Implementation Committee Agenda - 9 March 2022

Meeting conducted in the Council Chamber at Lvl 2, Philip Laing House
144 Rattray St, Dunedin (Councillors and staff only)
Members of the public may view livestream at: Otago Regional Council YouTube Channel

Members:
Cr Bryan Scott, Co-Chair
Cr Carmen Hope, Co-Chair
Cr Hilary Calvert
Cr Michael Deaker
Cr Alexa Forbes
Cr Gary Kelliher
Cr Michael Laws
Cr Kevin Malcolm
Cr Andrew Noone
Cr Gretchen Robertson
Cr Kate Wilson

Senior Officer: Sarah Gardner, Chief Executive

Meeting Support: Liz Spector, Governance Support Officer

09 March 2022 01:00 PM

Agenda Topic | Page

Cr Bryan Scott has tendered his apologies.

No requests to address the Committee under Public Forum were received prior to publication of the agenda.

Note: Any additions must be approved by resolution with an explanation as to why they cannot be delayed until a future meeting.

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

Minutes of previous meetings of the Implementation Committee will be adopted as true and accurate record(s), with or without changes.

Actions from resolutions of previous Implementation Committee meetings will be reviewed with staff.

Minutes of a meeting of the Implementation Committee held in the Council Chamber on Wednesday 8 December 2021 at 10:30AM

Membership

Cr Carmen Hope	*(Co-Chair)*
Cr Bryan Scott	*(Co-Chair)*
Cr Hilary Calvert	
Cr Michael Deaker	
Cr Alexa Forbes	
Cr Gary Kelliher	
Cr Michael Laws	
Cr Kevin Malcolm	
Cr Andrew Noone	
Cr Gretchen Robertson	
Cr Kate Wilson	

Welcome

Co-Chair Carmen Hope welcomed Councillors, members of the public and staff to the meeting at 10:38 am. Staff present included Sarah Gardner (Chief Executive), Nick Donnelly (GM Corporate Services), Gwyneth Elsum (GM Strategy, Policy and Science), Gavin Palmer (GM Operations), Richard Saunders (GM Regulatory and Communications), Liz Spector (Governance Support), and Andrea Howard (Manager Environmental Implementation), Julian Phillips (Implementation Lead – Transport) and Garry Maloney (Manager Transport).

1. APOLOGIES
There were no apologies. Cr Deaker was present electronically.

2. PUBLIC FORUM
There were no requests to address the Committee during Public Forum.

3. CONFIRMATION OF AGENDA
Co-Chair Hope noted that the paper previously scheduled to be considered with members of the public excluded, *Decision on Future of Rabbit Control Assets*, had now been requested to be considered in public by the General Manager of Operations. Cr Laws moved the paper be considered in public.

Resolution: Cr Laws Moved, Cr Calvert seconded

1) ***That*** *the paper Decision on Future of Rabbit Control Assets be considered in public.*

MOTION CARRIED

4. CONFLICT OF INTEREST
No conflicts of interest were advised.

5. CONFIRMATION OF MINUTES

Resolution: Cr Laws Moved, Cr Robertson Seconded
That the minutes of the public meeting held on 8 September 2021 be received and confirmed as a true and accurate record.

MOTION CARRIED

Resolution: Cr Hope Moved, Cr Robertson Seconded
That *the minutes of the public-excluded meeting held on 8 September 2021 be received and confirmed as a true and accurate record.*

MOTION CARRIED

6. ACTIONS
Cr Malcolm and Cr Wilson had questions on two Actions that had been marked complete. Dr Palmer noted that both items in question had been noted on the Quarterly Activity Report that had gone to the 24 November 2021 Finance Committee, however, he indicated each will be added to a future report to Implementation Committee agenda. He asked that the two items be shown to be "In Progress" rather than "Completed".

It was further requested to receive this information prior to the 9 March 2022 Implementation Committee meeting.

7. MATTERS FOR CONSIDERATION

7.1. Environmental Implementation Update

This report provided a quarterly summary of operational implementation activities being undertaken in the areas of freshwater, biosecurity, and biodiversity and included details of projects underway, and improvements being made to processes and systems supporting delivery of these activities. Andrea Howard (Manager Environmental Implementation) and Gavin Palmer (GM Operations) were present to respond to questions about the report.

Cr Wilson asked if staff members working out in the field in environmental implementation could be identified to allow community members to be aware who they may be working with. Chief Executive Sarah Gardner said there is an established protocol for governors and the public to contact individual staff members. After a discussion of this query, Cr Forbes moved:

Resolution IMP21-116: Cr Forbes Moved, Cr Laws Seconded

That the Committee:

1) ***Bring** to the next Governance, Communications and Engagement meeting advice on protocols around how we approach governance/staff engagement.*

MOTION CARRIED

After further discussion of the report, Cr Malcolm moved the staff recommendation:

Resolution IMP21-117: Cr Malcolm Moved, Cr Forbes Seconded

That the Committee:

1) ***Notes** this report.*
2) ***Notes** the range of standard business and transformational activities being undertaken to maintain and improve Otago Regional Council's delivery of environmental implementation activities.*
3) ***Notes** progress towards the development of a joint Memorandum of Understanding for a Southern Biosecurity Partnership between ORC, Environment Southland and Environment Canterbury which will be considered by Council in early 2022.*

MOTION CARRIED

Cr Laws left the meeting at 11:52 am.
Cr Laws returned to the meeting at 11:54 am.

7.2. Outcomes from Dunedin Electric Bus Trial

This report outlined outcomes from the electric bus trial that operated in Dunedin from 28 September to 29 October 2021. Abbey Chamberlain (Implementation Advisor - Transport), Julian Phillips (Implementation Lead - Transport), Garry Maloney (Principal Advisor - Transport Planning) and Gavin Palmer (GM Operations) were present to respond to questions about the report. Also present via electronic link was Mike Parker from Global Bus Adventures and Russell Turnbull from Go Bus Transport.

Following a discussion and questions about the report and the electric bus trial, Cr Malcolm moved:

Resolution IMP21-118: Cr Malcolm Moved, Cr Calvert Seconded
That the Committee:

1) ***Notes** this report.*
2) ***Notes** that the trial was successful in providing a range of valuable data about operational performance of an electric vehicle in Dunedin.*
3) ***Notes** that the trial is representative of contracts operated by Go Bus Transport.*
4) ***Endorses** Council staff preparing a subsequent report for Council consideration to the 8 June 2022 Implementation Committee, regarding scope to prepare for a transition to a zero-emission public transport fleet.*

MOTION CARRIED

Cr Laws left the meeting at 12:07 pm.
Cr Laws returned to the meeting at 12:21 pm.
Cr Scott left the meeting at 12:31 pm.
Cr Scott returned to the meeting at 12:32 pm.

7.3. Decision on Future of Rabbit Control Assets

This report sought a final decision on the future of ORC-owned rabbit control assets and recommended sale and disposal of the Council's remaining rabbit control assets to support the private sector to undertake rabbit control. Andrea Howard, Manager Environmental Implementation, and Gavin Palmer, GM Operations, were present to respond to questions.

Cr Hope asked if the Council had obtained evaluations of the equipment. Nick Donnelly, GM Corporate Services, said the assets were many years old and were likely fully depreciated, with a $0 book value. Cr Kelliher noted his concerns regarding disposal of the Galloway Depot and oat processing equipment. He said he did not want these assets to be sold and potentially relocated from Otago as there were still uses for it. Chief Executive Gardner reminded Councillors that in 2018 the ORC had purchased and cooked oats and ended up not being able to deliver them at a competitive price. Cr Kelliher said he was aware of that previous attempt and he suggested the equipment be made available to lease by local contractors. Mrs Gardner also noted the report to Councillors stated there were potential health and safety issues involved with retaining the oat processing equipment and it would be her responsibility to ensure no risk or liability would be taken on that couldn't be appropriately managed.

Following further discussion, Cr Calvert moved:

Resolution IMP21-119: Cr Calvert Moved, Cr Kelliher Seconded
That the Committee:

1) ***Notes** this report.*
2) ***Notes** the outcome of the initiative to supply poisoned carrot bait to landholders on a trial basis over Winter 2021, based in Central Otago, for the purposes of rabbit control and promoting this opportunity to landholders.*
3) ***Approves** the extension of this arrangement for the Winter 2022 control season.*
4) ***Notes** the results of the contractor survey on the future use of Council-owned rabbit control assets.*
5) ***Notes** the results of the safety assessment of Council-owned rabbit control assets by an independent Senior Safety & Compliance Engineer.*
6) *Approves the staff recommendation to dispose of all remaining Council-owned rabbit control assets with the exception of the Galloway depot and oat processing equipment and report back before the end of the financial year 2021/22 with options for the*

Galloway depot and oat processing equipment including the value of the property, buildings and equipment.

7) ***Notes*** *the environmental incentive contestable funding package for 2021/2022 to support better rabbit management by communities (within existing LTP budgets).*

MOTION CARRIED

8. CLOSURE

There was no further business and Co-Chair Hope declared the meeting closed at 01:32 pm.

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Chairperson Date

OPEN ACTIONS OF COMMITTEE RESOLUTIONS – IMPLEMENTATION COMMITTEE

Meeting Date	Item	Status	Action Required	Assignee/s	Action Taken	Due Date
08/12/2021	BIO2119 Environmental Implementation Update	Completed	Provide a report with advice on protocols around how governance and staff engagement is approached to the 10/03/2022 Governance, Comms and Engagement Committee meeting. **Res IMP21-116**	General Manager Governance, Culture and Customer	**2/03/2022 Governance Support Officer** Report included on the 10 March 2022 GCE Committee agenda.	10/03/2022
08/09/2021	Notice of Motion -- Request for Reports	In Progress	Include details on progress on gravel extraction consents in regular quarterly reporting to the Implementation Committee. **Res IMP21-115**	General Manager Operations	**25/11/2021 Governance Support Officer** Dr Palmer (25/11/2021): Update provided in quarterly report "Council Activity Performance Report 1Q 2021/22" to the 24 Nov Finance Committee. **9/12/2021 Governance Support Officer** Dr Palmer noted that future regular quarterly reports to the Committee will include details on gravel extraction consents. **23/02/2022 Executive Assistant** Details will be reported to the 9 March meeting of the Implementation Committee.	08/12/2021
08/09/2021	Notice of Motion - Request for Reports	In Progress	Include information on development of work programmes for the 2022/23 and subsequent annual plans for river management in regular quarterly reporting to the Implementation Committee. **Res IMP21-115**	General Manager Operations	**25/11/2021 Governance Support Officer** Dr Palmer (25/11/2021): Update provided in quarterly report "Council Activity Performance Report 1Q 2021/22" to the 24 Nov Finance Committee. **23/02/2022 Executive Assistant** Information will be reported to the 9 March meeting of the Implementation Committee.	08/12/2021
08/09/2021	Notice of Motion - Request for Reports	In Progress	Present a staff report detailing timeframes and process to better develop asset management plans for plantings alongside riverbanks. **Res IMP21-115**	General Manager Operations	**25/11/2021 Governance Support Officer** Dr Palmer (25/11/2021): Update provided in quarterly report "Council Activity Performance Report 1Q 2021/22" to the 24 Nov Finance Committee.	08/12/2021

Meeting Date	Item	Status	Action Required	Assignee/s	Action Taken	Due Date
					23/02/2022 Executive Assistant Information will be reported to the 9 March meeting of the Implementation Committee.	
08/12/2021	ENV2102 Decision on Future of Rabbit Control Assets	In Progress	Report back prior to 30/06/2022 with options for the Galloway depot and oat processing equipment, to include information on values of the property, buildings and equipment. **Res IMP21-119**	General Manager Operations	**19/01/2022 Executive Assistant** To start **23/02/2022 Executive Assistant** The working party comprising Cr Kelliher and staff met on 24 February 2022 to discuss how to develop options for Council consideration.	30/06/2022

7.1. River Management Update: Quarters 1 and 2

Prepared for:	Implementation Committee
Report No.	OPS2112
Activity:	Environmental - Central Otago Rivers & Waterway Management Environmental - Clutha Rivers & Waterway Management Environmental - Lower Waitaki Rivers & Waterway Management Environmental - Waitaki Rivers & Waterway Management Environmental - Wakatipu Rivers & Waterway Management Environmental - Wanaka Rivers & Waterway Management Environmental - Dunedin Rivers & Waterway Management
Author:	Michelle Mifflin, Manager Engineering and Pam Wilson, Team Leader Infrastructure (Asset Management, Planning & Strategy)
Endorsed by:	Gavin Palmer, General Manager Operations
Date:	9 March 2022

PURPOSE

[1] To provide a quarterly summary of river management operational activities and an update on the three resolutions made at the Implementation Committee meeting of 8 September 2021 to do with gravel extraction consents, river management work programmes and asset management plans for plantings along riverbanks.

RECOMMENDATION

That the Committee:

1) ***Notes*** *this report.*
2) ***Notes*** *the River Morphology and Riparian Strategy's for the Waianakarua River, Pomahaka River, Kakanui River, Taieri River and Shag/Waihemo River.*
3) ***Notes*** *the progress that is being made with the reporting, planning and progression of the framework that supports river management activities.*

BACKGROUND

[1] Otago is administered by the Otago Regional Council. Situated in the southern half of the South Island and within an area of approximately 32,000 square kilometres, it is the second largest local government region in the country.

[2] The region has an extensive and diverse network of rivers, extending from the mountains to the sea. Many of the rivers are characterised by high rates of sediment supply and mobile beds (Figure 1). Some of the rivers are still responding to the effects of historical activities such as 19th Century alluvial gold mining, construction of hydro-electric dams, channel realignment and high rates of commercial gravel extraction.

Figure 1: The Dart-Rees River, Otago

[3] The ORC has a river management function which is based on the districts and rated accordingly within those districts across all of Otago (Figure 2).

[4] The ORC plays a role in managing flood risk and works with communities and district councils to manage this risk to people and property. This complements other activity of ORC including the monitoring, analysis and reporting of natural hazards and working collaboratively with the territorial authorities on land use planning.

[5] This role involves developing plans for works across the Otago rivers and waterways and communicating this to stakeholders. This communication includes and is not limited to, landowner meetings, notification process required through the resource consents and engagement sessions with specific communities as required.

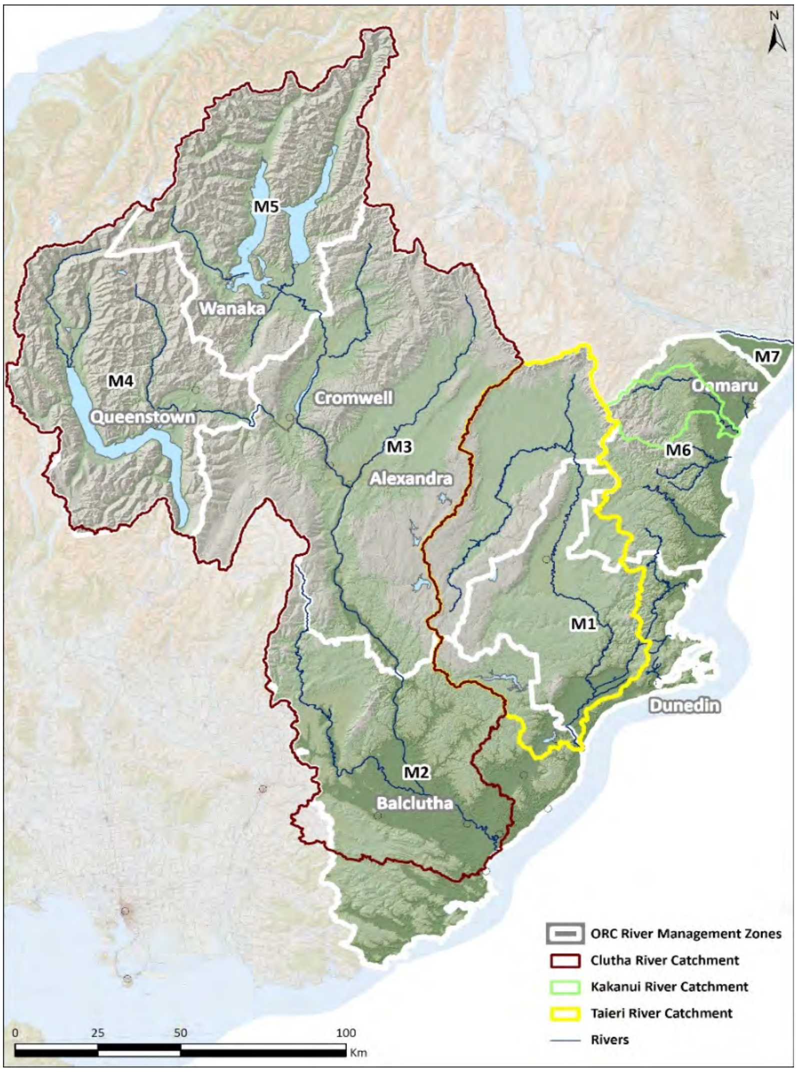


Figure 2: Map of Otago's River Management (M) Rating Districts of some of the rivers across Otago where river management activities are undertaken.

