain aquifer concept fitted our groundwater monitoring data best. This provides additional support that our river system conceptualisation is correct and that river morphology features can be realistically resolved by the HGS model.

We then used the pre-flood and post-flood models to quantify the effect of river morphology on river-groundwater exchange. To do this, the pre-flood time series was applied to the post-flood morphology model. The model was run for a 79-day period from 11 August 2020 to 29 October 2020 with a range in flow from 17 to 510 m^3/s. This "artificial" input series, combined with the same model parameter values enabled us to quantify the effect of riverbed changes on exchange rates between the river, braidplain aquifer and Wairau aquifer. The pre-flood parafluvial exchange rate between the Wairau River and the braidplain aquifer was found to average 370 l/s/km at a flow of 20 m^3/s, which is a similar value to our estimate derived from flow gauging. Higher loss rates occur during higher flows (mean 540 l/s/km), and the loss rate is controlled by head differences between the braidplain aquifer and water levels in the river channels.

We found that the change in channel positions after the July 2021 flood slightly increased both the parafluvial exchange and regional aquifer recharge rates. Prior to the July 2021 flood there was a large bar opposite w14 (Figure 8). The flood cut a channel through that bar, creating a large secondary braid along the right bank. This produced a channel along the right bank which was continuous for most of the length of the right bank. This increased the water level along the southern margin of the braidplain aquifer, and consequently increased the amount of recharge to the Wairau aquifer. This indicates that an increase in braiding distributes the exchange of water between river channels and the water table more evenly across the braidplain aquifer. This results in a higher water table across the braidplain, and greater rates of groundwater recharge.

7. MANAGEMENT IMPACTS

The influence that river management could have on groundwater recharge depends on the nature of the hydraulic connection between the river system and regional aquifer. If a river system is perched above the regional system, leakage occurs mainly in the vertical direction. In this setting, the rate of leakage is largely determined by the wetted area (active braidplain width), so confinement of braidplain width would reduce groundwater recharge, but the effect of reducing riverbed elevation on groundwater recharge is minor. If a river system is hydraulically connected to the regional system, as is the case with most of the Wairau River, the loss rate is largely determined by the relative difference in groundwater elevation between the two water bodies. In this setting, the effect of reducing riverbed elevation on groundwater recharge is significant, and the effect of a change in river width is relatively minor.

Bed Elevations

Groundwater levels at MDC monitoring well 3009 (Wratts Road) are a useful indicator of the effect of river management on groundwater levels since this site has a record extending back to 1996. This record can be extended back to 1958 by supplementing the continuous record with manual measurements from well 0238.

Figure 7a shows the long-term record of riverbed level expressed as differences from the 1984 mean bed elevation, as determined from MDC river cross section surveys. Figure 7b shows the observed groundwater level record at the Wratts Road well, together with a long-term trend fitted with a LOESS smoothing curve (dashed line). Comparing Figure 7a with 7b, it is apparent that the long-term decline in groundwater levels mimics the decline in mean bed elevation. Conceptually, this is expected, as a change in the elevation of an aquifer inflow boundary (e.g. a river) will result in an adjustment of groundwater levels.

The previously constructed and modified Modflow model (Wöhling et al. 2018) was used to understand the impact of river management changes (including width and bed level changes) on groundwater recharge, and groundwater levels. A scenario was carried out where the observed mean riverbed elevation change from 1992 to the end of 2023 (0.5 m) was added to the river stage. The objective was to "restore" groundwater levels to 1990's elevations, to see if the long-term decline could be explained by river management alone. The Modflow model predicts the loss in recharge is ~500 l/s, with the corresponding change in groundwater levels at Wratts Road to be 0.27m.

By assuming a linear relationship between bed level and groundwater level, the modelled ratio of change between the riverbed and Wratts Road well can be applied to the bed level record. This adjustment enables us to artificially adjust groundwater levels to see what they would look like if the river were the same as it was in the 1990's. The result is the red curve shown in Figure 7c, together with a corresponding long-term trend (dashed line). The result indicates that most of the long-term decline in groundwater levels in the recharge area can be explained by changes in riverbed elevation. This lowering of the riverbed over time has resulted in a loss of storage within the Wairau Aquifer, and a reduction of the hydraulic gradient towards the coast.

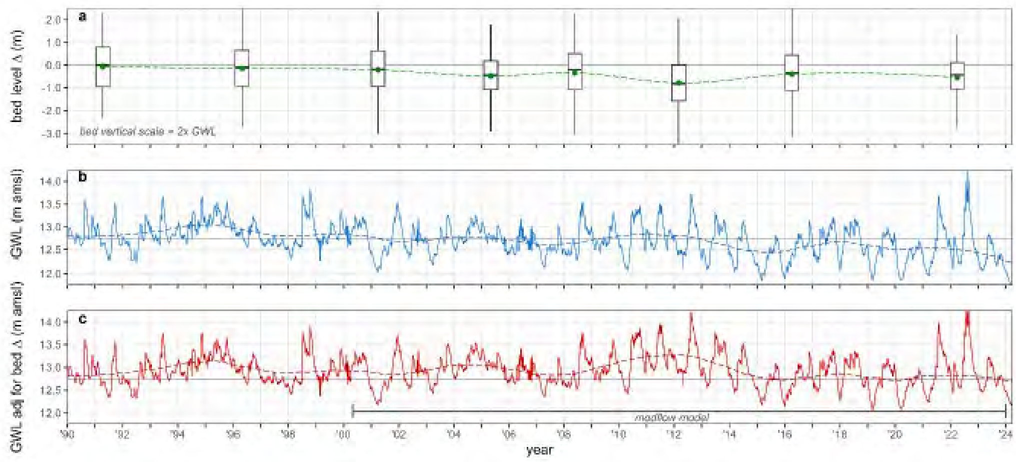


Figure 7. Time series plots for (a) riverbed elevation change since 1991 (green dots=mean), (b) observed groundwater levels at Wratts Road well (blue), and (c) groundwater levels at Wratts Road well adjusted for the bed level change (red).

An aspect of the long-term groundwater level response not explained by our Modflow model is the increase in amplitude of annual groundwater level fluctuations over time. Some of this increase can be attributed to groundwater abstraction and changes in climate. However, there may also be an increase in groundwater level amplitude resulting from changes in riverbed form over time. These localised changes in bed form cannot be represented by the Modflow model because the relationship between flow and river stage is averaged across the whole braidplain and kept constant throughout the simulation. In reality, water levels within the river system are influenced by localised changes in channel geometry, which changes over time.

There are two aspects to this change in bedform that are not simulated by the simple flow-stage relationship in the Modflow model. Firstly, the mean riverbed elevation has dropped over time which has resulted in less frequent inundation of the berms. In other words, inundation of the berms occurs at higher flows than it did prior to the river narrowing in the 1960's. Secondly, and more importantly, the active braidplain margins have become more established, and less erodible due to development of the tree buffer and rock bank protection. An increase in erosion resistance of these margins is expected to have promoted scouring along the margins of the active braidplain. The effect of this scouring is evident in the post-flood LiDAR surveys which show gravel building up in the middle of the active braidplain, with low bed levels remaining along the margins. Both of these factors cause a steepening of the flow-stage relationship over time, with a greater fluctuation in river stage being generated for the same river flow.

Bed form

Riverbed elevation changes give an indication of the effect of river management on groundwater recharge. However, bed level surveys do not represent the water level in the braidplain aquifer, which is what drives groundwater recharge. This is determined by the interaction between water levels in the braidplain aquifer and riverbed geometry.

Our groundwater monitoring network was active for a four-year period, during which time we recorded the response of two large flood events (July 2021 and August 2022) and a meteorological drought in February-March 2024. By comparing changes in groundwater level adjacent to the river through time with riverbed changes, we can understand how bed form influences groundwater recharge.