River Management Zone
M1 = Dunedin Rivers
M2 = Clutha
M3 = Central Otago
M4 = Wakatipu
M5 = Wanaka
M6 = Waitaki
M7 = Lower Waitaki River Control Scheme

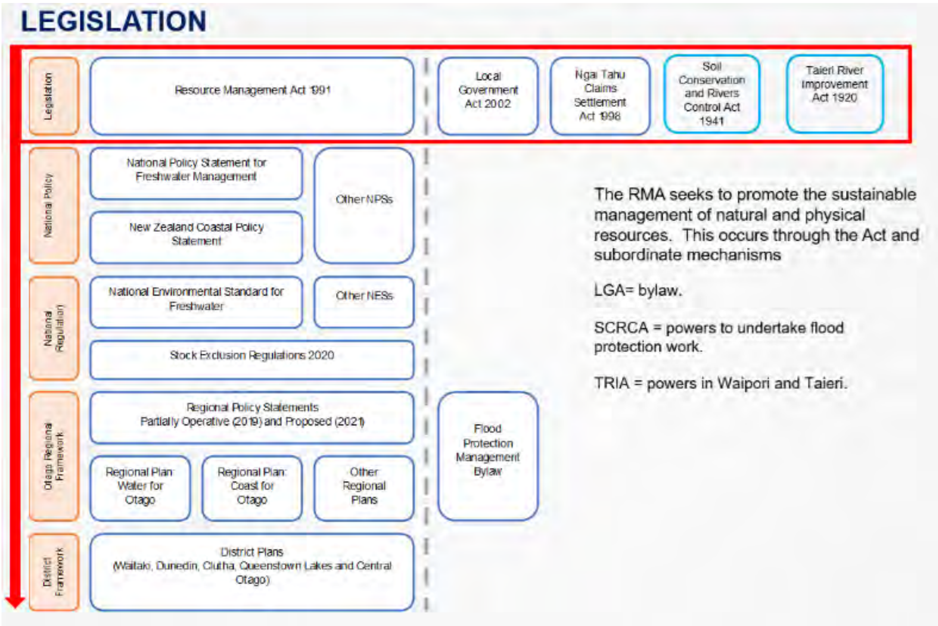
M' reflects the code used for river management with its respective numerical reference to a district

Table 1: Explanation of River management rating districts

[6] ORC's role is guided by legislation (Figure 3) which sets out the responsibilities of local government's role around lakes, rivers, and waterways in the context of river management.

[7] The responsibilities[1] of regional councils in relation to river management are principally defined by the Local Government Act 2002 and the Soil Conservation and Rivers Control Act 1941 (SCRCA). The overriding purpose of the SCRCA is to make provision for the conservation of soil resources, the prevention of damage by erosion and make better provision for the protection of property from damage by floods.

Figure 3:



Legislation that guides river management

[8] The framework of legislation is not discussed in detail in this paper, however the legislation that is most relevant to river management activities, the SCRCA is discussed. The legislation framework above shows how the framework guides river management activities. It also highlights the significance of an update to legislation, with possible multifactorial impact on policies/plans and subsequently the way we carry out our activities.

The Soil Conservation and Rivers Control Act 1941

[9] ORC has the functions and responsibilities of a catchment authority [2]under the SCRCA. Section 126(l) [3]of the Act provides that it shall be a function of every catchment board to minimise and prevent damage within its district by floods and erosion.

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[1] The Local Government Act 2002, section 12(2) provides councils scope to do anything withing the context of the purpose of local government, which includes, preparing long term plans and annual plans that set out responsibilities and activities that achieve outcomes.

[2] Catchment authority and boards were replaced by Regional Council in the late 1980's for Otago.

[3] As amended by the Eight Schedule of the Resource Management Act 1991

[10] Section 126(2) provides that each catchment board shall have such powers, rights and privileges as may reasonably be necessary or expedient to enable it to carry out its functions and, in particular, for the construction, reconstruction, alteration, repair and maintenance of its works where it is necessary for:

a. Controlling or regulating the flow of water towards and into watercourses.
b. Controlling or regulating the flow of water in and from watercourses.
c. Preventing or lessening any likelihood of the overflow or breaking of the banks of any watercourse.
d. Preventing or lessening any damage which may be occasioned by any such overflow or breaking of the banks.
e. Preventing or lessening erosion or the likelihood of erosion.
f. Promoting soil conservation.

Sections 131 to 140 [4] empower the ORC as a catchment board [5]with a number of specific powers under the Public Works Act 1981 and other statutes, including the duty to maintain, alter and improve the efficiency of all watercourses in order to provide defence against flooding and the power to deepen, widen, straighten, divert watercourses, and to construct stopbanks and similar works.

Resource Consents related to river management activities

[11] ORC carries out its river management activities under the following mechanisms:

a. Resource Management Act 1991 (RMA) (Consents),
b. Otago Regional Plans, (Permitted Rules), and
c. Statutory authority (SCRCA) where relevant.

[12] The Operations, Engineering function carries out the majority of its river management activities under consents, commonly termed “global consents”. Global consent means within the right framework, a number of activities can be carried out across Otago in relation to river management. The framework within the consents allows for the common management of these activities across the region.

[13] The ORC (Operations, Engineering) holds three consents that fall under the term global consent as follows.

a. RM10.408.16 Discharge consent. “To discharge silt, sediment and vegetative debris to watercourses throughout the Otago Region”.
b. RM10.408.17 Land use consent. “To disturb the beds of various watercourses throughout the Otago Region”.
c. RM10.408.18 Water permit. “To temporarily divert the flows of various watercourses throughout the Otago Region”.

All three consents are linked and must be used in conjunction with one another.

[14] RM10.408.17 is the main consent which allows vegetation management, gravel realignment, repair of erosion, and other activities. It does not authorise the extraction of gravel.

[4] These sections are included as an attachment to this paper, as extracts from the SCRCA.
[5] The Otago Regional Council replaces the Catchment Board

[15] The "global consents" have a prescriptive time period when work cannot occur in waterways which is set out in Figure 4.

Figure 4: Timeframe when work can be undertaken in rivers/waterways

[16] The timeframe (Figure 4) is important for the ecological values of rivers and waterways. During this time, aquatic values begin spawning. Working in the rivers and waterways during this period may have a detrimental effect on spawning activity. As a consequence, the work programme is designed and implemented taking into seasonal factors.

[17] The current "global consents" are undergoing renewal with the consent authority.

River management activities that are carried out across Otago

[18] The responsibility for rivers and waterways, from a river management perspective commenced with the establishment of catchment boards. These were set up under the SCRCA, their primary purpose being to control flooding through the management of rivers and soil erosion. The SCRCA promoted a "whole of catchment" approach.

[19] Regional councils as we know them today were established in 1989[6], under the Local Government Amendment Act. Regional council boundaries approximately followed river catchment boundaries. This legislation rationalised the bodies carrying out functions at a regional and local level, ultimately reducing the catchment boards and other government bodies that had proliferated over the last century from more than 800 to 86. The newly created regional councils inherited a range of resource management responsibilities from the existing boards and councils, including for flood and erosion control functions transferred from the catchment boards.

[20] The Operations, Engineering function has an operational management responsibility for the rivers and waterways in the Otago region.

[21] The role of river management through ORC, requires balancing natural processes of a river environment with a modified environment created through infrastructure and communities.

[22] Balancing the natural process of a river environment takes into consideration the principle of giving a river room to move. This is not a new idea or concept; it simply refers to giving rivers enough room to safely convey floods. A healthy river is resilient

[6] Source: Envirohistory NZ

and adjusts its path and regenerates habitats and has significant capacity to recover from disturbance.

[23] A modified environment results in river confinement, where we have infrastructure (such as bridges, roadways) and communities (urban and rural settlement), which results in confining the river within defined corridors to maximise the availability of land and manage flood risk.

[24] Engineering works such as flood banks and anchored tree protection are examples of confining the river and managing the flood risk.

[25] Effective river management taking into account, the previous discussion requires consideration of other river values (other than flooding) such as river habitats, water quality and aquatic ecology, and community values around access and use of rivers.

[26] The river management currently undertaken by ORC can be described as activities in the following categories[7]:

a. Soft-engineering solutions
   i. Using vegetation as defences against flooding and bank erosion
b. Maintenance activities
   i. Vegetation maintenance
   ii. Erosion control
   iii. Gravel realignment
c. Reactive/responsive activities
   i. Responding to river blockages/obstructions
   ii. Responding to erosion from flooding
   iii. Responding to gravel issues from flooding
d. Hard-engineering solutions
   i. River training lines
   ii. Rock armouring/stabilisation
   iii. Gravel realignment

[27] When physical works or activities are being considered within the river corridor, these works are usually undertaken with reference to the mapped river corridor and fairway zones. This is represented in Figure 5[8] below:

[7] This is not an exhaustive list of activities but rather a high-level overview
[8] This diagram is taken from the Taieri River Morphology and Riparian Management Strategy document. It is a policy diagram used to show the management of river boundaries and land use on floodplain areas.

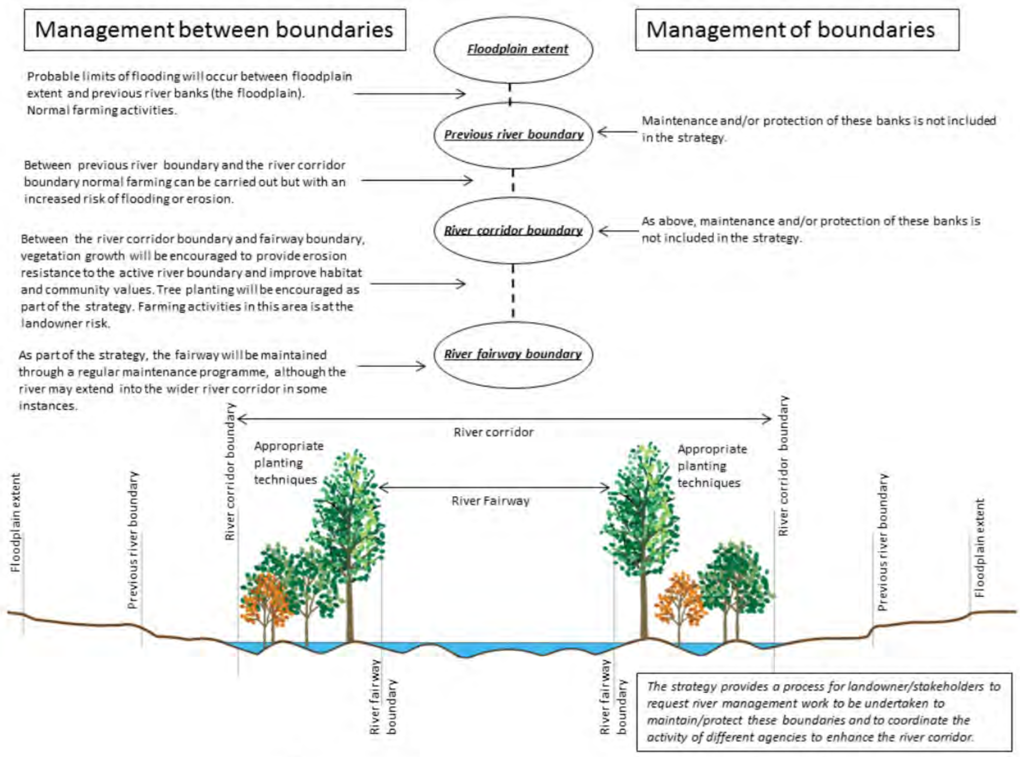


Figure 5: Diagram showing the fairway and corridor section where river management activities typically occur.

River Management Strategies

[28] The ORC has River Morphology and Riparian Strategy's (RMaRS) for the following rivers: Waianakarua River, Pomahaka River, Kakanui River, Taieri River and Shag/Waihemo Rivers (**attached**)[9]. These were developed during the period of 2016 to 2018 in consultation with stakeholders and the community and were formally approved by resolutions of Council. These documents are not statutory documents however they do represent best practice and the considerations of the respective communities and stakeholders.

[29] The strategies only reflect a portion of Otago's rivers and waterways and focussed on the priority areas at that time as directed by Council and community. In particular where there were tensions between those wanting to use rivers as low-cost sources of roading gravel and those wanting to keep rivers in a more natural state. The Strategies have helped balance these competing priorities and at the time brought the various stakeholders together to share their views on values and how the rivers should be managed.

[9] https://www.orc.govt.nz/plans-policies-reports/reports-and-publications/channel-morphology

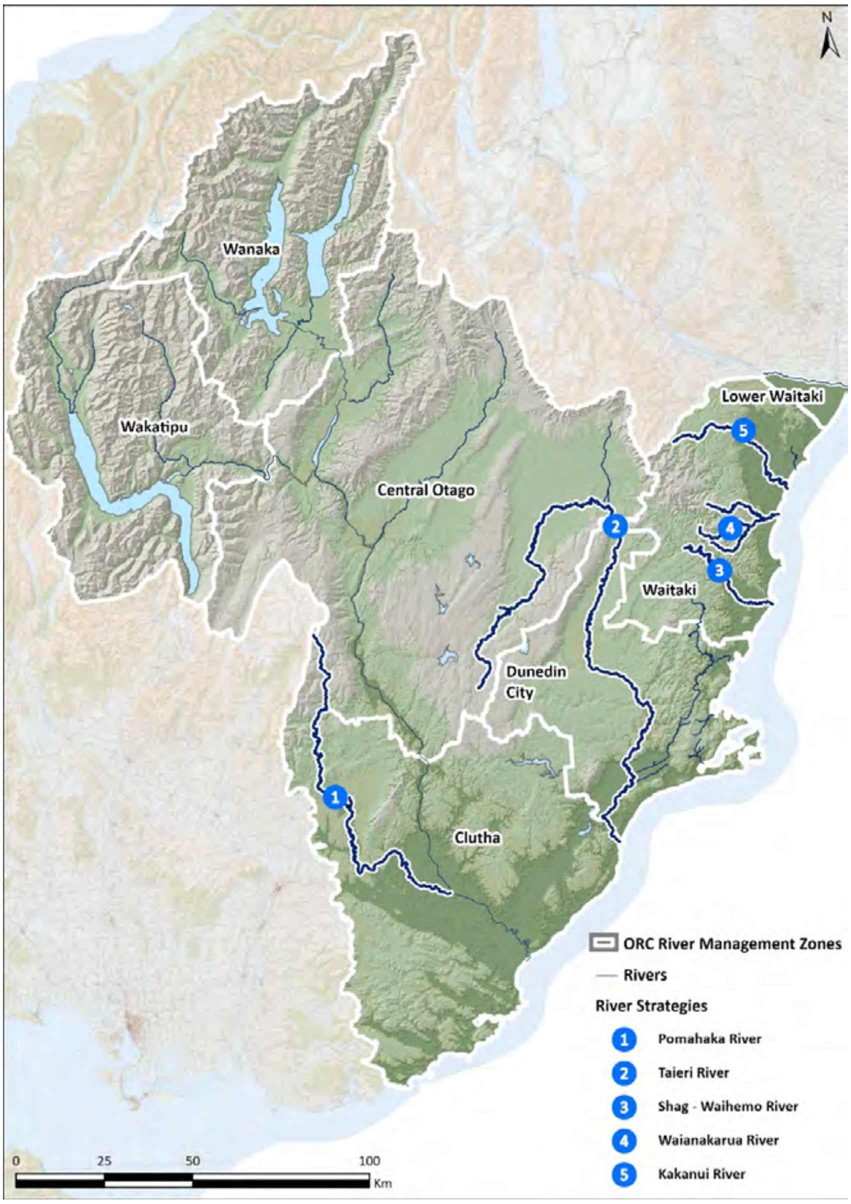


Figure 6: Map showing the location of the River Morphology and Riparian Strategy's and corresponding rivers.

[30] The current Long-Term Plan 2021 -2031 allows for the RMaRS to be reviewed and updated[10]. The principles around the river morphology and riparian strategy remain relevant. Allowance has been made in workstreams over Years 1, 2 and 3 for this work to commence.

[31] The review and update are a usual process with strategic documents. An extract from the "Pomahaka River morphology and riparian management strategy": *The strategy is intended to be a living document, which will evolve in response to new information, changes in the environment, the needs of the community, and the work of the ORC and other stakeholders. The strategy will be reviewed regularly, and this process will involve*

[10] Note update will require consultation with community and council and also involve internal stakeholders where relevant.

landowners with property alongside the river, other stakeholders, and ORC,2 and will help to set priorities and work programmes for all of these groups. The strategy document will also record progress made towards achieving the stated objectives. It is intended that version 2 of the strategy will include further guidance and plans for undertaking planting on riparian margins, for river management purposes, and for habitat enhancement.

[32] As part of their review, these River Morphology and Riparian Strategies will incorporate NPS-FM and te Mana o te Wai requirements and principles cognisant with best practice in river management of present day and future thinking.

[33] The update will include the development of relevant River Management Plans that cover the operational activities. The development of these Plans will further set out how river management activities provide a balance and strategic approach with rivers, especially with respect to river values and maintenance programs that align with integrated catchment management goals and with community expectations.

[34] The River Management Plans will belong to a suite of Asset Management Plans that were outlined in the Infrastructure Strategy 2021-2051[11]. Figure 7 shows the relationship and linkage between key council documents in relation to river management.

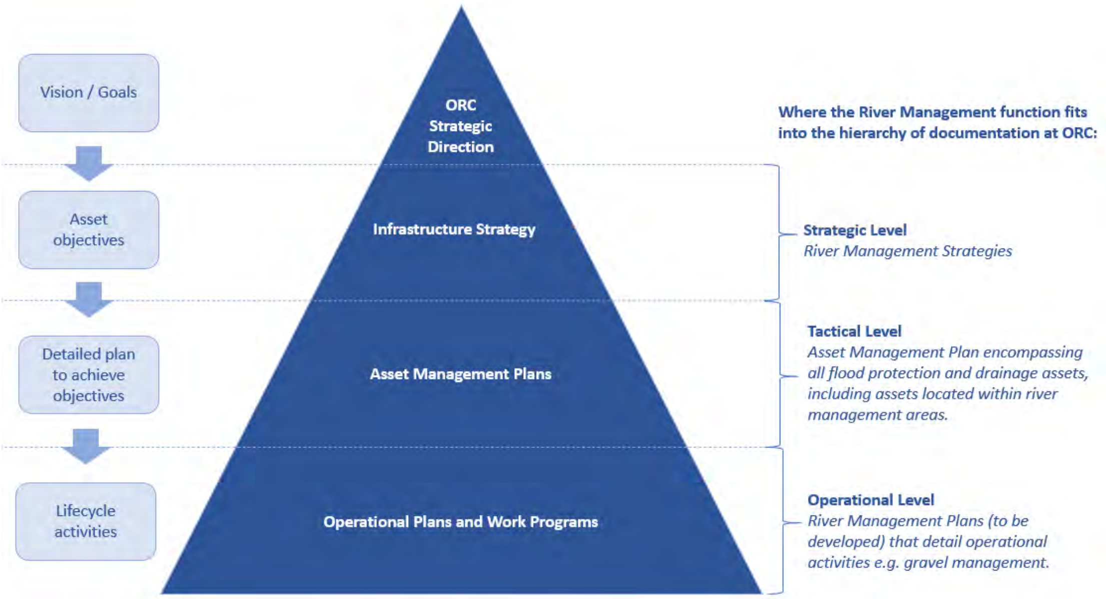


Figure 7: Extract from Infrastructure Strategy which shows the relationship between decision making and operational framework, with the addition of where the River Management function fits into the hierarchy of documentation.

DISCUSSION

[11] *Infrastructure Strategy for LTP 2021-31*, Report to 10 March 2021 meeting of the Implementation Committee, Report ENG2101, 1 March 2021.

River Management Reporting

[35] The Level of Service Statement for the River Management activity is "Maintain channel capacity and stability, while balancing environmental outcomes and recognising mana whenua values in rivers" (ORC Long-Term Plan 2021-2031). Figure 8 shows the performance measures and targets defined within this Level of Service Statement.

PERFORMANCE MEASURES	BASELINE RESULTS	2021/22 TARGET	2022/23 TARGET	2023/24 TARGET	2024-31 TARGET
Percentage of identified and reported issues that have been investigated and appropriate action determined and communicated to affected landholders within 20 working days	*2019-20: 100%*	100%	100%	100%	100%
Percentage of planned maintenance actions achieved each year	*New measure*	≥90%	≥90%	≥90%	≥90%

Figure 8: Performance measures and targets as defined in the ORC Long-term Plan 2021-2031.

[36] Performance to end of Quarter 2 for financial year 2021/22, in relation to communicating back to affected landowners on identified and reported issues within 20 working days, is summarised in Figure 9 below. 87% (41 out of 47) of identified and reported issues had been investigated and the appropriate action determined and communicated back to affected landowners within 20 working days. Of those queries responded to within 20 working days, the average response time was three working days.

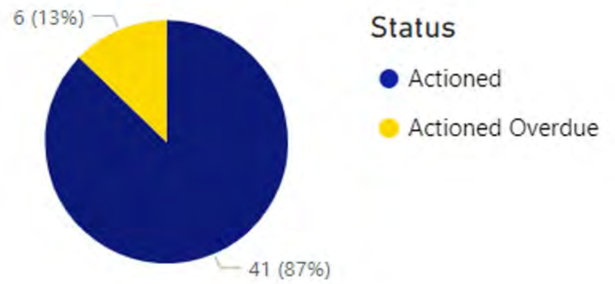


Figure 9: Status of performance to end of Quarter 2 FY 2021/22 for Performance Measure; Percentage of identified and reported issues that have been investigated and appropriate action determined and communicated back to affected landowners within 20 working days.

[37] 55% (26 out of 47) of customer queries received in Quarters 1 and 2 were in relation to concerns about sediment deposition or fallen trees blocking river channels or river mouths. 13% (6 out of 47) were received in relation to concerns about erosion. The remaining 15 enquiries were of a general nature about the functioning of rivers and coastal protection, with four of these directed to other ORC departments or a territorial authority to address.

[38] Six (6) reported issues in Quarters 1 and 2 were not recorded as being investigated and appropriate action determined and communicated back to affected landowners within 20 working days.

[39] Some overdue responses can be attributed to the development of Engineering's customer enquiries database and ongoing improvements in the record keeping process throughout Quarters 1 and 2. It is likely that responses were provided to affected landowners within the required 20 working day timeframe, however at the time of the quarterly reporting this was not able to be confirmed by staff. The issues raised in these six customer queries were assessed as not being a threat to life or property. Measures are in place to make further improvements to data accuracy in Quarter 3.

[40] Full resolution of a customer query often takes time to implement due to a range of factors that must be considered, including consent requirements, weather, design, or contractor availability. This performance measure therefore only measures the time taken to investigate any matters raised and communicate the appropriate action back to affected landowners. Full resolution of the enquiry then occurs when any required physical works have been completed.

[41] Performance to end of Quarter 2 for financial year 2021/22, in relation to percentage of planned maintenance actions achieved, is summarised is Figure 10 below. 36% of the river engineering workplans had been completed to date.

Figure 10: Status of performance to end of Quarter 2 FY 2021/22 for Performance Measure: Percentage of planned maintenance actions achieved each year.

[42] The commencement of the nationwide Level 4 Covid-19 lockdown on 18 August 2021, and subsequent restrictions, delayed the river management work programme. Critical tasks were prioritised, and plans are in place to catch up on any delayed works or inspections.

[43] River levels were also high throughout Quarter 2 and resulted in the delay in the majority of planned works within the riverbed. These works have been re-scheduled for Quarter 3.

Update on Committee Resolutions

[44] At the Implementation Committee meeting held on 8 September 2021 three (3) resolutions were made to do with river management as follows:

a. Include details on progress on gravel extraction consents in regular quarterly reporting to the Implementation Committee.
b. Include information on development of work programmes for the 2022/23 and subsequent annual plans for river management in regular quarterly reporting to the Implementation Committee.

c. Present a staff report detailing timeframes and process to better develop asset management plans for plantings alongside riverbanks.

[45] These matters have been addressed in the Quarterly Reports attached. Additional detail is set out below addressing each resolution specifically.

Details on progress on gravel extraction consents in regular quarterly reporting to the Implementation Committee.

[46] This section discusses the resolution relating to gravel extraction. This includes discussion around gravel source and process to provide an understanding of the natural process of gravels in rivers.

Gravel source and process

[47] Rivers transport sediment (including gravel) that is produced by erosion in their catchments and channels. It is a natural process. The amount of gravel entering a river system depends on the area and topography of the catchment, rock type and geological history, climate (rainfall, wind, temperature variation), physical phenomena such as earthquakes, and vegetative cover.

[48] In the cycle of rivers natural behaviours (and including artificial interventions such as damming) transported gravel is deposited. The distance it is transported before being deposited depends on particle size and water velocity. The coarser material is deposited in the riverbed where the river changes grade, often where it emerges from the hills onto the plains. As the river grade flattens, its velocity decreases, and it deposits progressively finer material. **Particles are carried out to the coast where they form an important source of material for coastal processes.**

[49] During floods, gravel that has been previously deposited can be reworked from the riverbed or eroded from its banks and transported by floodwater further downstream. The transport of gravel through the river system, therefore, is typically complex, as the riverbed itself is a storage area/supply source.

[50] As gravel is deposited in the bed and on the inside of river bends, the river erodes its banks and gradually changes course. All rivers change course. Where they flow through hard rock the changes are negligible; where, however, they flow through alluvial deposits the changes can be very large. In these places the river course can change dramatically every time it floods.

[51] Some rivers are actively being fed with material from erosion in their catchments. Excessive supply of material to rivers from such erosion will also cause bank erosion. In this situation the beds build up with deposits on the river beaches and this can result in the formation of gravel islands. This in turn can cause the direction of the river flow into the banks which further increases erosion. Thus, a cycle of riverbank erosion can be initiated by excessive erosion in the catchment.

[52] In other rivers there is no measurably significant source of supply and the gravel that exists in the bed has either been there for a very long time or it is being supplied from the bed and banks upstream.

[53] If gravel is removed from a riverbed the river, through natural processes will try to re-establish the same grade by eroding the adjacent banks. Unless material is supplied quickly enough from the catchment, the upstream bed will erode. As soon as the bed upstream is lowered more bank erosion will occur and the effect can be transmitted for some distance upstream.

[54] Furthermore, when a riverbed is lowered, the channel can carry more water when the river is flowing bank full. The resulting increased energy will make bank erosion more likely. Eventually a reasonable equilibrium may be re-established with the bed once again at its old grade, but the river channel may have changed significantly by that time. In the absence of a sufficient supply of gravel from the catchment, equilibrium is likely to be re-established through increased bank erosion.

Reasons for gravel extraction

[55] Typically, gravel is excavated from rivers for primarily two (2) reasons: river management and private/commercial use.

[56] Gravel extraction for river management traditionally considers the following aspects:

a. Reducing gravel supply to the river.
b. Relocating gravel from aggrading reaches to those parts of the river that are eroding or degrading.
c. Controlling river location, flood flows and bank or bed erosion through the use of flood banks, protection structures and vegetative buffers.
d. Increasing gravel transport through the river.
e. Removing gravel directly from the river system.
f. Protection of flood protection assets.

[57] The above aspects must take into consideration along with the natural system, the natural processes, and the objectives of te Mana o te Wai. Gravel extraction needs to be a consideration of the whole of the effect on the natural system, therefore when we consider gravel extraction facilitated or managed by ORC, the reasons must have the appropriate risk to benefit ratio assessed within current legislative requirements.

Progress with gravel extraction

[58] As noted above, ORC (Operations, Engineering) does not hold gravel extraction consents.

[59] The Operations, Engineering function recognises across the region that there are concerns at levels of gravel aggradation in some rivers. There has been a request through communities that the ORC will facilitate and manage gravel extraction in some rivers where the aggradation appears exacerbated.

[60] The factors contributing to the Operations, Engineering function being requested to facilitate gravel extraction are summarised as follows:

a. Landowners are of the view that the process to obtain a consent is a barrier to the quick removal of gravel,
b. The gravel aggradation is contributing to increased flooding and erosion effects, and
c. The landowners want to have input into the areas of gravel extractions.

The above factors are not exhaustive and only represent a common theme across engagement with communities.

[61] For the ORC's Operations and Engineering Function to incorporate gravel extraction into its responsibility and management a stepped process needs to occur. This means, that there are two (2) mechanisms to facilitate gravel extraction controlled and managed by the ORC as follows:

a. The Otago Regional Plans (permitted activity rules), and
b. Resource Consent (global consents).

[62] With the review of the Otago Regional Plans currently in progress, consideration will be given to reviewing the current permitted activity rules to assess whether revision is relevant, along with the development of a Gravel Management Strategy.

[63] It is the intention through this long-term plan cycle to investigate a longer-term solution to gravel management as described in para [61]. The timeframe to investigate this proposal will be during Year 2 of the 2021-31 Long Term Plan, as it will proceed after the completion of the renewal of the global consents.

[64] Gravel extraction for hazard mitigation has been included in the current consent application and the supporting Environmental Management Plan.

[65] The update on the progression of the global consents is included in the attached Quarterly Reports, and summarised by Figure 11 below:

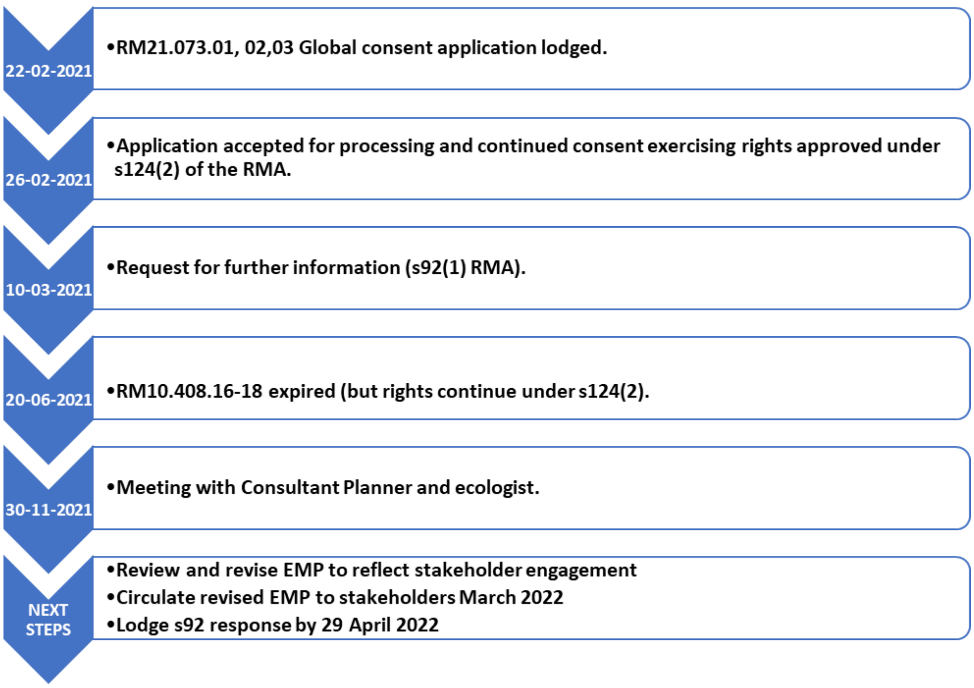


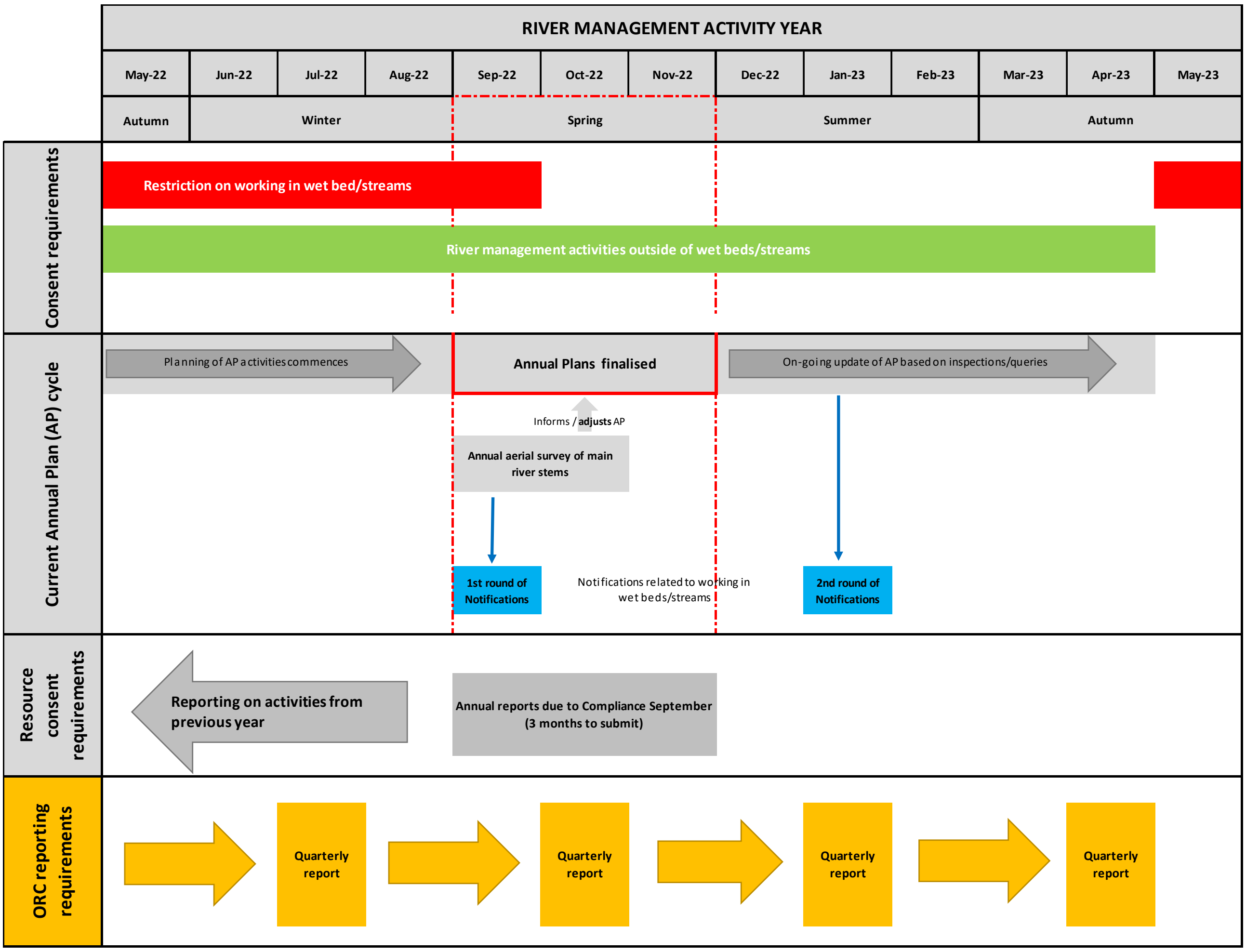
Figure 11: Summary of Global Consent renewal