Figure 8 shows satellite imagery for each summer of our monitoring period which can be used to understand the influence that changes in river channel position has on groundwater recharge. During 2020 and summer 2021 there was a large river bar that had formed opposite sites w14 and w19. The

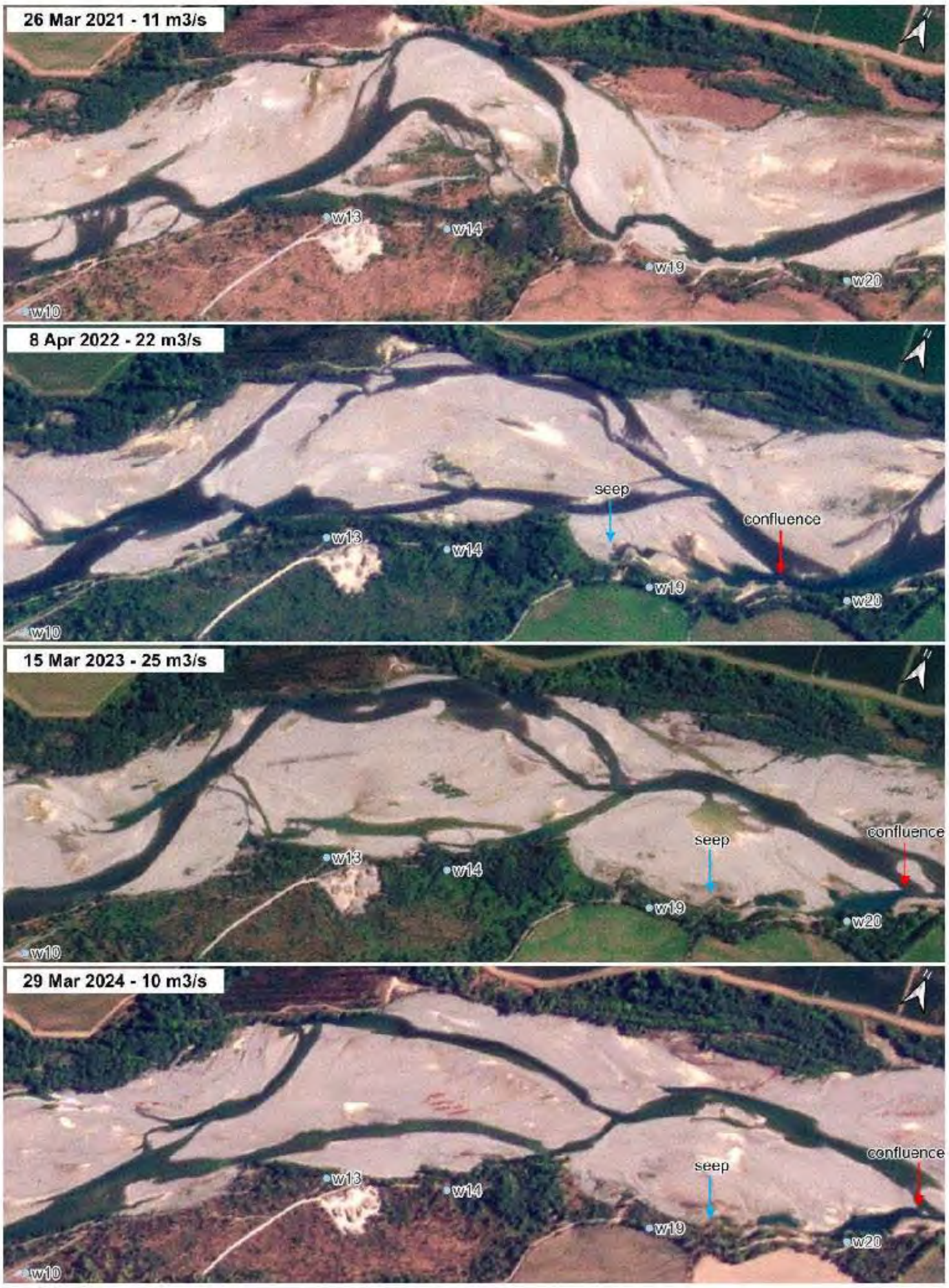


Figure 8. Satellite imagery for summer 2021, 2022, 2023 and 2024 showing changes in river channel geometry. Groundwater monitoring sites are also shown. Notice the changed position of the seep and confluence locations and the increased distance between them.

July 2021 flood increased the amount of braiding within the braidplain and created a large secondary braid through this bar. This same braid also increased the amount of recharge along the south bank opposite w19, which was previously in a draining position. This secondary braid increased groundwater levels along most of the south bank, which is confirmed by the Hydrogeosphere model.

The main shift in channel position after the August 2022 flood event is a relocation of the position at which the channel bend meets the south bank adjacent to site w20. This is marked by the red arrow, which shows that the bend has migrated down-river. Associated with this change was a movement of the large secondary braid opposite w19 northwards. The second change is the location of the seep located upgradient of this confluence, which is marked by the blue arrows. This seep or drainage channel is a remnant channel position from before the July 2021 flood event. The position of the seep moved down-river after the August 2022 flood event, and the drainage channel increased in length from 450m in 2021 to 515m in 2022 to 550m in 2023.

The length of this drainage channel has a large influence on groundwater levels and recharge along the south bank of the river system during low flow conditions. To understand this effect, we can plot our groundwater monitoring data as a time series. A visual comparison between sites can be made if we subtract the median from each site to create a graph of median-centred groundwater levels. This is shown in Figure 9a for site w10 which is at the up-river margin of our study area, and sites w19 and w20 which are down-river. From this graph alone it is difficult to determine whether groundwater levels are more influenced by changes in flow (Figure 9c), or channel geometry. Because groundwater levels are known to have a logarithmic relationship with flow, we can fit a linear model (a straight line) between the log of flow, and groundwater levels. If the bed were stable over time, we would expect little difference between individual points and the linear model, all the points would fit on that line. If the riverbed shifts and influences groundwater levels, we will see departures from that straight line, which are known as residuals. Figure 9b shows a plot of those departures from the linear model (residuals) over time.

We can see in Figure 9b that after the first flood (July 2021) groundwater levels at the down-river sites are high, and this can be explained by the model residuals. Looking at the satellite photo for April 2022 on Figure 8, we can see that this is because the length of the drainage channel is short, and the confluence is located up-river of site w20. Flow conditions fluctuate during the summer of 2023, so we don't get a good appreciation of the influence of the change in channel position on groundwater recharge until the prolonged low flow period of the summer 2024. Groundwater levels during the meteorological drought at w20 were lower than the previous monitoring record. Residuals from the liner model indicate that ~0.25m of this difference can be explained by channel geometry alone.