<u>Information on development of work programmes for the 2022/23 and subsequent annual plans for river management in regular quarterly reporting to the Implementation Committee.</u>

[66] The development of work programmes in the river management area current relies on; ground inspections, annual aerial surveys, staff knowledge of known areas of concern/issue and the reporting of concern/issues from landowners, territorial authorities and others.

[67] The Operations, Engineering function has been taking a proactive approach in improving the development of the planning of river management activities since FY2019/2020. The approach has been a staged approach which firstly required an understanding of the interrelationship with the activities undertaken and requirements of the resource consents held.

[68] The resource consents provide the framework in which the planning and reporting has a baseline relationship to. This is largely due to the resource consents requiring annual reports in September. The planning cycle for river management activities is shown in Figure 12.



NOTES: Spring is a key seasonal window for river management planning. It allows rivers and waterways to be viewed without vegetation cover
River management activities IN WET BEDS/STREAMS means activities such as gravel alignment, channel reshaping, redistributing gravels.
River management activities OUTSIDE OF WET BEDS/STREAMS means activities such as erosion control, vegetation maintenance.

Figure 12: Summary of River Management 'Year', Planning and Reporting cycles

[69] The delivery of planned river management activities is dependent on several factors, which are expectantly related to a natural environment. The factors that influence the delivery of planned activities include:

a. Weather. Wet weather can cause access issues and impact the suitability of the natural environment for intervention.
b. River levels. River levels fluctuate throughout the year depending on seasons and rainfall events. These can be localised or more widespread depending on the nature of the event.
c. Land access. Access to areas of works is also determined by weather. As most locations are remote and across landowners' property, access is an active communication process to ensure all parties are aligned.
d. Stakeholder approvals. Approvals to carry out works may be subject to scrutiny by stakeholders and take time to reach an agreeable outcome.
e. Seasons. Working in a natural environment subjects work programs to specific set of availability around some work activities. For example, willow pole planting occurs during winter.
f. Resources internal. Staffing resources have been an issue since FY2019/2020. This places a strain on the engineering team to provide appropriate response across Otago for planned and unplanned activities.
g. Resources external. Contracting resources to complete activities across the region are becoming strained with their own capabilities to complete workloads and retain staffing levels.
h. Unplanned activities. During quarters 1 and 2 of the current FY2021/2022, 62 enquiries were responded to which included action required to address.
i. Flood events. Flood events cause disruption to all business-as-usual activities and require reassessment and reprioritisation of resources and work streams to respond to the event.
j. Other restrictions. Covid19 has since 2020, introduced an unprecedented set of challenges to workflow continuity.
k. Diversion of resources to new, unplanned work.

[70] To manage the risks and constraints outlined above the Operations, Engineering team has been adapting work programs where possible to address priority works. Priority activities are those activities that pose an imminent risk to the environment, people, or property.

[71] Development of the framework mentioned in para [41] will allow for planning to be long-term based and consistent with integrated catchment management (ICM) principles. ICM is being delivered through the development of catchment action plans (CAPs) and aligning river management plans with CAPs will enable key river management activities to contribute to the objectives of environmental and community expectations and outcomes.

[72] To achieve maturity in how river management activities are planned and carried out which interrelate to ICM and the community, the steps and processes outlined in this paper will require development. The development of this framework described above will continue to occur in Years 2 and 3 of the Long-Term Plan 2021 – 2031.

<u>Present a staff report detailing timeframes and process to better develop asset management plans for plantings alongside riverbanks.</u>

[73] ORC's Infrastructure Strategy 2021-2051 states that there are some tree and vegetation assets located within our flood protection schemes and river management areas that have not been fully captured in ORC's Asset Management Information System (AMIS).

[74] Trees or vegetation are considered an asset where they have been planted by Engineering to stabilise a riverbank. These specific types of plantings assist in minimising lateral erosion and help to maintain river or channel alignment. There are two main types of edge protection that are deployed across the Otago region for this purpose:

a. Standard edge protection – Trees that have been planted along a riverbank or channel as a buffer to help stabilise the bank or channel edge.
b. Anchored or tied tree protection – Trees that have been planted more densely and tied together using wire rope that has been anchored in place, providing a stronger and more continuous structure to assist in buffering flows.

Both types of edge protection may also be used in combination where standard edge protection is planted as a buffer, either in front or behind, a line of anchored or tied tree protection.

[75] Some plantings may hinder the ability of a waterway to convey water during high flows, contributing to greater erosion or direct a river on an unintended path. These types of plantings are monitored and often removed at the appropriate time. Trees of this nature are not deemed to be assets and as such are not recorded in ORC's AMIS.

[76] A significant programme of work is underway to capture data pertaining to trees and vegetation that have been planted, or are being maintained, as assets by Engineering for the purpose of providing edge protection. Initially this involves the Operations Engineering staff recording the location of trees and vegetation that are deemed to be assets as they work through their annual work programme. This information will then be translated into ORC's AMIS database and GIS.

[77] Collecting and adding data to ORC's asset management database is an iterative process that, as for all ORC flood protection and drainage assets, requires ongoing work to maintain and improve the quality of data available. It is anticipated that it will take 12-24 months to collect base levels of data on tree and vegetation assets. Within this timeframe Engineering also expects to begin mapping the nuisance trees for the purpose of developing work programmes. Maintaining and increasing the level of confidence in this data will be an iterative process that continues indefinitely.

[78] Ongoing improvements are being made in the process for the collection, addition and maintenance of asset management data for GIS and ORC's AMIS. Efficiencies in this process are highly likely to be developed as work progresses and the timeframe for collecting data may reduce as a result.

[79] As depicted in Figure 7, Engineering is in the process of finalising the structure for a suite of asset management documentation that clearly defines the purpose of each document at a tactical and operational level for both engineering and river management activities.

[80] At a tactical level it has been identified that the current practice of maintaining an Asset Management Plan per flood protection or drainage scheme is no longer appropriate due to the repetitive nature of the information across the existing scheme documents and the similarities in how asset management principles are applied across the same types of assets across each scheme or river.

[81] Engineering is due to commence the process of compiling one Asset Management Plan to cover all engineering assets identified within schemes and rivers across Otago. This is more in keeping with the type and scale of assets that ORC manages, as well as the size of the team that manages them. It is anticipated that the draft Asset Management Plan will be completed this financial year.

[82] Information on assets within specific schemes or rivers will still be available by scheme or river within the Asset Management Plan despite only one document being created and maintained.

[83] Current records of tree and vegetation assets will be used to develop the relevant section/s of the Asset Management Plan. This will identify areas where data confidence and reliability could be improved, particularly around tree and vegetation asset data where it is known that the data in ORC's AMIS needs improvement.

[84] The review period for the Asset Management Plan will be shortened to two years to enable ORC to incorporate data from its targeted approach to collecting tree and vegetation asset data over this time period, and subsequently demonstrate a greater degree of confidence and reliability in this information moving forward. Further reviews will be carried out as part of a routine schedule alongside the broader suite of asset management documentation, including the asset management system and processes.

[85] Asset management is a journey for every organisation and the ongoing review of ORC's asset management system, including the Asset Management Plan, are a must for improving and maintaining confidence in the information recorded. This information is pertinent to decision making that affects the Long-term Plan and Infrastructure Strategy.

River management resources

[86] The resources for river management are currently located in Dunedin and Central Otago. The coverage provided by the resources is shown below in Figure 13.

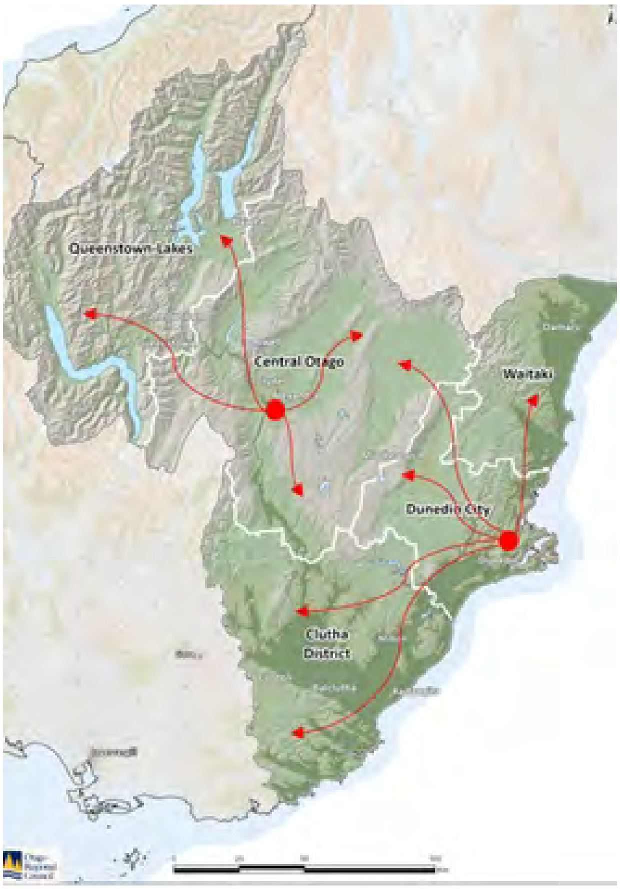


Figure 13: Operations, Engineering Team resource locations (Alexandra and Dunedin) as of February 2022

[87] The development and progression of ORC's River management function relies on resources as well as the framework around plans and processes.

CONSIDERATIONS

Strategic Framework and Policy Considerations

[88] The effective delivery of river management contributes to community resilience to natural hazards, which is a key component to ORC's vision for Otago.

[89] There are no policy considerations associated with receiving this report.

Financial Considerations

[90] There are no financial considerations associated with receiving this report.

[91] If Council recommend further consideration of one or more matters outlined in this report, there will be a financial consideration, and this would need to be considered under separate Council approval.

Significance and Engagement Considerations

[92] No considerations arising from this paper.

Legislative and Risk Considerations

[93] No considerations arising from this paper.

Climate Change Considerations

[94] There are no climate change considerations with receiving this report.

Communications Considerations

[95] There are no climate change considerations with receiving this report.

NEXT STEPS

[96] Provide Quarter 3 report to the Implementation Committee

ATTACHMENTS

1. River Management Quarter 1 Report 2021 FINAL [**7.1.1** - 14 pages]
2. River Management Quarter 2 Report 2021 Final [**7.1.2** - 17 pages]
3. Kakanui River Morphology and Riparian Management [**7.1.3** - 100 pages]
4. Shag.Waihemo River Morphology and Riparian Management Strategy (current) [**7.1.4** - 2 pages]
5. 2018 Shag.Waihemo River Morphology and Riparian Management Strategy [**7.1.5** - 108 pages]
6. Waianakarua River Morphology and Riparian Management Strategy (current) [**7.1.6** - 2 pages]
7. 2018 Waianakarua River Morphology and Riparian Management Strategy [**7.1.7** - 99 pages]
8. Taieri River Morphology and Riparian Management Strategy 2016 [**7.1.8** - 92 pages]
9. Pomahaka River Morphology and Riparian Management Strategy 2016 [**7.1.9** - 68 pages]
10. Extracts from Soil Conservation and Rivers Control Act 1902 [**7.1.10** - 7 pages]

Otago Regional Council

Objective Reference No.:

Quarter 1 Report FY2021/2022

July 2021, August 2021, and September 2021

River Management

Otago Regional Council

Objective Reference No.:

Context of Report

This report is a non-financial summary of the completed work streams undertaken by Engineering across the rivers of Otago.

The information provided in this report is based on planned[1] and unplanned activities, and the progress achieved through metrics provided from various sources of current recording and measuring.

The reporting is set out under the following sections:

1. Contracts and Procurement Update
2. Customer Enquiries
3. Community Engagement
4. **Response to Issues**
5. **Planned Maintenance**

Levels of Service

6. Council Resolutions
7. Coastal Mouths
8. Capital Projects Update
9. River Management global consent
10. Photos

Information Sources

The information contained in this report is sourced from:

- Operations and maintenance plans and records (excel databases, pump station data),
- Global consent records (excel database and Objective),
- Customer enquiry records (excel database),
- Procurement transactions (IPOS),
- Corporate Services reporting systems (Opal),
- Asset management (ConQuest),
- Water online information, and
- Project delivery records.

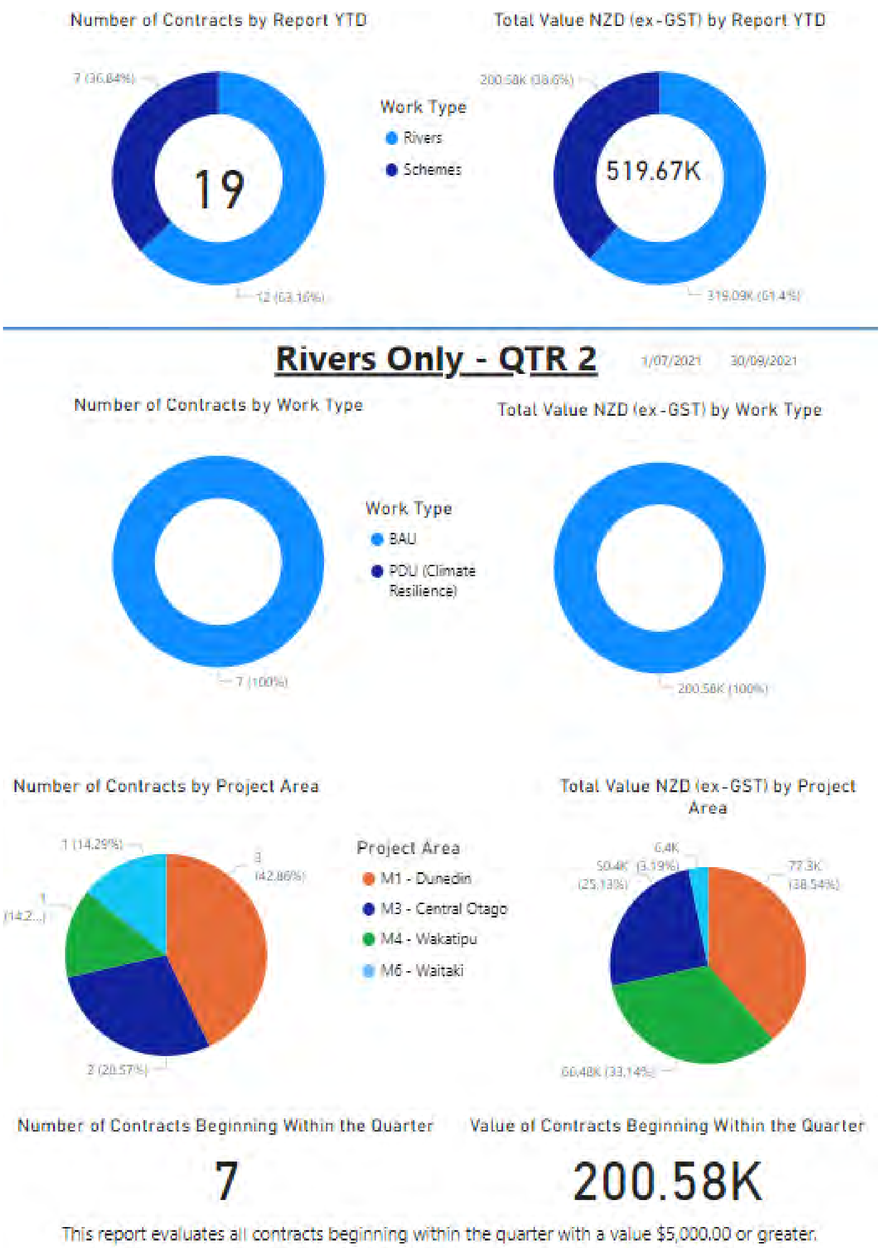
The systems that support these records are currently a combination of Objective for records, ConQuest and relevant financial systems.

[1] Planned activities are currently those known activities that are undertaken as set out in the Long-Term Plan (2021-2031), and as outlined in respective Scheme operating manuals.

Otago Regional Council

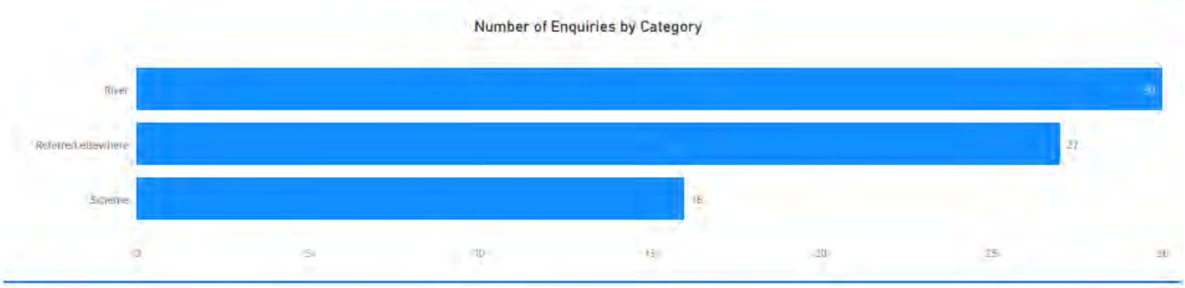
Objective Reference No.:

1. Contracts and Procurement Update

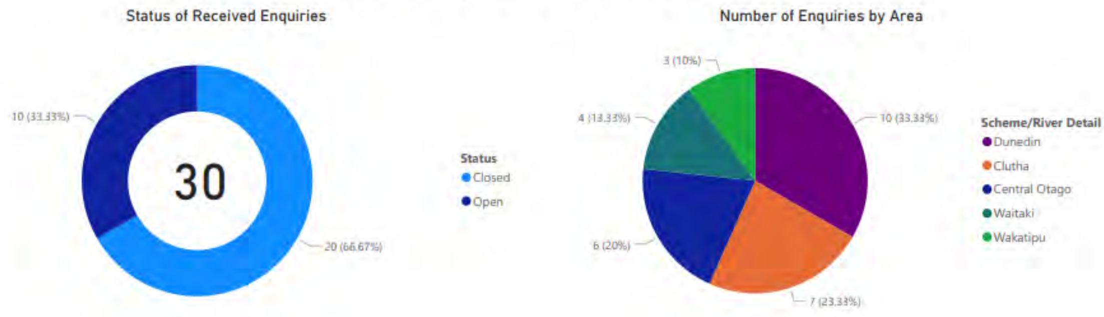


Objective Reference No.:

2. Customer Enquiries



River Enquiries Breakdown



Objective Reference No.:

3. Community Engagement

While no specific community engagement sessions have been held in relation to Engineering's monitoring and maintenance of our natural rivers, the team has been active in attending other meetings in the community and has been visible on worksites across Otago.

Planned community engagement involving river management staff this quarter:

- Straith/Taieri Community board meeting – 30 September 2021

Otago Regional Council

Objective Reference No.:

4. Response to Issues

Performance Measure: *Maintain channel capacity and stability, while balancing environmental outcomes and recognising mana whenua values in rivers.*

Target: *100% of identified and reported issues that have been investigated and appropriate action determined and communicated to affected landholders within 20 working days.*

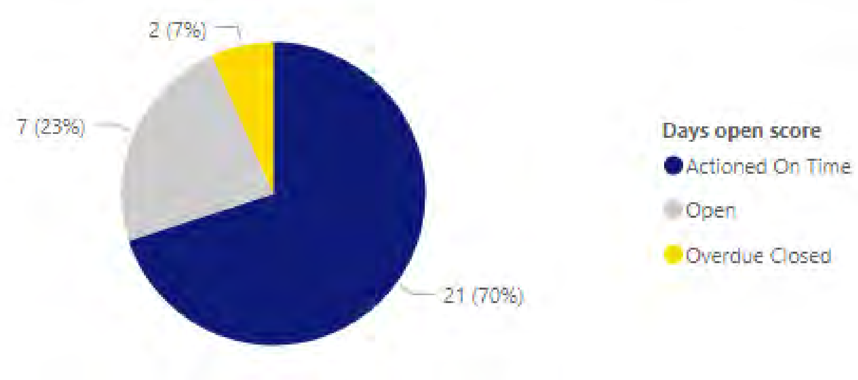


Figure 1 No. of customer issues by status. Overdue equates to an enquiry being open for greater than 20 working days.

Data for this measure is currently limited to the customer enquires database only. Work is underway to include the wider scope of issues that the river engineers respond to daily. Detail for all enquires is available via Engineering's issues database upon request. This system database is still under development and some of the overdue scores can be attributed to system development not necessarily reflecting the customer response times for action.

There were two issues which were responded to outside the target (extract from database below). They were assessed as low risk, and the response for the Alexandra issue was also subject to access to the site. The Dunedin issue did not require action.

No	Naming Convention	Open/Closed	Date Received	Closed	Time taken to respond (< or = 20 days target)	Territorial Authority	Scheme/River
Eng259	210709 33 Marshall Road, Alexandra	Closed	9/07/2021	30/09/2021	60	Central Otago	River
Eng284	210809 Green Island Stilling Basin	Closed	9/08/2021	12/09/2021	25	Dunedin	River

Otago Regional Council

Objective Reference No.:

5. Planned Maintenance

***Performance Measure:** Maintain channel capacity and stability, while balancing environmental outcomes and recognising mana whenua values in rivers.*

***Target:** 90% of planned maintenance actions achieved each year.*

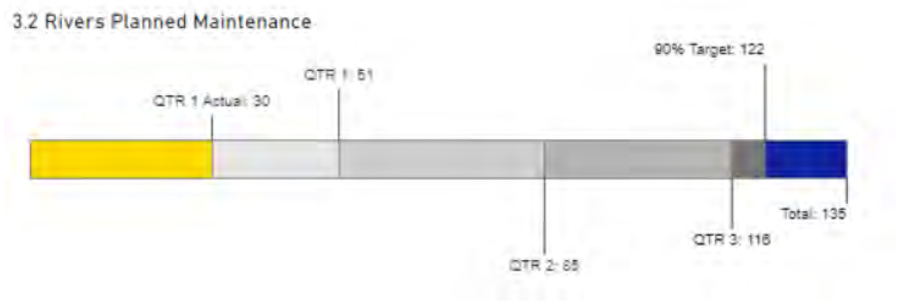


Figure 2: Progress of planned activities

Quarter 1 shows that 30 planned activities were completed from the river engineering workplans.

With the nationwide level four Covid-19 lock down on 18th August and subsequent restrictions, the team was unable to complete all planned tasks for the quarter. Critical tasks were subsequently prioritised, and plans are in place to catch up on any delayed works or inspections.

Annual helicopter inspections were completed across Otago, with any problems identified being added to the programme on a prioritisation basis. The annual survey provides input into the setting of the annual work plan activities.

River flow and weather warnings

Peak River Flow Rates During Quarter

River/location	Quarterly Peak Flow Rate m^3/s	Date	First Warning Level
Arrow @ Cornwall	53.61	6/07/2021	-
Shotover @ Bowens	323.02	6/07/2021	508
Kawrau @ Chards	552.38	13/09/2021	1200
Dart @ Hilllocks	726.79	12/09/2021	1450
Silverstream @ Gordon Rd	7.09	7/07/2021	65
Taieri @ Sutton	68.99	13/09/2021	100
Waiporti @ Berwick	32.201	14/07/2021	-
Lindsay @ North Road	3.76	16/07/2021	51
Clutha @ Cardrona confluence	427.94	6/08/2021	600
Clutha @ Clyde	1179.75	13/09/2021	3450
Clutha @ below Roxburgh	1087.42	14/09/2021	1548
Pomahaka @ Glenken	105.625	13/09/2021	86
Kakanui @ Clifton Falls Bridge	18.31	7/07/2021	50

Otago Regional Council

Objective Reference No.:

Highted figures indicate flows above warning level

Number of Met service heavy rain warnings

July: 1
August: 2
September: 5

6. Council Resolutions (Notice of Motions, NOM)

The following section details progress against the following resolutions made by Council during an Implementation Committee Meeting on 8 September 2021 (Res IMP21-115).

Include details on progress on gravel extraction consents in regular quarterly reporting to the Implementation Committee.

The renewal of ORC's Global Consent is currently in progress. ORC (Engineering) has submitted an application (February 2021) and the Environmental Management Plan (EMP) is being developed to enable the application assessment to be completed.

Affected Parties (Fish and Game, Department of Conservation, Iwi, Waka Kotahi, territorial authorities etc.) have been consulted. A meeting is scheduled with affected parties for November 2021.

The new Global Consent includes provision for gravel management (extraction) related to flood protection/hazard requirements only and for non-commercial use. The new Global Consent is for a term of five years.

Include information on development of work programmes for the 2022/23 and subsequent annual plans for river management in regular quarterly reporting to the Implementation Committee.

Development of work programmes for 2022/2023 will commence in Quarter 3 and 4 of the current Annual Plan.

Present a staff report detailing timeframes and process to better develop asset management plans for plantings alongside riverbanks.

All river management plantings are recorded by staff on maps, in hard copy or electronic format. The current Annual Plan will see the recording of information transferred into relevant GIS layers and ORC's asset management software, where relevant. The timing to update the previous years of river management planting maps will occur over Year 1 and Year 2 of the current Long-Term Plan.

Otago Regional Council

Objective Reference No.:

7. Coastal Mouths

Please note that coastal mouth opening is not an activity that is associated with Engineering's current performance measures.

Figure 3 Number of Coastal Mouths openings during quarter 1

Comment: No coastal mouth openings in the Clutha district during Quarter 1.

Otago Regional Council

Objective Reference No.:

8. Capital Projects

Note that there are no performance measures associated with capital works projects for the rivers across Otago. This performance measure is applied only to the flood protection and control works (refer to 'Flood Protection and Drainage Schemes' report).

The below table reports on project progress year to date.

Project Name	Project Status	Planned Status by Year End	Progress	Exception Progress Notes
Roxburgh - Reservoir Creek Debris Trap Cleaning	Scoping	Project Completed	●	
Rees/Dart - Gravel Management	Not Started	Scoping	●	
Albert Town Bathymetry	Not Started	Project Completed	●	
Lower Waitaki Designation Review	Concept Design	Project Completed	●	

● On track ● Project delays ● Planned status not achievable by year end

Otago Regional Council

Objective Reference No.:

9. River Management Global Consent Update

Engineering performs its activities under a Global Consent which applies across Otago's waterways, as per the summary in Figure 3.

Activities cannot be performed within waterways from May through to September annually, unless express approval and/or emergency works are required in accordance with the RMA.

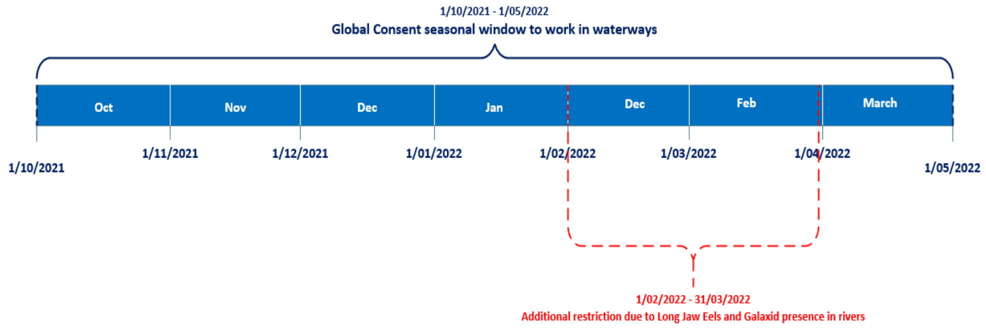


Figure 3: Global Consent summary of when working in waterways can occur annually.

Global Consent application (renewal) summary as of 30th September 2021	
Date	**Action**
22 February 2021	RM21.073.01, 02,03 Global consent application lodged.
26 February 2021	Application accepted for processing and continued consent exercising rights approved under s124(2) of the RMA.
10 March 2021	Request for further information (s92(1) RMA).
20 June 2021	RM10.408.16-18 expired (but rights continue under s124(2).

NEXT STEPS	• Receive comments from Aukaha, Department of Conservation (received) and Fish & Game (following 11/11/21 meeting). Due by 26/11/21.
	• Review and alter EMP to reflect stakeholder engagement (including email discussions with Waka Kotahi and Heritage NZ).
	• In relation to gravel extraction: add in examples and thresholds
	• Engagement with Consultant Planner and his ecologist on 5/11/21 information.
	• **The expectation is to:**
	  ▫ **have undertaken discussion between the ecologists by 23 December2021.**
	  ▫ **circulate the revised EMP to stakeholders in January 2021.**

Otago Regional Council

Objective Reference No.:

Global Consent application (renewal) summary as of 30th September 2021	
Date	**Action**
	▫ **then lodge our s92 response following.**

Explanation of "Gravel extraction for hazard Mitigation" included in the EMP and Consent.
Gravel extraction is a method for managing flood and bank erosion hazards by maintaining and increasing the flood carrying performance of river channels. Management of the gravel and vegetation within riverbeds can enhance channel stability, channel alignment, and reduce the risk of flooding and damage to key infrastructure, people and property. Gravel extraction in this context: - is used as a last resort method only, and is used when other methods, such as re-distributing gravel are no longer possible, due to the sheer volume of gravel in the bed. - will not be for commercial purposes, with all extracted material donated to, and used in the community from which it came. - the total volume of gravel extracted per event [2] is unlikely to exceed 50,000 cubic metres. The principles defining gravel extraction include: • Recognising and protecting the natural character of riverbeds • Considering habitat and morphologic diversity • Minimising works within flowing water • Minimising discharges of sediment or contaminants • Mitigating/avoiding effects of activities on native bird breeding and associated habitat • Mitigating/avoiding effects on activities of fish spawning migration and habitat • Recognising the sensitivities of archaeological or historic sites • Recognising rivers ecological values • Being aware of and responding to social, cultural, and spiritual values • Being aware of and responding to recreational activities • Consider existing infrastructure in, on along or over the riverbed • Recognising and considering emergency contingencies • Mitigating against transfer of aquatic pests • Consider the natural replenishment rates • Managing flood and erosion risks

[2] Event is defined as the requirement for the gravel extraction in accordance with the EMP and notification submitted.

Otago Regional Council

Objective Reference No.:

Explanation of "Gravel extraction for hazard Mitigation" included in the EMP and Consent.
Areas that the ORC have identified as riverbeds that may require gravel extraction for managing flood and erosion risks are: • Pomahaka River; • Kauru River; • Strath Taieri River; • Lower Taieri within the Lower Taieri Flood Protection Scheme; • Kakanui River; • Clutha/Mata -Au River; and • Silver Stream.

Objective Reference No.:

10. Photos

Figure 4 Manuherekia River, Leasks Bend before work took place

Figure 5 Manuherekia River, Leasks Bend after realignment and commencement of planting of willows.

Otago Regional Council

Objective Reference No.: A1602309

Quarter 2 Report FY2021/2022

October 2021, November 2021, and December 2021

River Management

Otago Regional Council

Objective Reference No.: A1602309

Context of Report

This report is a non-financial summary of the completed work streams undertaken by Engineering across the rivers of Otago.

The information provided in this report is based on planned[1] and unplanned activities, and the progress achieved through metrics provided from various sources of current recording and measuring.