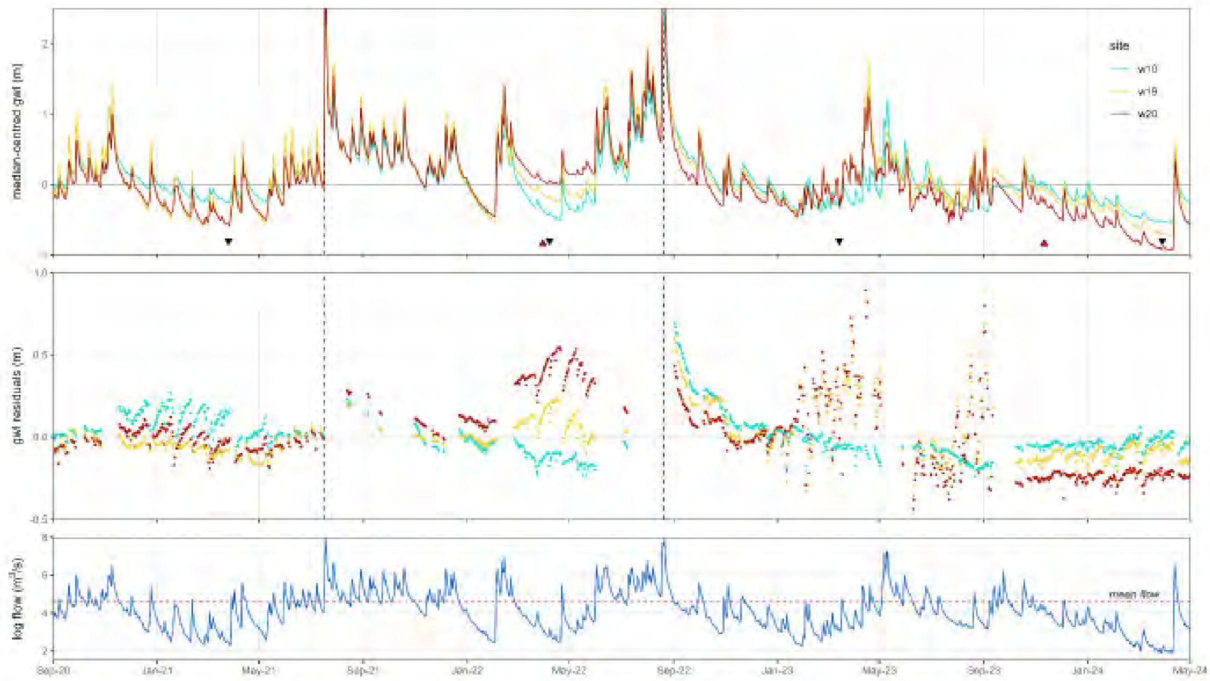


Figure 9. A comparison of groundwater levels adjacent to the river (a) compared to the predicted influence of bed changes (b) and the log of river flow (c). The two flood events are shown by vertical dashed lines. The dates of topo-bathy surveys and the four satellite photos are shown on plot (a) as red and black triangles respectively.

The reason that channel geometry is influencing groundwater levels is because of the presence of remnant channels which are draining braidplain aquifer groundwater back into the river. The lowering of braidplain water levels also lowers groundwater levels in the downgradient regional aquifer. These remnant channels are deeply scoured because of the presence of hard rock along the channel margins and form long pools of still water. In these drainage channels, the water level elevation of the seep and confluence are essentially the same because the bed of the pools are deep and do not influence water levels. The elevation of the pool is controlled by the water level elevation at the confluence, which is the elevation at which water freely drains into a river run. A longer drainage channel extends the influence of the confluence elevation up-river, thereby lowering the water levels in the braidplain aquifer below what they would be if there were no drainage channel. This effect is particularly significant for groundwater recharge during lower flows since groundwater levels within the braidplain aquifer can drop to lower levels during a prolonged recession.

A good example of a drainage channel is shown in Figure 10, where a remnant channel is following the long rock groyne opposite Rock Ferry. The pool on the left is the surface expression of the water table in the braidplain aquifer, in which the water level is set at the outlet of the pool to the main river channel in the foreground. The water level in the braidplain aquifer at the upstream margin of the pool is the same as at the outlet. In the photograph, the relict channel is draining and lowering groundwater levels at the headwaters of the pool.

Figure 10. Photograph looking up-river from the rock groyne opposite Rock Ferry. The pool on the left is a relict, deeply scoured channel which flows into the main channel in the foreground.

In summary, an increase in scouring along the southern bank promotes drainage of the braidplain aquifer into the river, thereby decreasing the hydraulic head and gradient to the regional aquifer. This results in lower groundwater levels during summer months. This is likely to be the main cause of the observed increase in annual groundwater level fluctuations since monitoring began in the 1990s (Figure 7). It seems logical that a more braided river morphology would provide more recharge to the Wairau Aquifer compared to a channelised morphology, particularly during low flow periods. An increase in braiding distributes water exchange more evenly across the braidplain aquifer, resulting in a less undulating and higher elevation braidplain water table. The result will be an increase in groundwater recharge, particularly during summer months.

8. ECONOMIC ANALYSIS

An economic analysis was undertaken to understand how river management interventions (expressed as changes in width and bed elevation) balance in terms of economic value. Doing this valuation includes a large range of market (e.g. gravel extraction, irrigation demand) and non-market (e.g. ecological habitat, recreation) values. To inform the scenarios, workshops were carried out with staff from MDC and te Rūnanga a Rangitāne o Wairau to derive hypothetical river changes which are documented in online story maps[2]. These scenarios were then implemented in the Wairau Modflow model to understand how changes in riverbed elevation (-0.5 m and +0.5 m) and braidplain width (moderate and aspirational widening) affect recharge rates and groundwater levels at the Wratts Road monitoring well. A similar exercise was carried out for the Ngaruroro River in Hawkes Bay.

The economic modelling of these scenarios is documented in (Tait et al. 2024). The non-market valuation was informed by interviewing ecologists to understand ecological response to the scenarios (Delphi process) and responses from a public survey (Choice experiment) Market valuations were developed in consultation with industry experts and regional council staff (Saunders and Tait, 2024).

The market valuations assume that reliability of water supply for irrigators will be compromised under scenarios where declining groundwater trends continue. The corollary is that if the trend of falling groundwater levels can be stabilised, reliability of supply will be retained regardless of the thresholds emplaced in policy. To estimate the value of reliability of supply for irrigators, an arbitrary groundwater level threshold needed to be chosen to enable a cost to be calculated based on the hypothetical number of days groundwater levels fall below that threshold. There is no standard approach for deriving a threshold groundwater level in New Zealand literature. A hypothetical restriction threshold of 11.8 m was derived for the Wratts Road well, representing the lowest recorded groundwater level. It was subsequently realised that this threshold doesn't acknowledge the current value of continuity of supply for irrigators. This implies there may be additional benefits of maintaining the reliability of supply in the Wairau which are not reflected in the analysis. We stress that the use of a threshold, and the value chosen, in no way reflects MDC policy, it is simply a means to derive a valuation for irrigation which would otherwise not be addressed by the economic model.

The combined economic analysis indicates that continued lowering of the riverbed within the recharge reach does not make economic sense due to the increased pressure it places on water availability. There is some economic advantage to widening the active braidplain, providing a short term (one-off) increase in gravel availability from the berms, and enduring increases in a wide range of ecological values. Our Modflow model indicates that a blanket widening of the river does not benefit groundwater recharge. However, shifting the south bank southwards will benefit recharge in some areas due to the underlying north bank fan deposits. Also, a widening of the river corridor may help to reduce the need for rock bank protection and help to decrease scouring.

Raising the riverbed in the recharge reach by reducing the rate of gravel extraction would reverse the declining groundwater trend, increase spring flows, increase ecological habitat, and potentially increase the reliability of supply for irrigators (depending on future MDC policy).

9. SUMMARY OF KEY FINDINGS

- Braided rivers should be considered as a 'river system', comprising their river channels, gravel beds, and the water stored within those gravel beds (braidplain aquifer).
- The Wairau River system is hydraulically connected to the regional aquifer. In this setting, the rate of recharge is determined by the hydraulic gradient between the river system (braidplain aquifer water level) and adjacent regional groundwater level.
- In other river systems, for example on the upper Canterbury Plains, rivers can be perched above the regional aquifer, with water percolating vertically downwards to the water table.
- The Wairau River provides recharge at an average rate of 6.65 m^3/s to the Wairau Aquifer (range 4 to 26 m^3/s). Parafluvial exchange is estimated to be up to ~500 l/s/km at a flow of 20 m^3/s.
- Riverbed levels between SH6 and Wratts Road have declined by ~0.5m since the early 1990's. Implementation of this bed level change in our groundwater model confirms that lowering of the riverbed elevation can account for the long-term decline in groundwater levels. This has resulted in a loss of aquifer storage, and a reduction in the hydraulic gradient from the river to the coast. The resulting reduction in the average recharge rate is ~ 500 l/s.
- Further losses in recharge are caused by scouring along the south bank of the river braidplain. Scouring in this area leaves remnant channels which act as drainage channels, and lower water levels in the braidplain aquifer. This decreases groundwater recharge rates, particularly during low flow periods.
- We expect that a more braided and less channelised river would provide more recharge to the Wairau Aquifer, particularly during summer months.
- There is a balance to be achieved between the costs and benefits of river widening and bed elevation changes, considering economic value of land and gravel, ecological benefits, and flood protection.
- For the Wairau River, there are economic advantages to stabilising or increasing riverbed elevations. There may also be benefits from localised modest widening of the active braidplain.
- The ongoing collection of river and groundwater temperature data in the Marlborough region would prove useful for future analysis. Temperature is a relatively inexpensive tracer which currently provides the best constraint on groundwater fluxes from river systems.
- Further investigations should focus on the area between Conders Bend and Waihopai confluence to improve our understanding of groundwater recharge in this area. It is particularly important to map the surface of the buried low permeability north bank fan deposits.