The reporting is set out under the following sections:

1. Contracts and Procurement Update
2. Customer Enquiries
3. Community Engagement
4. **Response to Issues**
5. **Planned Maintenance**
6. Council Resolutions
7. Coastal Mouths
8. Capital Projects Update
9. River Management global consent
10. Notifications
11. Provision for gravel management (extraction) for hazard mitigation
12. Photos

Levels of Service (items 4 and 5)

Information Sources

The information contained in this report is sourced from:

- Operations and maintenance plans and records (excel databases, pump station data),
- Global consent records (excel database and Objective),
- Customer enquiry records (excel database),
- Procurement transactions (IPOS),
- Corporate Services reporting systems (Opal),
- Asset management (ConQuest),
- Water online information, and
- Project delivery records.

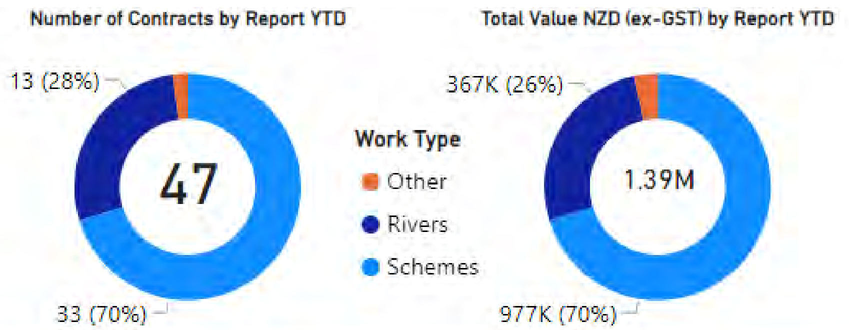
[1] Planned activities are currently those known activities that are undertaken as set out in the Long-Term Plan (2021-2031), and as outlined in respective Scheme operating manuals.

The systems that support these records are currently a combination of Objective for records, ConQuest and relevant financial systems.

Otago Regional Council

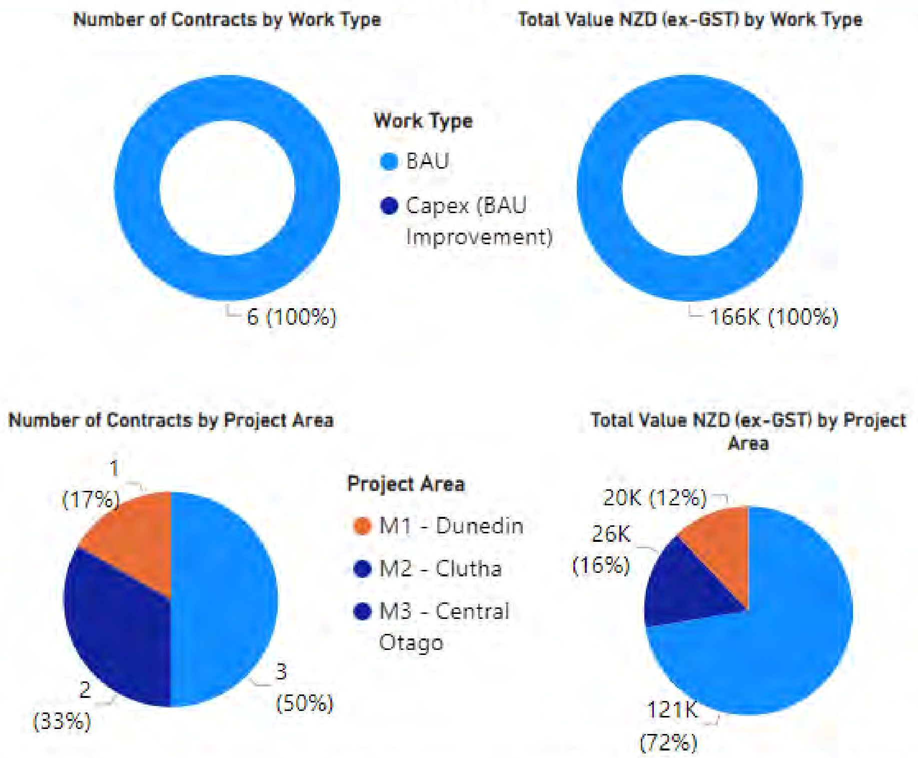
Objective Reference No.: A1602309

1. Contracts and Procurement Update



Rivers Only - QTR 2

1/10/2021 31/12/2021



Number of Contracts Beginning Within the Quarter	Value of Contracts Beginning Within the Quarter
6	166.42K

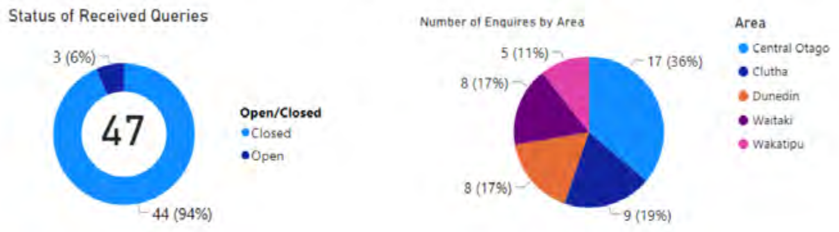
This report evaluates all contracts beginning within the quarter with a value $5,000.00 or greater.

Otago Regional Council

Objective Reference No.: A1602309

2. Customer Enquiries

River Enquiries Breakdown for QTR 2



Open queries for Quarter 2 consist of:

ID	Date Received	Location	Details
ENG 299	21/12/2021	Start Street, Palmerston	Blocked drain behind property/neighbours.
ENG 317	20/9/2021	Kurinui Creek	Proposal from Waka Kotahi to undertake gravel extraction at this location.
ENG 325	1/12/2021	Gilligan Street, Waitaki	Concerns about land subsidence due to waterway.

Otago Regional Council

Objective Reference No.: A1602309

3. Community Engagement

No specific community engagement sessions have been held in relation to Engineering's monitoring and maintenance of our natural rivers this quarter, however the team has been active in attending worksites across Otago and engaging with individual stakeholders to respond to issues.

Otago Regional Council

Objective Reference No.: A1602309

4. Response to Issues

***Performance Measure:** Maintain channel capacity and stability, while balancing environmental outcomes and recognising mana whenua values in rivers.*

***Target:** 100% of identified and reported issues that have been investigated and appropriate action determined and communicated to affected landholders within 20 working days.*

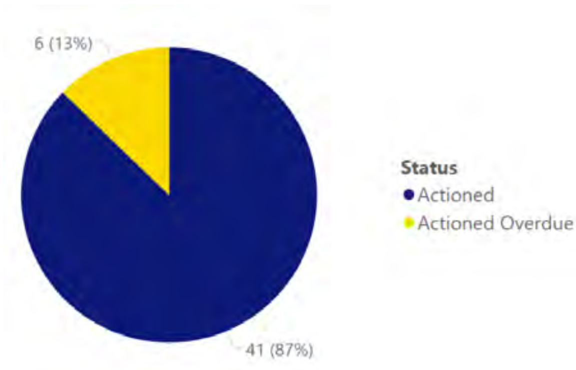


Figure 1 No. of customer issues by status. Overdue equates to an enquiry being open for greater than 20 working days.

Data for this measure is currently limited to the customer enquires database only. Work is underway to include the wider scope of issues that the river engineers respond to daily. Detail for all enquires is available via Engineering's issues database upon request.

To date there are six issues which were responded to outside the target.

ID	Date Received	Location	Details
ENG 278	8/9/2021	Takakopa Valley Road, Catlins	Discussions regarding management of creek through back of callers property.
ENG 284	12/9/2021	Green Island	Green Island Stilling basin concrete panel concerns.
ENG 289	17/9/2021	Bowlers Creek, Evans Flat	Willows fallen into Bowlers Creek, flooding concern.
ENG 299	21/12/2021	Start Street, Palmerston	Blocked drain behind property/neighbours.
ENG 325	1/12/2021	Gilligan Street, Waitaki	Concerns about land subsidence due to waterway.
ENG 353	21/12/2021	Corner Montgomery Avenue, Leith River	Untidy riverbanks on Leith River around Montgomery Avenue.

This system database is still under development and some of the overdue scores can be attributed to system development not necessarily reflecting the customer response times for action.

Otago Regional Council

Objective Reference No.: A1602309

5. Planned Maintenance

Performance Measure: *Maintain channel capacity and stability, while balancing environmental outcomes and recognising mana whenua values in rivers.*

Target: *90% of planned maintenance actions achieved each year.*

Figure 2: Progress of planned activities

Over the first two quarters of the year 48 planned activities were completed from the river engineering workplans.

With the nationwide Level 4 Covid-19 lockdown on 18 August and subsequent restrictions, the team was unable to complete all planned tasks. Critical tasks were subsequently prioritised, and plans are in place to catch up on any delayed works or inspections.

Through Quarter 2 river levels have remained high across the Otago district, delaying the majority of planned works within the riverbed. These have been re-planned for Quarter 3 accordingly.

River flow and weather warnings

Peak River Flow Rates During Quarter

River/location	Quarterly Peak Flow Rate m^3/s	Date	First Warning Level
Arrow @ Cornwall	10.7	21/11/2021	-
Shotover @ Bowens	113.62	20/12/2021	508
Kawrau @ Chards	285.14	18/10/2021	1200
Dart @ Hilllocks	561.24	20/12/2021	1450
Silverstream @ Gordon Rd	10.48	12/10/2021	65
Taieri @ Sutton	48.45	13/10/2021	100
Waiporti @ Berwick	24.63	13/10/2021	-
Lindsay @ North Road	2.94	12/10/2021	51
Clutha @ Cardrona confluence	320.2	5/12/2021	600
Clutha @ Clyde	596.64	19/10/2021	3450
Clutha @ below Roxburgh	872.71	21/10/2021	1548
Pomahaka @ Glenken	108.97	6/12/2021	86
Kakanui @ Clifton Falls Bridge	57.11	5/12/2021	50

Highted figures indicate flows above warning level.

Number of Met service heavy rain warnings

October: 0
November: 3
December: 1

Otago Regional Council

Objective Reference No.: A1602309

6. Council Resolutions Update needed

The following section details progress against the following resolutions made by Council during an Implementation Committee Meeting on 8 September 2021 (Res IMP21-115).

Include details on progress on gravel extraction consents in regular quarterly reporting to the Implementation Committee.

The renewal of ORC's Global Consent is currently in progress. ORC (Engineering) submitted an application (February 2021) and the Environmental Management Plan (EMP) is being developed to enable the application assessment to be completed.

The new Global Consent includes provision for gravel management (extraction) related to flood protection/hazard requirements only and for non-commercial use. The new Global Consent is for a term of five years.

This is detailed in Section 9.

Include information on development of work programmes for the 2022/23 and subsequent annual plans for river management in regular quarterly reporting to the Implementation Committee.

Development of work programmes for 2022/2023 will commence in Quarter 3 and 4 of the current Annual Plan.

Present a staff report detailing timeframes and process to better develop asset management plans for plantings alongside riverbanks.

All river management plantings are recorded by staff on maps, in hard copy or electronic format. The current Annual Plan will see the recording of information transferred into relevant GIS layers and ORC's asset management software, where relevant. The timing to update the previous years of river management planting maps will occur over Year 1 and Year 2 of the current Long-Term Plan.

Otago Regional Council

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7. Coastal Mouths

Please note that coastal mouth opening is not an activity that is associated with Engineering's current performance measures.

Figure 3 Number of Coastal Mouths openings during quarter 2

Comment: No coastal mouth openings in the Clutha district during Quarter 2.

Otago Regional Council

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8. Capital Projects

Note that there are no performance measures associated with capital works projects for the rivers across Otago. This performance measure is applied only to the flood protection and control works (refer to 'Flood Protection and Drainage Schemes' report).

The below table reports on project progress year to date.

Project Name	Project Status	Planned Status by Year End	Progress	Exception Progress Notes
Roxburgh - Reservoir Creek Debris Trap Cleaning	Scoping	Project Completed	●	
Rees/Dart - Gravel Management	Not Started	Scoping	●	
Albert Town Bathymetry	Completed	Project Completed	●	Completed as part of construction project
Lower Waitaki Designation Review	Commenced	Project Completed	●	

● On track ● Project delays ● Planned status not achievable by year end

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9. River Management Global Consent Update

Engineering performs its activities under a Global Consent which applies across Otago's waterways, as per the summary in Figure 3.

Activities cannot be performed within waterways from May through to September annually, unless express approval and/or emergency works are required in accordance with the RMA.

Figure 3: Global Consent summary of when working in waterways can occur annually.

Global Consent application (renewal) summary as of 30th September 2021	
Date	**Action**
22 February 2021	RM21.073.01, 02,03 Global consent application lodged.
26 February 2021	Application accepted for processing and continued consent exercising rights approved under s124(2) of the RMA.
10 March 2021	Request for further information (s92(1) RMA).
20 June 2021	RM10.408.16-18 expired (but rights continue under s124(2).
30 November 2021	Meeting with Consultant Planner and ecologist.

NEXT STEPS January 2022 onwards	• Receive comments from Aukaha.
	• Review and alter EMP to reflect stakeholder engagement (including email discussions with Waka Kotahi and Heritage NZ), and engagement with Consultant Planner and ecologist.
	• In relation to gravel extraction: add in examples and thresholds.
	• Seek additional advice and add in additional information on cumulative effects or thresholds for activity which could be considered higher risk.
	• Identify drain clearing activity which is occurring in rivers and identify appropriate methodology for this work.
	
	• **The expectation is to:**
	  ▫ **have undertaken additional discussion with Consultant Planner and ecologist and stakeholders as necessary during February.**
	  ▫ **circulate the revised EMP to stakeholders in February 2021.**
	  ▫ **then lodge our s92 response by 28 February 2022. To progress matters, the s92 response may be lodged with the proviso that stakeholders are still to comment on the EMP.**

Otago Regional Council

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10. Notifications

As a condition of ORC's Global consent RM10.408.16 -18 the engineering team is required to post notification for any works taking place within the wetted bed. This work includes, but is not limited to:

- Mechanical clean
- Gravel re-distribution
- Bank protection
- Willow removal
- Willow trimming
- Vegetation removal
- Aerial spray
- Channel spraying

Notifications[2] issued in accordance with Global Consent for 2021/2022 planned activities:

District	**No. of Notifications**
Central Otago	15
Clutha	14
Dunedin	5
Waitaki	4
Total	**38**

[2] Notifications are a requirement under the Global Consent that provides details of the work being undertaken including location and extent of works. The notifications are issued to stakeholders and landowners. Stakeholders include DoC, F&G, Forest & Bird and Iwi. The notification relates to works that the global consent grants authority to be undertaken as set out above.

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11. Provision for gravel management (extraction) related to flood protection/hazard requirements only and for non-commercial use

"Gravel extraction for hazard mitigation" which is included in the EMP[3] and Consent

Gravel extraction is a method for managing flood and bank erosion hazards by maintaining and increasing the flood carrying performance of river channels. Management of the gravel and vegetation within riverbeds can enhance channel stability, channel alignment, and reduce the risk of flooding and damage to key infrastructure, people and property.

Gravel extraction in this context:

- is used as a last resort method only, and is used when other methods, such as re-distributing gravel are no longer possible, due to the sheer volume of gravel in the bed.
- will not be for commercial purposes, with all extracted material donated to, and used in the community from which it came.
- the total volume of gravel extracted per event4 is unlikely to exceed 50,000 cubic metres.

The principles defining gravel extraction include:

- Recognising and protecting the natural character of riverbeds
- Considering habitat and morphologic diversity
- Minimising works within flowing water
- Minimising discharges of sediment or contaminants
- Mitigating/avoiding effects of activities on native bird breeding and associated habitat
- Mitigating/avoiding effects on activities of fish spawning migration and habitat
- Recognising the sensitivities of archaeological or historic sites
- Recognising rivers ecological values
- Being aware of and responding to social, cultural, and spiritual values
- Being aware of and responding to recreational activities
- Consider existing infrastructure in, on along or over the riverbed
- Recognising and considering emergency contingencies
- Mitigating against transfer of aquatic pests
- Consider the natural replenishment rates
- Managing flood and erosion risks

Areas that the ORC have identified as riverbeds that may require gravel extraction for managing flood and erosion risks are:

- Pomahaka River;
- Kauru River;
- Strath Taieri River;
- Lower Taieri within the Lower Taieri Flood Protection Scheme;
- Kakanui River;

---

[3] EMP = Environmental Management Plan required to support Global Consent

[4] Event is defined as the requirement for the gravel extraction in accordance with the EMP and notification submitted.

- Clutha/Mata -Au River; and Silver Stream.

Objective Reference No.: A1602309

12. Photos

Figure 2 March Ck d/s of Rail line

Figure 3 March Ck diversion sluice gate

Figure 4 Deadbollock Ck looking u/s from Garthmyl Rd

Otago Regional Council

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- *Figure 5 Waikoura Floodway before and after spraying*

Figure 6 Hilderthorpe Floodway before and after spraying

Kakanui River
morphology and riparian management strategy

Version 1.0 – October 2015

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ISBN: 978-0-908324-20-0

Report writers: Michael Goldsmith, Manager Natural Hazards
Jacob Williams, Natural Hazards Analyst

Cover image: Kakanui River looking south east towards Gemmells Crossing (30 October, 2014).

Published November 2015

Overview

The Kakanui River morphology and riparian management strategy has been prepared by Otago Regional Council (ORC), with input from the local community, to help protect the recreational, cultural and ecological values of the Kakanui and Kauru riverbeds, and to enable long-term, sustainable use of the land which borders the river.[1] The strategy, as summarised in the two diagrams below, is intended to help achieve this by guiding work programs, decision-making and activities, for the community, stakeholders, and ORC. It is therefore recommended that people who live, work or play within the Kakanui catchment consider, and give effect to the principles, objectives, and actions listed in this strategy.

The strategy is not a statutory document; rather it is intended to present the aspirations of the community and the various stakeholder agencies. However, the statutory processes which do influence river management activities[2] are more likely to be used effectively and efficiently if there is a general consensus on what is valued about the river, and commonly understood objectives.

The strategy is intended to be a living document, which will evolve in response to new information, changes in the environment, the needs of the community and the work of ORC and other stakeholders. The strategy will be reviewed regularly, and this process will involve landowners with property alongside the river, other stakeholders and ORC,[3] and will help to set priorities and work programs for all of these groups. The strategy document will also record progress made towards achieving the stated objectives. It is intended that version 2 of the strategy will include further guidance and plans for undertaking planting on riparian margins, for river management purposes and for habitat enhancement.

1 Note that both the English and Maori spelling of Kakanui/Kākaunui are used in this strategy
2 Including the Local Government Act (in regards to funding considerations), and the Resource Management Act (in regards to managing environmental effects)
3 In particular, staff with responsibilities for rivers and waterway management and natural hazards

Kakanui River morphology and riparian management strategy - overview

Purpose

→ To provide guidance to landowners, stakeholders, and the community for good decision-making and appropriate activities within the riverbed and riparian margins of the Kākaunui and Kauru rivers.

Vision

→ The long-term sustainable use and enjoyment of the Kākaunui and Kauru rivers and their riparian margins.

Functions

Appropriate guidance and active engagement to empower good decision-making and to ensure that activities are undertaken in a sustainable and appropriate manner

Understand natural river processes and morphological characteristics, and the potential effects of those on the river and its margins.

The wise use of resources to:

- → manage the risk to property and assets
- → enable sustainable gravel extraction
- → protect and enhance community values
- → improve community resilience.

A shared vision of the rivers values and features to be utilised, preserved and enhanced.

Objectives & associated actions

(these are further refined in Section 7 - implementation)

1

Recognise and characterise natural river processes

- Collect information about flood and erosion processes.
- Report on changes in channel morphology.
- Provide information to the community.
- Identify the location of river corridors, within which the river will naturally meander.

2

Equip the community to live with the effects of changes in river morphology

- Promote land-use practices and the placement of assets which reduce the risk associated with changes in riverbed morphology
- Consider all available options to manage the effects of bank erosion, including structural and non-structural options.
- Enable works that will, where necessary, improve the conveyance of floodwater and 'train' the river within its natural corridor, without compromising the features which are of high value to the community.

3

Enable sustainable gravel extraction

- Identify areas where gravel accumulation can naturally occur.
- Identify areas where permanent removal of gravel may have a detrimental effect on assets, riverbed morphology or community values.
- Identify minimum bed levels/profiles, below which extraction will not occur.

4

Promote activities that enhance the natural character and enjoyment of the river

- Provide maps showing the location and characteristics of features which are of high value to the community.
- Encourage the establishment of riparian plantings that are practical and appealing.
- Provide access and habitat for fishing and whitebaiting activities.
- Support pest and weed control activities.
- Discourage dumping, and arrange the regular collection of rubbish.

4

Contents

1. Introduction

Changes in the morphology (physical form) of unconfined and braided riverbeds occur as a result of natural processes that are often uncontrollable, and also from human intervention. The Kākaunui and Kauru riverbeds are an integral part of the wider Kākaunui catchment (Figure 1). The riverbeds are part of a dynamic river system, and have experienced changes in morphology in recent decades. These changes will have occurred in response to naturally occurring flood events, as well as gravel extraction activities and historic river management decisions. Changes to riverbed morphology have included degradation[4] and sedimentation within the main channel, and significant bank erosion in places (Figure 2). In some cases, these changes have negatively affected the values placed upon the river by the community and stakeholders (landowners, iwi, Fish & Game NZ, Department of Conservation (DoC), Waitaki District Council (WDC) and residents).

Land alongside the river channel is often referred to as the 'riparian margin'. More intensive use of the land that borders the river has occurred in recent decades, with valuable farmland replacing what was previously rough vegetation (Figure 2, Figure 3 and Figure 4). As a result, changes in the position and form of the riverbed can cause issues for landowners and other river users.

The Otago Regional Council (ORC) has proposed the Kākaunui River morphology and riparian management strategy ('the strategy') to help provide guidance (for all users of the rivers) for good decision-making and appropriate activities on the riverbed and riparian margins of the Kākaunui and Kauru rivers. The strategy has a vision of long-term sustainable use and enjoyment of the Kākaunui and Kauru riverbeds and their riparian margins. It is also important when undertaking activities within the riverbed and on the riparian margins of the Kākaunui and Kauru rivers that people recognise, and allow for, the traditional, spiritual and cultural values of the local iwi.

The strategy's key objectives are to:

- recognise and characterise the natural river and catchment processes that occur in the Kākaunui and Kauru rivers
- equip the community to understand, and live with, the effects of changes in river morphology
- enable sustainable gravel extraction
- promote activities that enhance the natural character and enjoyment of the river.

The strategy is also intended to guide the nature and extent of land use, so that the negative effects of morphological change in the riverbed do not increase, and, where possible, are progressively reduced. It provides a framework for decision-making, so that activities undertaken by people occur in such a way that results in:

- a visually appealing river system
- a habitat that supports existing wildlife, fish and preferred plant species

[4] The term 'degradation' in this case refers to the wearing down of the channel by the erosive action of water

- limited effects on assets as a result of flood events
- resilient infrastructure (roads, bridges, water supply).

Many of the actions listed in this strategy are voluntary, and will rely on interactions between the key stakeholders and the community to be successful. It is therefore recommended that people who live, work or play within the Kākaunui catchment consider, and give effect to, the principles, objectives and actions listed in the strategy.

1.1 Report outline

Section 2 describes the scope of the strategy; while Section 3 summarises the natural environment within which it sits, and the community values associated with the river[5]. Section 4 describes the legislative context within which the strategy has been defined and will operate. Section 5 outlines the strategy's guiding principles and core components. Section 6 outlines the work that ORC has undertaken to help define an appropriate and sustainable river form for the riverbed and riparian margins. Section 7 summarises the methods that the various parties (ORC, stakeholders and the community) have designed to meet the strategy's key objectives.

A series of appendices are included at the end of this document:

- Appendix 1 describes the physical river management work to be undertaken by ORC in the next three years, which will also assist in achieving the strategy's objectives.
- Appendix 2 describes the areas where gravel has been identified as naturally accumulating and the river management profiles which have been calculated for those areas.
- Appendix 3 contains the mapped river corridors (the active fairway, and buffer zones).
- Appendix 4 provides location maps of particular values identified by the community and other stakeholders.
- Appendix 5 provides a summary of the public feedback received in mid-2015 regarding the initial proposal of the strategy.
- Appendix 6 contains information from the initial consultation with landowners and stakeholder groups in 2014 - early 2015.
- Appendix 7 shows the longitudinal profile of the river.
- Appendix 8 contains a guide on planting on river banks.
- Appendix 9 contains information on the threat status of native fish and birds.

[5] as determined by landowners, stakeholders and members of the public during community consultation in July 2014, and May 2015.

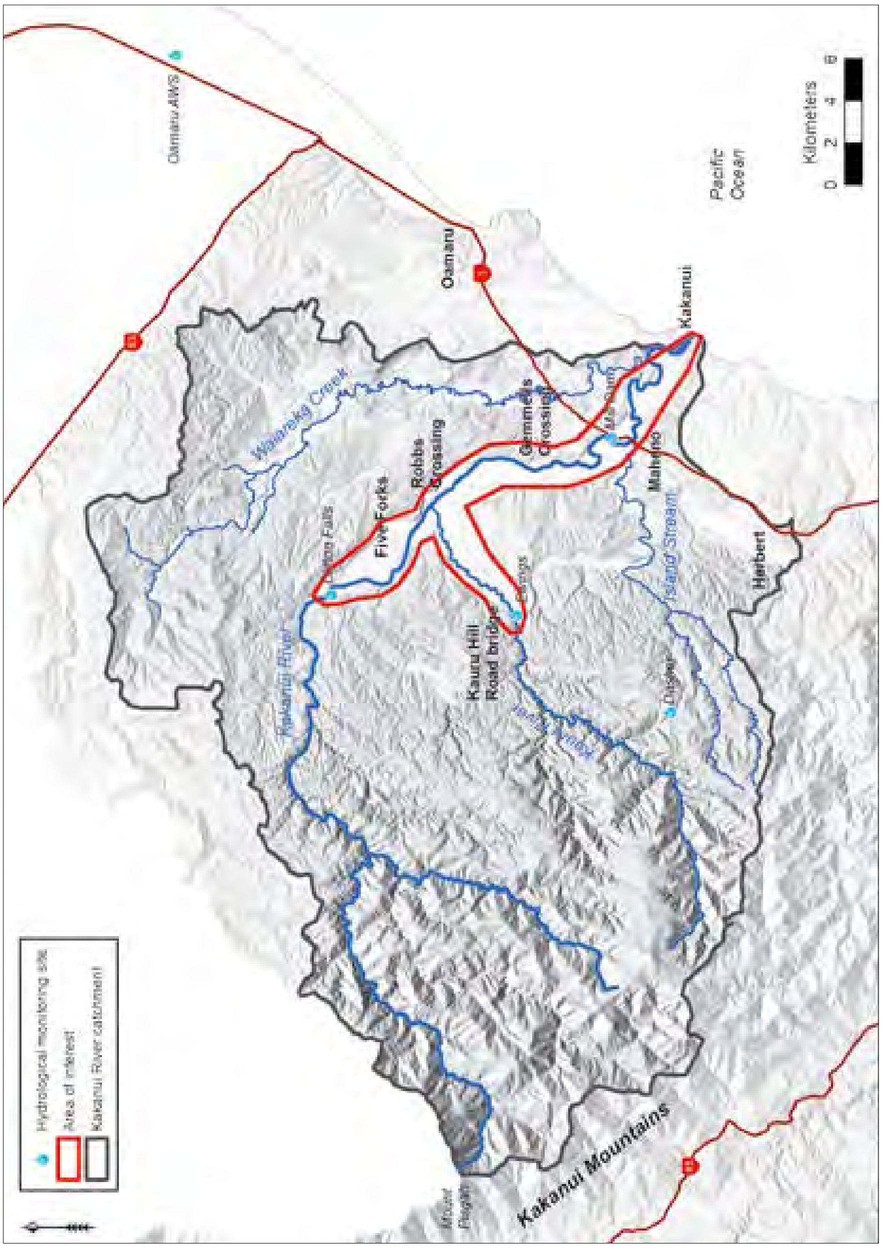

Figure 1. Kākaunui catchment boundary, showing main tributaries and the area of interest

Figure 2. Examples of recent changes in channel morphology. Top: Bank erosion on the true-right bank of the Kauru River (June 2013). Bottom: Bank erosion and sediment deposition in the Kākaunui River downstream of Gemmells Crossing (May 2014).

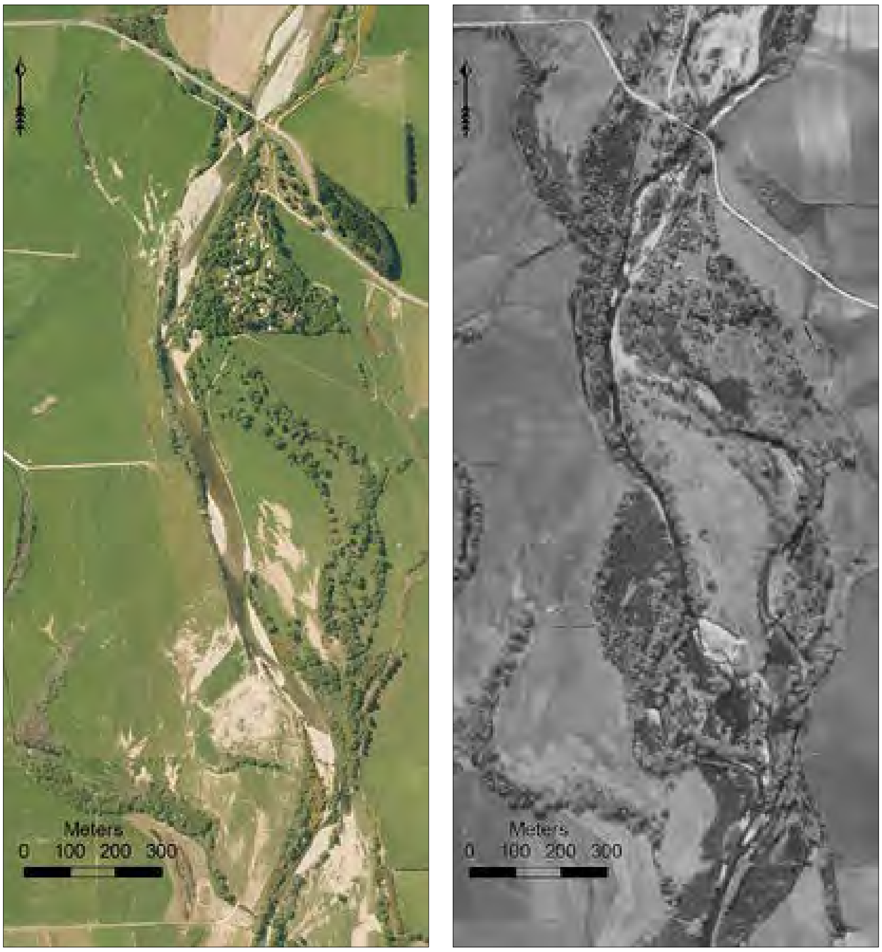

Figure 3. Comparison of aerial photography illustrating changes in vegetation, aerial photography collected in summer 2013/2014 (left) and 1957 (right)

Figure 4. Kākaunui River at the confluence with the Kauru River, looking upstream, highlighting changes in vegetation and river morphology (September 1969 (top), April 2015 (bottom))

2. Scope

2.1 Geographical

The strategy's geographical scope is the lower reaches of the Kākaunui and Kauru rivers (Figure 5), respectively:

- from Clifton Falls to the township of Kākaunui, and
- between Kauru Hill Road bridge and the confluence with the Kākaunui River.

Activities that occur in the upper catchments of both rivers and in other tributaries, such as Waiareka Creek and Island Stream, may have an effect on the lower reaches of both rivers. The upper reaches of the Kākaunui and Kauru rivers, as well as tributary waterways, were not investigated, because most concerns raised by the community concerned the lower reaches. The focus, therefore, was on these locations.

2.2 Risk

This strategy has a focus on the risks and effects associated with changes in riverbed morphology (including channel degradation and bank erosion, sedimentation and flooding) in the lower reaches of the Kākaunui and Kauru rivers. However, it is acknowledged that heavy rainfall events may lead to a range of other risks, including widespread river flooding and surface runoff.