10. REFERENCES[3]

Close, M. 2014. Analysis of Radon Data form the Wairau River and Adjoining Wairau Plains Aquifer February 2014. ESR Client Report CSC14001, 18 pp.

* Di Ciacca, A., Wilson, S., Kang, J., Wöhling, T. (2023). Deriving transmission losses in ephemeral rivers using satellite imagery and machine learning. *Hydrology & Earth System Sciences* 27, 703-722, https://doi.org/10.5194/hess-27-703-2023

Di Ciacca, A. Wilson, S.R., Durney, P., Stecca, G., Wöhling, T. (2024). Model simplification to simulate groundwater recharge from a perched gravel-bed river. Research paper accepted for publication in Journal of Hydrology, manuscript HYDROL58276.

*Hatch, C.E., Fisher, A.T., Revenaugh, J.S., Constantz, J., Ruehl, C. (2006). Quantifying surface water groundwater interactions using time series analysis of streambed thermal records: Method development. Water Resources Research 42. https://doi.org/10.1029/2005WR004787

Mielke, P., Weinert, S., Bignall, G., & Sass, I. (2016). Thermo-physical rock properties of greywacke basement rock and intrusive lavas from the Taupo Volcanic Zone, New Zealand. *Journal of Volcanology & Geothermal Research 324*, 179–189.

Tait, P., Saunders, J.T., Rutherford, P. (2024). Economic valuation of braided river management. Lincoln University Agribusiness & Economics Research Unit, report prepared for MBIE contract LVLX1901, 126pp.

Vang, M., Grombacher, D., Larsen, J.J., Wilson, S. (Subm.). Efficient Mapping of Complex Groundwater Systems Associated with Braided Rivers Using Small Coil Surface Nuclear Magnetic Resonance. Research paper submitted to Geophysics, manuscript GEO-2023-0765.

* Wilson, S.R., Hoyle, J., Measures, R., Di Ciacca, A., Morgan, L.K., Banks, E.W., Robb, L., Wöhling, T. (2024). Conceptualising surface water-groundwater exchange in braided river systems. *Hydrology & Earth System Sciences 28*, 2721–2743, https://doi.org/10.5194/hess-28-2721-2024.

Wöhling, T., Gosses, M. J., Wilson, S. R., Davidson, P. (2017). Quantifying River-Groundwater, Interactions of New Zealand's Gravel-Bed Rivers: The Wairau Plain. *Groundwater 56*, 647-666, https://doi.org/10.1111/gwat.12625.

11. APPENDICES

Appendix 1: Published papers related to this MBIE programme

Banks EW, Morgan LK, Sai Louie AJ, Dempsey D, Wilson SR (2022). Active distributed temperature sensing to assess surface water-groundwater interaction and river loss in braided river systems, Journal of Hydrology, 615, 128667, https://doi.org/10.1016/j.jhydrol.2022.128667

Di Ciacca A, Wilson S, Kang J, Wöhling T (2023). Deriving transmission losses in ephemeral rivers using satellite imagery and machine learning, Hydrology & Earth Systems Sciences, 27, 703-722, https://doi.org/10.5194/hess-27-703-2023

Ejaz F, Wöhling T, Höge M, Nowak W (2021). Lumped geohydrological modelling for long-term predictions of groundwater storage and depletion, Journal of Hydrology, 127347, https://doi.org/10.1016/j.jhydrol.2021.127347

Ejaz F., Guthke A., Wöhling, T., Nowak W. (2023). Comprehensive uncertainty analysis for surface water and groundwater projections under climate change based on a lumped geo-hydrological model. *Journal of Hydrology 130323*, https://doi.org/10.1016/j.jhydrol.2023.130323

Gosses M, Wöhling T (2021). Robust data worth analysis with surrogate models, Groundwater, https://doi.org/10.1111/gwat.13098

Sai Louie AJ, Morgan LK, Banks EW, Dempsey D, Wilson S (2023). Active-distributed temperature sensing dataset beneath a braided river, Data in Brief, 51, 109756, https://doi.org/10.1016/j.dib.2023.109756

Sai Louie AJ, Morgan LK, Banks EW, Dempsey D, Wilson S (2024). Testing the reproducibility of active-distributed temperature sensing for measuring groundwater specific discharge beneath a braided river, Journal of Hydrology, 633, 130877, https://doi.org/10.1016/j.jhydrol.2024.130877

Wilson, S.R., Hoyle, J., Measures, R., Di Ciacca, A., Morgan, L.K., Banks, E.W., Robb, L., Wöhling, T. (2024). Conceptualising surface water-groundwater exchange in braided river systems. Hydrology & Earth System Sciences 28, 2721–2743, https://doi.org/10.5194/hess-28-2721-2024.

Wöhling T, Burbery L (2020). Eigenmodels to forecast groundwater levels in unconfined river-fed aquifers during flow recession, Science of the Total Environment, 747, 141220, https://doi.org/10.1016/j.scitotenv.2020.141220

Wöhling T, Wilson S, Wadsworth V, Davidson P (2020). Detecting the cause of change using uncertain data: Natural and anthropogenic factors contributing to declining groundwater levels and flows of the Wairau Plain aquifer, New Zealand, Journal of Hydrology Regional Studies, 31, 100715, https://doi.org/10.1016/j.ejrh.2020.100715

Appendix 2: Tables of data collected for the Wairau field site

Table 1. Summary of all the field methods used in the Wairau study site

Measurement type	Number
Differential flow gauging	2
Lidar & bathy surveys	2
Piezometers	31
Holes cored	8
Particle size distribution	38
Core porosity	12
Field porosity	10
Radon-222 samples	53
tTEM	Y
DualEM	Y
ERT surveys	9
NMR soundings	33
DTS installations (vertical)	2

Table 2. Summary of Wairau drilling investigations

Piezo	MDC no.	E	N	Depth (m)	Screen top (m)	Screen bot (m)	Ground RL	Collar RL	Type	Logger
w01	w20150	1670451	5409444	5.56	2.56	5.56	29.327	29.727	rotary	Y
w02	w20151	1670477	5409318	4.67	2.67	4.67	29.315	29.695	rotary	Y
w03	w20153	1670758	5409600	4.62	1.62	4.62	27.717	28.117	rotary	Y
w04	w20152	1670787	5409493	5.605	2.605	5.605	29.287	29.627	rotary	Y
w05	w20149	1671152	5409674	4.65	1.65	4.65	27.233	27.573	rotary	Y
w06	w20158	1671570	5409688	4.83	1.83	4.83	25.895	26.245	rotary	Y
w07	w20148	1672033	5409956	4.52	1.52	4.52	23.769	24.119	rotary	Y
w08	w20157	1670732	5409022	6.54	3.54	6.54	30.86	31.24	rotary	Y
w09	w20139	1670599	5408874	4.59	1.59	4.59	30.511	30.751	rotary	Y
w09 (ys)	w20139	1670599	5408874	4	1.246	4	29.723	30.407	rotary	Y
w10	w20147	1670325	5408557	4.69	1.69	4.69	30.278	30.608	rotary	Y
w11	w20146	1670718	5408619	5.58	2.58	5.58	28.771	29.081	rotary	Y
w12	w20154	1671016	5408758	6.82	3.82	6.82	28.913	29.263	rotary	Y
w13	w20145	1670920	5409084	4.82	1.82	4.82	28.47	28.89	rotary	Y
w14	w20144	1671210	5409179	4.74	1.74	4.74	27.338	27.768	rotary	Y
w15	w20159	1671110	5409355	4.7	2.7	4.7	26.95	27.4	rotary	Y
w16	w20160	1671168	5409247	4.92	1.92	4.92	27.332	27.722	rotary	Y
w17	w20143	1671415	5409349	6.535	3.535	6.535	27.962	28.392	rotary	Y
w18	w20142	1671552	5409260	6.18	3.18	6.18	26.39	26.79	rotary	Y
w19	w20141	1671715	5409299	5.38	2.38	5.38	25.932	26.282	rotary	Y
w20	w20140	1672183	5409471	5.85	2.85	5.85	26.888	27.288	rotary	Y
w21	w20155	1672275	5409247	5.49	2.49	5.49	23.681	24.061	rotary	Y
w22	w20156	1671857	5408948	4.79	1.79	4.79	27.61	27.99	rotary	Y
w23	w20123	1670684	5408887	28.88	NA	NA	30.399	NA	core	N
w24	w20124	1670665	5408901	8.55	7.43	8.55	30.497	31.067	core	Y
w25	w20125	1670667	5408902	4.02	2.16	3.66	30.51	31.05	core	Y
w26	w20126	1670609	5408863	8.57	5.95	7.45	30.991	31.541	core	Y
w27	w20127	1671190	5409209	28.88	NA	NA	28.07	NA	core	N
w28	w20128	1671171	5409248	10.39	8.39	10.39	27.797	28.047	core	Y
w29	w20129	1670724	5408871	10.21	8.71	10.21	29.694	30.124	core	Y
w30	w20130	1670723	5408870	7.13	5.93	6.93	29.694	30.164	core	Y
wrb1	w20189	1670588	5408920	9.12	NA	NA	28.932	NA	core	N
wrb2	w20190	1670620	5409096	7.6	NA	NA	27.855	NA	core	N

Table 3. Summary of field method application in the research programme

Method	Purpose	Spatial Scale	Temporal Scale	Pros	Cons	Cost	Successful?
tTEM	Subsurface saturation & structure	>1m	One-off	Mobile method	Gravels are too resistive	Expensive	N
GCM	Subsurface saturation & structure	>1m	One-off	Mobile method	Gravels are too resistive	Expensive	N
ERT	Subsurface saturation & structure	1-100m	One-off, but can do time-lapse	Cheap & easy geophysical method	Success depends highly on surface conductance & arrays take a lot of work to install	Moderate	Only in river channels
NMR	Subsurface saturation & structure	1-20m	One-off	Performs better than resistivity	Method in development stages, so difficult to capture, process and interpret	Moderate	Y
DTS	Subsurface structure	1-100m	One-off, but can do time-lapse	High resolution temperature transects	Difficult to install	Expensive	Y
ADTS	Subsurface flux	1-100m	One-off, but can do time-lapse	High resolution flux transects	Difficult to install & model	Expensive	Y
Satellite Imagery	River extent	> 100m	Daily, depending on cloud cover	Loss estimates with little fieldwork required	Great for ephemeral rivers, requires upstream rated flow	Cheap	Y
Concurrent gauging	River flow	>100m	One-off, but repeatable	Direct measurement of flow loss	Errors can be significant, interpretation at small scales requires stream morphology	Cheap-Moderate	Y
Lidar/Bathy	River morphology	>0.1m	One-off but repeatable	Detailed river stage and bed data	Requires expertise to capture and process	Cheap-Moderate	Y
Aerial thermal	River spatial temperature	0.1m-1km	One-off but repeatable	Easy spatial temperature coverage	Only measures surface temperature, difficult to process & interpret	Cheap-Moderate	Some
Diurnal Temperature	Subsurface flux	<300m	Continuous record	Easy flux estimate	Diurnal signals are spatially variable	Cheap	Y
Annual Temperature	Subsurface flux	>1000m	Continuous record	Easy flux estimate	Requires a large lag time for accurate flux estimation	Cheap	Y
Coring	Collect sediment, install sensors	<30m	One-off	Core recovery	Expensive drilling method, success depends on operator	Expensive	Y
Grainsize analysis	Subsurface structure	<1m	One-off	Direct measurement of sediment structure	Neglects sediment structure, can miss micro-scale structures	Cheap	Y
Porosity measurement	Subsurface structure	<1m	One-off	Direct measurement of sediment structure	Core samples highly sensitive to measured volume	Cheap	Some
Thermal capacity	Rock heat capacity	0.1m	One-off	Constrains temperature flux methods	Wide range of values measured from a single rock	Cheap-Moderate	Y
Radon-222	Subsurface flux	<1000m	One-off but repeatable	Estimates of vertical flux & hyporheic exchange	Large measurement uncertainty, requires end-members to be estimated	Cheap-Moderate	Y

Table 4. Summary of Wairau River flow gauging data. The distance is the distance along the thalweg from SH6. This distance is used to calculate the flow change per km of river. The satellite image was taken on 18 Feb 2021

Site	Gauged by	Distance (m)	E	N	16-Feb-21 (time)	Flow (m3/s)	Uncertainty	Corrected Flow	Flow change (l/s/km)	18/02/2021 (time)	Flow (m3/s)	Uncertainty	Corrected Flow	Flow change (l/s/km)
SH6	MDC	0	1667780	5408150	11:47	22.224		22.22		11:49	21.090		21.09	
G1	NIWA	2540	1669972	5408421	10:30	19.651	4.8%	19.65	-1,012	12:08	16.431	5.2%	16.43	-1,835
G2	NIWA	3800	1670901	5409183	11:37	18.681	3.6%	18.94	-187	12:49	15.287	4.1%	15.23	-316
Are Are Creek	NIWA	3805	1670632	5409387	15:11	0.447	3.6%		0	10:35	0.417	3.4%		
G3	NIWA	5240	1671769	5409385	12:42	19.541	3.8%	19.27	63	13:49	15.526	3.8%	15.11	-23
G4	NIWA	5980	1672373	5409761	13:31	19.331	3.7%	18.97	-50	14:32	15.667	4.4%	15.19	13
Wratts	MDC	7290	1673477	5410358	13:30	17.406		17.22	-240	13:18	11.314		10.90	-588
Selmes	MDC	11360	1676568	5411638	14:30	17.895		17.88	58		14.370		14.07	279
Barnetts Bank	MDC	15550	1680224	5412302	15:21	19.365		19.00	73		14.892		14.66	38

Table 5: Summary of thermal conductivity, heat capacity, and density data measured from sections of core using a Tempos thermal properties analyser

	Thermal Conductivity (W/m.K)			Heat Capacity (J/Kg.K)			Grain Density (g/cm³)		
Site	Mean	Std Dev	Values (n)	Mean	Std Dev	Values (n)	Mean	Std Dev	Values (n)
w23_10.9	2.63	0.35	13	759	86	11	2.30	-	11
w23_9	2.66	0.31	15	626	123	10	2.54	-	10
w23_9	2.48	0.2	15	677	123	12	2.47	-	12
w23_9	2.77	0.16	15	437	53	13	2.75	-	13
Wairau	**2.65**	**0.22**	**58**	**618**	**156**	**46**	**2.53**	**0.17**	**46**
Ngaruroro	2.10	0.28	103	679	323	90	2.44	0.41	90
Selwyn BPA	2.19	0.23	35	889	109	32	2.19	0.06	32

Table 6: Summary of radon sample data (Bq/m³) and 2σ uncertainties in the field area, separated into sources. Note that samples labelled Wairau Aquifer are from the pre-1960's braidplain (<500 m from the river).

Source	min	±2σ	median	±2σ	max	±2σ	mean	±2σ	n
Riffle or run	233	19	345	160	610	210	367	152	14
Seep	360	160	410	170	1120	300	625	207	6
Pool	520	200	920	255	2590	430	1208	287	6
BPA piezos	1700	360	2425	425	3540	490	2522	425	4
Wairau Aquifer	730	98	2790	440	5730	660	3160	406	23

6. Hill Country Erosion Programme

(Clr Burgess) (Report prepared by Jenny Buck) **E355-019-004**

Purpose of Report

1. To provide an update on the Hill Country Erosion Programme.

Executive Summary

2. The HCE Programme is a partnership between the Ministry for Primary Industries (MPI), councils and landowners. It provides funding support in four-year blocks to regional erosion-control projects that are beyond the capacity of councils to address on their own. The first four year block started in 2019 in Marlborough, the second four year cycle commencing in 2023.

3. The HCE Programme is working to give landowners the support, advice and incentives they need to retain productive soils and to reduce sediment loss to waterways. It provides assistance and funding support to landowners looking to treat eroding or erosion-prone land through the use of retirement, pole planting, native reversion planting, or advice on alternative site-specific treatment methodologies.

4. Both MPI and MDC combined subsidise 66% of costs associated with erosion control, such as fencing for retirement and plants. The landowners contribute towards costs by 33%.

5. Loss of productive land through erosion has a significant impact on the environment and the economy. Erosion and its effects in hill country areas alone are estimated to cost New Zealand's economy $100-$150 million a year. Reducing erosion in the upper areas of a catchment costs less than the cost of flooding and of flood control structures in the lower areas.

6. Marlborough has a large and diverse land area (over 10,000km^2) with 89% classified as hill country in land use classes 6, 7 and 8, much of which is erosion-prone or actively eroding.

RECOMMENDATION

That the information be received.

Highlights from 2023/24

7. In the 2023-2024 financial year, nearly 3000 Poplar and Willow poles were supplied to landowners, 20,000 native seedlings went into 134ha of retired land and another 19ha went into exotic species woodlots. The majority of this work was undertaken in South Marlborough's dry east-coast hill country.

8. Dryland species of Eucalyptus trees have been used successfully on particularly challenging dry environments with a northerly aspect where poles and/or natives struggle to establish. There are provisions in the HCE programme for the establishment of coppicing woodlot forestry species, which can provide alternatives to pine forestry, reducing harvest-related erosion risks.

Image 1: Erosion on hill slopes following pine tree harvest – Medway Valley, Marlborough

9. So far, the 2024 planting season has seen considerable interest in native seedlings from Marlborough Sounds landowners after the 2022 weather event when continuous heavy rain caused severe landslips and flooding. In contrast, there has been a reduction in the number of poles planted on pastoral land, with landowners citing drought and the economic downturn as reasons they're not planting this year.

Presentation

A short presentation will be given by Jenny Buck (15 minutes).

Author	Jenny Buck, Catchment Care Advisor
Authoriser	Peter Hamill, Team Leader Land & Water

7. Catchment Care for At-Risk Catchments in Marlborough

(Clr Burgess) (Report prepared by Rosanne Homewood) **E355-021-04-01**

Purpose of Report

1. To provide an update on the Catchment Care Programme for At-Risk Catchments in Marlborough.

Executive Summary

2. The Catchment Care Programme is in its final year of a five-year programme aimed at improving water quality in degraded/at risk of degradation catchments in Marlborough. Catchment Care support the Are Are, Flaxbourne, Linkwater and Tuamarina Catchments.

3. The Catchment Care programme is jointly funded by MfE, MDC and landowners. This funding supports landowners to implement mitigation strategies aimed at improving water quality such as riparian fencing and planting, and the release of dung beetles.

4. Over the last four years, the Programme has subsidised over 17km of fencing, the planting of over 45,000 plants and release of 10 dung beetle packs. The programme has exceeded its target for planting and is on track for fencing.

5. In the final year of the MfE funded programme, we have another ~13,000 plants being planted and another ~7.5km of fencing being erected.

6. Successes of the programme so far include exceeding/being on track for key targets (planting and fencing), interest from landowners now exceeding the amount of funding support available, a continued increase in uptake from new landowners, and collaboration with various other groups/organisations/teams in Council to collectively support outcomes.

7. Challenges have included the uncertainty around changing Government regulations, financial challenges being faced by landowners (consequences of weather events and economic climates), and more interest from landowners than funding available.

8. Next year will see us moving to the next phase of this programme, transitioning to supporting landowners without the support of MfE funding. Aim to continue building on the positive relationships and work that has been done so far and continue supporting landowners to take action to improve water quality.

Figure 1: Fencing and planting along Lake Elterwater

RECOMMENDATION

That the information be received.

Presentation

A short presentation will be given by Rosanne Homewood (10 minutes).

Author	Roseanne Homewood, Catchment Care Advisor
Authoriser	Peter Hamill, Team Leader Land & Water

8. Te Whānau Hou Grovetown Lagoon

(Clr Burgess) (Report prepared by Justine Johnson) **C230-001-G01-02**

Purpose of Report

1. To provide an update on Te Whānau Hou Grovetown Lagoon Incorporation restoration work at the Grovetown Lagoon.

Executive Summary

2. The Grovetown Lagoon is an oxbow, or horseshoe lake, four kilometres northeast of Blenheim, beside the Wairau River.

3. Historic land practises, long-term neglect of the riparian margins along with silt and effluent discharges have resulted in the degradation of the Lagoon.

4. Te Whānau Hou Grovetown Lagoon (the Society) is a long running community habitat restoration program. The project is a partnership between, Ngāti Rārua, Ngāti Toa Rangatira, Rangitāne, DOC, Council, and the community.

5. The Society aims to enhance the Lagoon wetland habitat, by planting trees, controlling predator pests, eradicating weeds, and improving public access around the outside of the Lagoon.

RECOMMENDATION

That the information be received.

Background/Context

Finance and Infrastructure

6. Council supports the project with a contracted coordinator $15,000 per annum. MDC Reserves and Amenities Section funds the Society $15,000 per annum for running costs.

7. In addition to the Council funding the habitat restoration is supported by sponsors. Isaac Conservation and Wildlife Trust (ICWT) is the principal sponsor donating $5,000 per annum. The ICWT funding is in conjunction with its Marlborough owned subsidiary Simcox Construction, who undertook $15,000 of in-kind track work in the 2023/24 financial year. Dog Point Vineyard also support the project donating $2,000 per year for the last eight years.

8. As the Society is a registered charity it can apply for grants and funding. Over the years grant funding has provided for many projects, including building infrastructure (bridges, boardwalks, and culverts) to complete the loop track around the outside of the Lagoon.

9. A car park and toilet were installed in early 2021, funded from the Long-Term Plan 2018. Council installed a track counter at the Lagoon in 2022.

Community

10. The Society is managed by the Community. The foundation partnership members form the Executive Group, and the daily operations are undertaken by the Working Group.

11. The work at the lagoon is managed through several volunteer programmes, including weekly and monthly working bees, predator eradication with weekly trap checking, school and corporate/business volunteer days.

12. The track counter at the Lagoon recorded a total of 15,471 visitors in 2023. Up to July in 2024 there had been 11,697 visitors at the Lagoon. The daily average of users has increased from 42 in 2023 to 60 in 2024.

13. This year the Society has been working closely with Landcare Trust on several community and educational events at the Lagoon. This partnership has enabled a community planting day, and for enviro-schools to work alongside the weekly volunteers. More education events are planned for the remainder of the year.

Environment

14. The restoration project aims to improve the water quality and ecological values of the lagoon to provide a better habitat for fish and birds.

15. The plants for the project are propagated by volunteers from seed collected in the ecological district. The Society manage two shade houses to propagate and grow seedlings. Tens of thousands of native plants have been planted over the duration of the project. In the 2023 planting season 994 root trainers and 885 plants, or a total of 1879 plants were planted at the Lagoon.

16. There are many weed species present at the Lagoon. In the 2023/2024 financial year several projects worked on weed control. A drone was used to spray young grey willows in Springs Wetland. A funding for nature program operating in the Kelly's Creek area (southwest of the boardwalk) poisoning crack willow and old man's beard was completed. A contractor was employed to knapsack spray old man's beard and grey willow on the outside edge of the Lagoon. Native Restorations donated a day's labour of six staff to control old man's beard, convolvulus, wild grapevines and climbing rose on Otamawaho (Māori Island). The regular volunteers also manage weeds in the weekly and monthly working bees.

17. The society started a predator control program in 2017. There are 80 traps at the Lagoon which are monitored weekly by volunteers. There are trap lines both around the outside of the Lagoon and internally on Otamawaho. There are no public walkways on Otamawaho, and the outside edge of the island is managed for bird nesting habitat. Rats are the main target species, with 674 rats being trapped since 2017, 1442 pest have been caught in total.

Presentation

A short presentation will be given by Justine Johnson (10 minutes).

Author	Justine Johnson, Grovetown Lagoon Coordinator
Authoriser	Alan Johnson, Environmental Science and Monitoring Manager

9. Biosecurity Operational Plan Report 2023/2024

(also refer separate report available on Council's website)

(Clr Faulls) (Report prepared by Liam Falconer) E315-002-005-10, E315-002-005-11

Purpose of Report

1. For Council approval of the Biosecurity Operational Plan Report for 2023/2024.

2. For Council approval of amendments to the Biosecurity Operational Plan contained within the 2023/2024 report.

Executive Summary

3. A final report has been prepared on the Biosecurity Operational Plan at the completion of the 2023/2024 financial year, covering the activities of Council's Biosecurity Section.

4. A review of the Biosecurity Operational Plan 2018-2028 was also carried out by staff on 29 July 2024. Proposed amendments are contained within Part Four of the report.

5. It has been a reasonably successful year for the Biosecurity Section with 96% of the operational delivery targets achieved, 4% almost achieved.

6. National funding reductions in the national wilding conifer programme increases the long-term risk of not meeting our regional objectives.

7. In terms of the progress of the pest programmes, many continue to be on track. Of particular importance, there continues to be no establishment for majority of the pests under Exclusion Programmes within the Regional Pest Management Plan. The exception being the Mediterranean fanworm incursion in Waikawa.

8. For those programmes not on track, this often reflects the biological challenges and realties of managing invasive species and even those at low incidence.

RECOMMENDATIONS

1. That the report be received.

2. That the annual report on the Biosecurity Operational Plan for the 2023/2024 financial year be approved by the Council in accordance with section 100B(2) of the Biosecurity Act 1993.

3. That the amendments proposed within Part Four of the 2022/2023 Biosecurity Operational Plan Report, as a result of the annual review of the Operational Plan, be approved by the Council in accordance with section 100B(1)(b) and (c) of the Biosecurity Act 1993.

Background/Context

9. Council delivers a wide range of services with respect to the management of invasive species threats. This is mandated by section 12B of the Biosecurity Act 1993 where Council provides leadership for pest management within its region.

10. A major instrument used by Council is the making of a Regional Pest Management Plan (RPMP) prepared under the Biosecurity Act 1993. This is a regulatory instrument that outlines several programmes targeting the most strategic threats to our region. These programmes range from high threat species not in our region but elsewhere in NZ (e.g. wallabies, fanworm), to high threat/low incidence species already in our region (numerous pest plant species), and high threat/widespread however manageable species (e.g. nassella tussock, rabbits).

11. Other key services include oversight or involvement in specific projects such as the National Wilding Conifer Control Programme, or biological control agent research initiatives. In the background, staff are also continually keeping up to date on, assessing or investigating new potential threats.

12. The Biosecurity Operational Plan 2018-2028 was prepared to meet the requirement under section 100B of the Biosecurity Act 1993 in relation to the Regional Pest Management Plan. However, given the Biosecurity range of services are wider than just the RPMP, it also outlines plans for those other components of work delivered by Council and the community.

13. In accordance with section 100B(2) of the Biosecurity Act 1993, a management agency implementing a RPMP must prepare a report on the Operational Plan and its implementation not later than five months after the end of each financial year. This report on the Operational Plan is intended to meet this obligation.

14. In accordance with sections 100B(1)(b) and (c), the Operational Plan must also be reviewed annually, and a decision made on appropriate amendments, if necessary.

15. A review of the Operational Plan was completed on 29 July 2023, with a small number of proposed amendments identified. These amendments primarily are due to the inclusion of Wilding Conifers in the Regional Pest Management Plan and to reflect the reduction of service with unconfirmed external funding in the marine programme.

16. The proposed amendments to the Operational Plan do not result in any further demands with respect to resourcing levels for the Biosecurity Section.

Highlights from 2023/24

17. As outlined in the report, the work of the Biosecurity in 2023/24 is wide-ranging and has continued to be of high quality. This has been through committed implementation by the team, the community and our partners.

18. For Exclusion Programme Wallabies – there continues to be no evidence that this highly invasive species has established in Marlborough.

19. Numerous pest plant programmes where the long-term objective is to suppress populations to low levels – these are tracking well and in many instances, tracking downwards.

20. Initial control work started on the large infestation of woolly nightshade found in Squally Cove, this programme will likely see a substantial spike in plant numbers before that is bought under sustained management.

21. Strong progress has been made strengthening relationships working towards delivering the Mediterranean fanworm programme in conjunction with our partners, Marlborough marinas, Aquaculture NZ, TOS partnership and Biosecurity NZ.

22. Council has continued to fulfil its regional role implementing the National Wilding Conifer Control Programme. The scale of the programme at its peak was $5.6M in 2022/23 subsequently reducing to ~$2.54M in 2023/24 with active operations spanning from Rangitoto ki te Tonga/D'Urville Island through to Molesworth Station. National funding for these programmes has continued to reduce with Marlborough funding for 2024/2025 sitting at $1.35M.

23. The reduction in funding risks achievement of regional and national objectives and is further impacting on maintaining the gains already achieved. The impacts are evident with the continuous spread of wildings in the Clarence, Awatere and Waihopai catchments threatening landscape, biodiversity values and the long-term sustainability of our water resources.

24. While Council directly oversees some of these programmes, others are delivered by community-led organisations, the Marlborough Sounds Restoration Trust and South Marlborough Landscape Restoration Trust.

25. The Jobs for Nature programme has now been completed with some significant gains being made investigating the distribution of and undertaking some initial control work on Wilding Kiwifruit populations.

26. Operations continue to investigative and undertake early intervention work to get a handle on the emerging threats; Wild kiwifruit, Pink ragwort, Mexican feather grass, and Bomarea. Many of these are worth considering as long-term management programmes supported through the Regional Pest Management Plan.

Option One (Recommended Option)

27. Council approves the Operational Plan Report 2023/24 and amendments proposed to the Biosecurity Operational Plan 2018-2028.

Advantages

- Council will be meeting the requirements of sections 100B(1)(b) and 100B(2) of the Biosecurity Act 1993.

Disadvantages

- Nil

Option Two – Status Quo

28. Council does not approve the Operational Plan Report 2023/24 and amendments proposed to the Biosecurity Operational Plan 2018-2028.

Advantages

- Nil

Disadvantages

- Council will not be meeting the requirements of sections 100B(1)(b) and 100B(2) of the Biosecurity Act 1993.

Next Steps

29. If approved, both the Biosecurity Operational Plan Report 2023/2024 and amended Biosecurity Operational Plan 2018-2028 will be made publicly available on the Council website.

Presentation

A short presentation will be given by Liam Falconer (20 minutes).

Attachment

Attachment 1 – Biosecurity Operational Plan Report 2023/24 – the report is available on Council's website via the following link here

Author	Liam Falconer, Biosecurity Manager
Authoriser	Alan Johnson, Environmental Science and Monitoring Manager

Summary of decision-making considerations

Fit with purpose of local government

The proposal enables Council to fulfil statutory obligations under sections 100B(1)(b) and 100B(2) of the Biosecurity Act 1993.

Fit with Council policies and strategies

	Contributes	*Detracts*	*Not applicable*
LTP / Annual Plan	✓	☐	☐
Financial Strategy	✓	☐	☐
Infrastructure Strategy	☐	☐	✓
Social well-being	☐	☐	✓
Economic development	✓	☐	☐
Environment & RMA Plans	✓	☐	☐
Arts & Culture	☐	☐	✓
3 Waters	☐	☐	✓
Land transport	☐	☐	✓
Parks and reserves	☐	☐	✓

10. Resource Management (Extended Duration of Coastal Permits for Marine Farms) Amendment Act 2024

(The Chair) (Report prepared by Pere Hawes) **L150-019-R01**

Purpose of Report

1. To inform the Committee of the enactment of the Resource Management (Extended Duration of Coastal Permits for Marine Farms) Amendment Act (the Act)

2. To recommend that Variation 1 is retained in order to complete the content of the PMEP.

Executive Summary

3. Previous reports to Committee have highlighted the introduction of legislation to Parliament proposed to extend the duration of existing coastal permits for marine farms.

4. Following consideration of submissions by the Primary Production Select Committee and the Committee's reporting to Parliament, the Bill received its second and third readings and was enacted on 27 August 2024.

5. All coastal permits are now extended by 20 years or to 2050, whichever is lesser.

6. In making a submission to the Primary Production Select Committee the Council highlighted the option of withdrawing Variation 1. On reflection, the benefits of retaining Variation 1 are considered to outweigh the risks associated with withdrawal. There is still the prospect of relocating existing marine farms to more appropriate and sustainable locations, but Variation 1 is required to achieve this end.

RECOMMENDATIONS

1. That the report be received.

2. That the Council does not withdraw Variation 1 to the PMEP.

Background/Context

7. On Thursday, 30 May 2024, the Government introduced the Resource Management (Extended Duration of Coastal Permits for Marine Farms) Amendment Bill to Parliament. Under the Bill marine farms would automatically get a 20-year extension to their coastal permit expiry dates.

8. The Council prepared a submission on the Bill that was approved by the Mayor and Chair. The Council submission was lodged on 14 June 2024.

9. The key points of the Council submission were:

    a) It is fundamentally unsound to have both central and local government attempting to allocate the same coastal marine area, particularly when that allocation is at cross-purposes. The status quo is working efficiently and effectively, without the need for legislation, and the Bill should not proceed;

    b) A feasible alternative that would complement Variation 1 would be to amend s 123A of the Resource Management Act 1991 to provide for a longer minimum term for marine farm coastal permits;

    c) If the Bill is to proceed, then marine farms within Marlborough should be exempt from the new legislation as a robust allocation and planning framework for marine farming has been provided through Variation 1, together with the existing planning framework for finfish farming;

d) In the event Marlborough is not exempt, then to avoid uncertainty and unnecessary duplication of regulation, one option available to Council is to defer to central government's prerogative to take over the allocation of space in the coastal marine area and withdraw Variation 1; and

e) Amendments are required to the Bill to ensure its workability and effectiveness, including removing the ability of consent holders to elect between an extant coastal permit or replacement permit, and require consent holders to operate under the replacement permit.

10. Council staff presented an oral submission to the Primary Production Select Committee on 26 June 2024.

Resource Management (Extended Duration of Coastal Permits for Marine Farms) Amendment Act 2024

11. Following consideration of submissions by the Primary Production Select Committee and the Committee's reporting to Parliament, the Bill received its second and third readings and was enacted on 27 August 2024.

12. The Select Committee's Report can be accessed here: https://selectcommittees.parliament.nz/v/6/8c66b8ec-fb94-45d2-b2b4-08dca6b263bb

13. There was not substantial change to the intent or direction of the Bill during the parliamentary process. The most significant change was that the 20-year extension to the duration of coastal permits was limited to (i.e., cannot exceed) 2050. The Council was not successful in achieving an exemption for marine farms in Marlborough in order that Variation 1 could operate as intended.

14. All marine farms authorised by deemed coastal permits, which were expiring on 31 December 2024, had applied for replacement coastal permits by enactment on 27 August 2024. In this circumstance, marine farmers have applied for the space allocated for the farm via the relevant Aquaculture Management Area in Variation 1.

Relationship to Variation 1

15. One of the drivers for Variation 1 was to provide certainty of tenure to marine farmers. This was achieved through controlled activity status for reconsenting existing marine farms within Aquaculture Management Areas (AMA).

16. The Act also provides certainty of tenure but by extending the duration of the existing coastal permits authorising the marine farms.

17. As mentioned above, in making its submission to the Primary production Select Committee, Council highlighted the option of withdrawing Variation 1.

18. Although it might be argued that Variation 1 is redundant in the circumstances above, Variation 1 also identifies appropriate locations for existing marine farms. In most cases this involves a seaward movement of the marine farm. Marine farmers still have the option to apply to reconsent the marine farm under Variation 1 and within the AMA.

19. If Council was to withdraw the Variation, then the management of marine farming would revert to the operative Marlborough Sounds RMP (for new farms) and the NES for Marine Aquaculture (for reconsenting existing farms).

20. This approach would present risks. These are set out below.

- Council is still required to give effect to the NZCPS, including the identification of areas appropriate for aquaculture under Policy 8 of the NZCPS. Withdrawing the Variation, especially when Council has stated a position on appropriate locations through AMA, does not respond to these responsibilities. The decision to withdraw the variation could be legally challenged for the same reason.

- The policy direction, and matters of control and discretion in rules, set out in the Variation for reconsenting are contemporary and build upon many years of administering the provisions of the MSRMP and the outcomes of Court appeals. On withdrawal, determination of consents will have to rely on the provisions of the MSRMP only, which were developed in the late 1990s and are inadequate to manage all issues associated with marine farming. There is also no management framework for open water aquaculture in the Marlborough Sounds RMP.

- Variation 1 provides certainty of tenure for the existing industry while also providing certainty to the community over future growth of the industry. Marine farming within the enclosed waters of the Marlborough Sounds is prohibited outside of AMA. Reverting to the provisions of the Marlborough Sounds RMP risks encouraging applications for new space. Coastal Marine Zone 2 in the Marlborough Sounds RMP allows applications for new space to be made. There is significant coastal space within Coastal Marine Zone 2 not currently occupied by marine farming. Withdrawal of Variation 1 presents that opportunity to make an application when such an opportunity does not exist under Variation 1.

- The Council is currently midway through Court assisted mediation of appeals on Variation 1. Mediation of appeals to Volume 1, 2 and 3 provisions occurred earlier in March and April. Except for the appeal by Ngāi Tahu, the mediation process is yet to result in agreed resolution and work streams are ongoing (as previously reported to the Committee). Mediation on spatial/AMA appeals is to commence on 14 October 2024. The mediation process has been entered into by all parties in good faith. The withdrawal of Variation 1 so late in the First Schedule process creates a reputational risk at the very least and may create the opportunity for an appellant or Section 274 party to seek costs incurred as part of the mediation process to date from Council.

21. In summary, it is considered that there remains a strong argument to continue encouraging marine farmers to move to more appropriate and sustainable locations in the Marlborough Sounds and the variation provisions clearly identify those locations. Retaining the provisions of Variation 1 allows the notified PMEP content to be completed.

22. It is understood that the Marine Farming Association is similarly encouraging its members to utilise the AMA.

23. Applications for resource consent made since Variation 1 was notified typically seek the space provided for in the AMA.

24. For the reasons set out above, it is recommended that Council **not** withdraw Variation 1.

Next steps

25. As mentioned above, Environment Court mediation is about to recommence on spatial/AMA appeals in October. The mediation is scheduled to run through to November.

26. If the Committee adopts the recommendations, and retains Variation 1, the mediation will run as currently directed by the Environment Court.

Author	Pere Hawes, Manager Environmental Policy
Authoriser	Hans Versteegh, Manager of Environmental Policy, Science and Monitoring

11. Information Package

RECOMMENDATION

That the Regulatory Department Information Package dated 3 October 2024 be received and noted.