There are several other environmental issues and hazards in the Kākaunui catchment. These include natural hazards such as seismic activity and extreme sea levels, and water quality and quantity issues. While numerous other issues do exist, this strategy is primarily concerned with the negative effects of changes in river form on the values associated with the Kākaunui River. Guidance and regulations relating to other issues can be obtained from the ORC. [6]

[6] For example, the Otago Natural Hazards Database, the Water Info website and the Regional Plan: Water, all available from www.orc.govt.nz

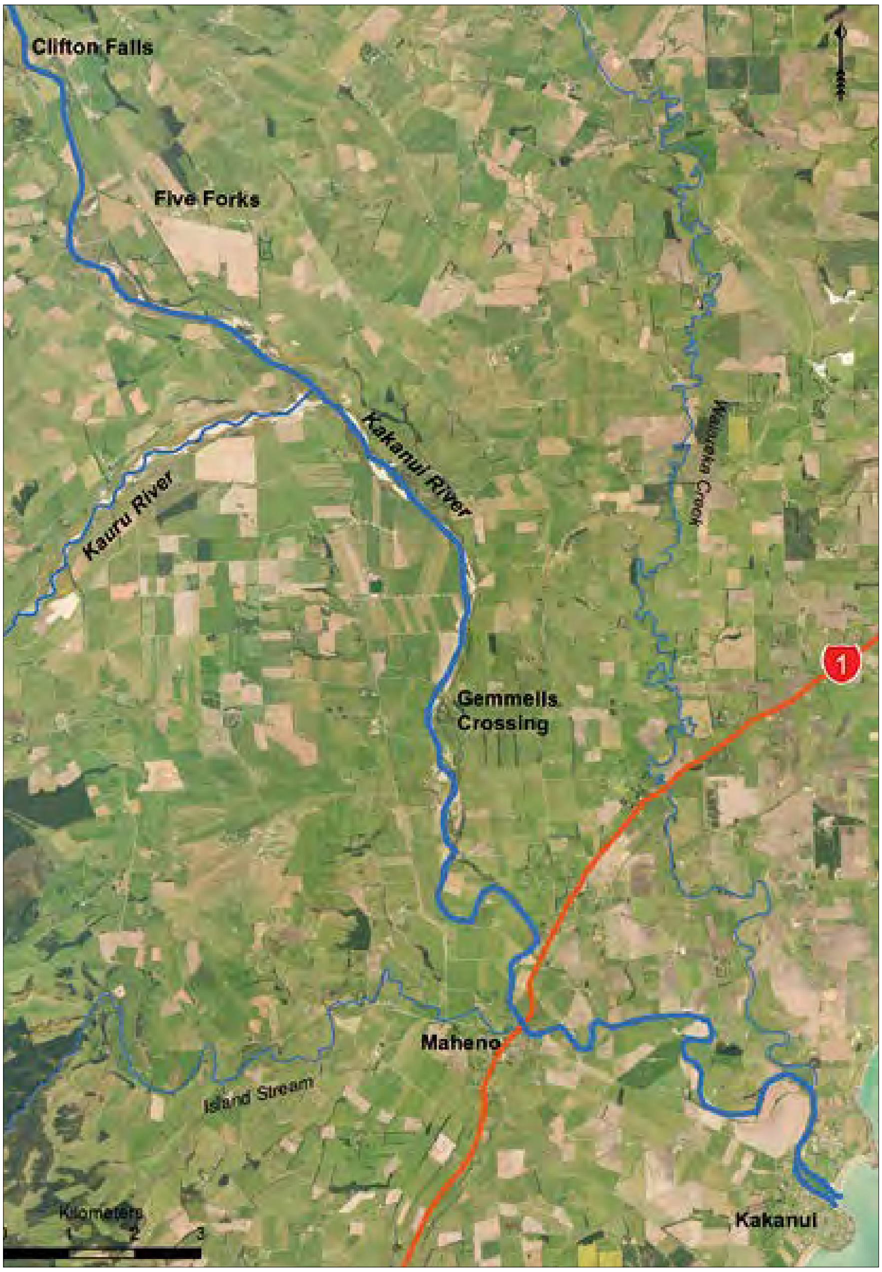

Figure 5. Map showing the reaches of the Kākaunui and Kauru rivers to which this strategy applies, and other tributaries of the Kākaunui River

2.3 Strategy development

The strategy is intended to be a living document, which will evolve in response to new information and changes in river morphology,[7] the needs of the community and the work of the ORC and other stakeholders. It will be reviewed regularly as part of council's annual and long-term planning process, or in response to large flood events. The review process will involve landowners with property alongside the river, other stakeholders, and ORC staff with responsibilities for rivers and waterway management and natural hazards. The review is proposed to monitor the effectiveness of the strategy, the workability of its stated objectives and to note progress towards achieving those objectives. It will also help ORC to set priorities when considering funding and undertaking river-maintenance work in the rivers concerned.

Before the review process, ORC will arrange and facilitate a workshop with the local community and invited stakeholder groups. This will consist of two parts:

1. an opportunity for participants to present to the group any issues they face as to changes in channel morphology or riparian management; work they have undertaken or would like to see undertaken; or to discuss, question or suggest changes to the strategy itself
2. a facilitated process to coordinate activity and work towards achieving the principles and objectives outlined in the strategy.

3. Environment setting

The natural and social settings of the Kākaunui catchment are described in this section, with particular focus on the special characteristics that give rise to the risks associated with changes in riverbed morphology.

3.1 Geological setting

The stretch of river to which this strategy applies is located within the broad floodplain areas in the mid- to lower reaches of the Kākaunui catchment, to the west and south of Oamaru (Figure 1 and Figure 5). Sediment has been eroded from the surrounding hill country, and subsequently deposited by fluvial processes to create the wide floodplain within which the river sits. This process is thought to be still occurring on a limited scale, in areas actively affected by floodwater at the base of the surrounding hill country, such as upstream of the Kauru Hill Road bridge (Figure 6) (Opus, 2009). The geology of the floodplain is described as gravel, sand, silt and mud, consisting of postglacial floodplains and low-river terraces (Forsyth, 2001). In several locations, the floodplain (and the Kākaunui River itself) lies alongside areas consisting of much older 'tuff' rocks of volcanic origin (Figure 7).

[7] Including additional understanding gathered during future flood events

Figure 6. View upstream of Kauru Hill Road bridge (July 2013)

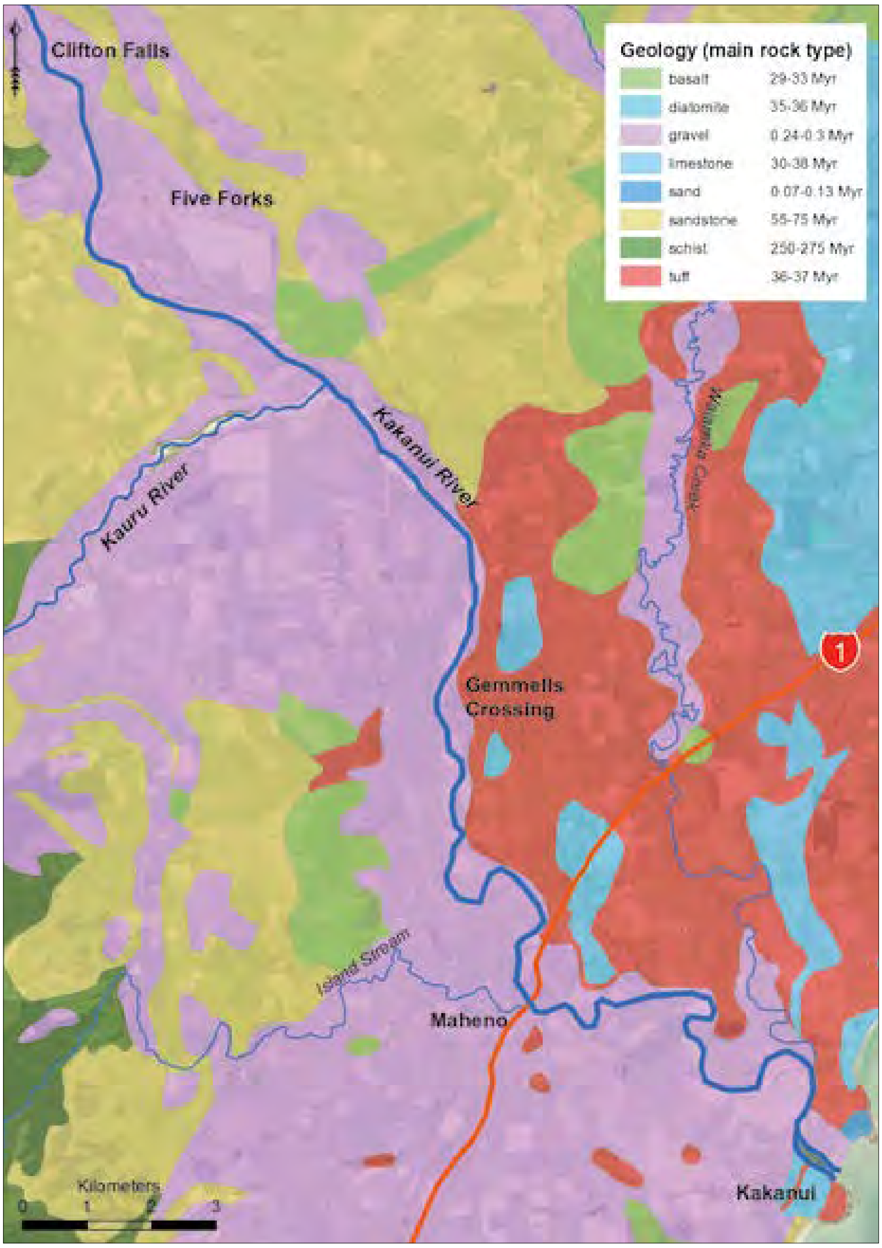

Figure 7. Geological map showing the reaches of the Kākaunui and Kauru rivers to which this strategy applies. The approximate ages of the main rock types are shown (in millions of years).

3.2 Geographical setting

The upper catchment (upstream of Clifton Falls) consists of rolling hills and steeper mountainous country, with the river having a single thread meandering planform that passes through tussock land, native and indigenous forest. The lower part of the catchment consists of rolling hill country and floodplains, with farmland extending to the river margins.

The Kauru River has a catchment area of 143 km^2, which is 16% of the total Kākaunui catchment. It rises to an elevation of 1,285 m above mean sea level (amsl) at Siberia Hill. The upper reaches of the Kauru River consists of gorges and steep valley slopes, with the river constrained to a single-thread, wandering channel planform (Figure 8). The lower catchment consists of a terraced alluvial fan, which starts at the gorge (1.5 km upstream of Kauru Hill Road bridge), and then slopes downwards towards the confluence of the Kākaunui and Kauru rivers.

Figure 8. Upper Kauru River catchment (photograph taken October 2014)

The entire Kākaunui catchment is 894 km^2, and is bounded by the Kākaunui Mountains and Pisgah Spur to the south and west (Figure 1). Mount Pisgah is the highest point in the catchment, at an elevation of 1,630 m amsl. The main tributaries of the Kākaunui River include the Kauru River, Island Stream and Waiareka Creek.

3.3 Meteorological setting

The Kākaunui catchment is located on the east coast of the lower South Island, within the Waitaki District. Flood events in coastal catchments such as the Kākaunui are generally caused by persistent rain-bearing easterlies, with continual rainfall over several days saturating the soil, leading to rapid runoff. Generally, these types of events occur in late summer to late autumn, although they can occur at any time of the year.

The nearest long-term automatic gauges are at Clifton Falls, The Dasher and Oamaru (Figure 1). Annual average and peak daily-rainfall intensities for these sites are listed in Table 1.

Table 1. Annual average and maximum observed 24-hour rainfall intensities for rain gauges in North Otago

Site (date records commence)	Annual average rainfall (mm)	Peak 24-hour rainfall (mm)	Date of peak 24-hour rainfall (mm)
Kauru at The Dasher (1953-2014) (missing data 1995)	809	187.9	5 June 1980
Kākaunui at Clifton Falls (1988-2014)	465	108	19 March 1994
Oamaru AWS (1982-2013)	504	69.9	26 April 2006

Although weather conditions tend to clear quite quickly after heavy rainfall events, enabling river levels to drop away, a sequence of fronts will occasionally move across the east coast, bringing further rain to already saturated catchments. The effect of these frontal bands can sometimes be compounded by the added runoff from snowmelt in the upper catchment.

3.4 Hydrological setting

Information on river flow is available from a number of long-term monitoring sites (Figure 1 and Table 2). The Mill Dam, Clifton Falls and Ewings sites have been operating since 1989, 1981 and 1991, respectively, and the ten largest flows on record for these sites are shown in Figure 9 Figure 10 and Figure 11. The largest flood event on record at all three sites was in April 2014, although historical records of larger flows do exist (OCB, 1988). There have been a relatively high number of large flood events in the last decade (2006-2015) at all three sites. The river can rise very quickly during flood events, with a rate of rise of greater than 100 cumecs[8] per hour observed at the Clifton Falls site, and an increase in flow of almost 50 cumecs in just 15 minutes observed at Mill Dam in April 2006. Peak velocities observed at these sites range from 3 m/sec. to 5 m/sec., with velocities likely to be higher in the steeper more confined sections of the Kākaunui River.

[8] 1 cumec equals 1 m^3 of water per second

Additional evidence (photos, council reports) of flood events in the Kākaunui catchment during the 1960s and 70s also exists, and this can be accessed through the Otago Natural Hazards Database.

Table 2. Summary of hydrological information for sites within the Kākaunui catchment

Site	Maximum observed flood (date)	Annual flood (2.3 yr return period) (cumecs)	Median flow (cumecs)
Kākaunui at Clifton Falls	565.8 (18 April 2014)	170	1.5
Kākaunui at Mill Dam	688.7 (17 June 2013)	298	2
Kauru at Ewings	159 (18 April 2014)	70	0.5

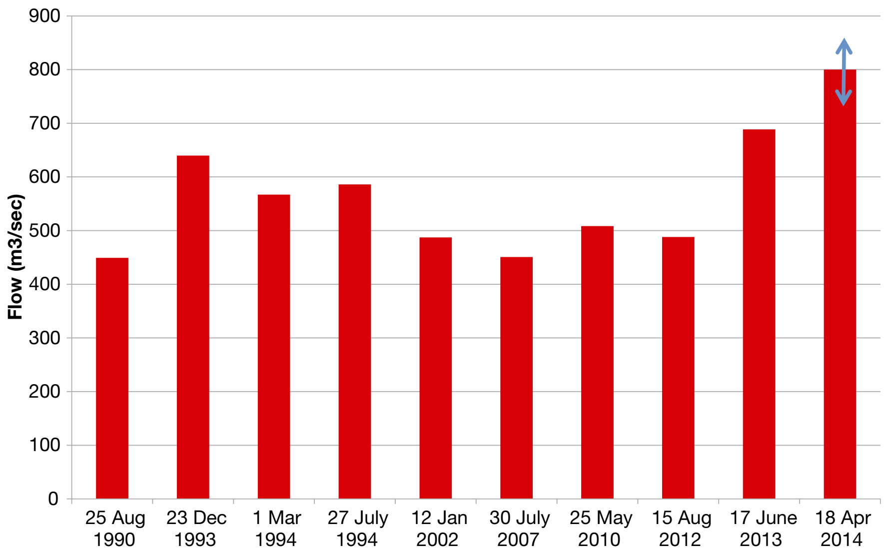

Figure 9. Ten highest flows in the Kākaunui River at Mill Dam since records began in December 1989. The accuracy of the April 2014 event is less than smaller events, due to some floodwater flowing out of its channel and bypassing the flow recorder.

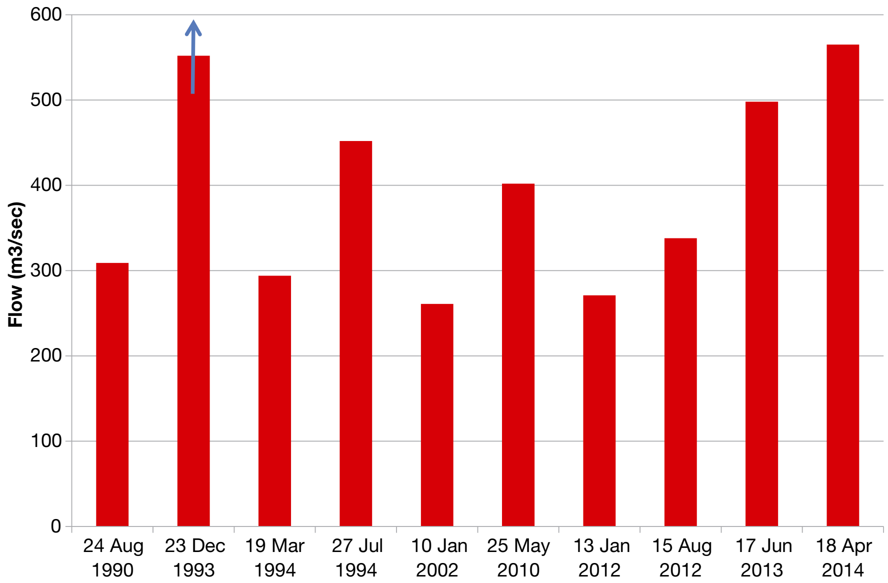

Figure 10. Ten highest flows in the Kākaunui River at Clifton Falls since records began in April 1981. The flow site failed prior to the peak of the December 1993 flood - the maximim flow is therefore not known, but was larger than shown in this figure.

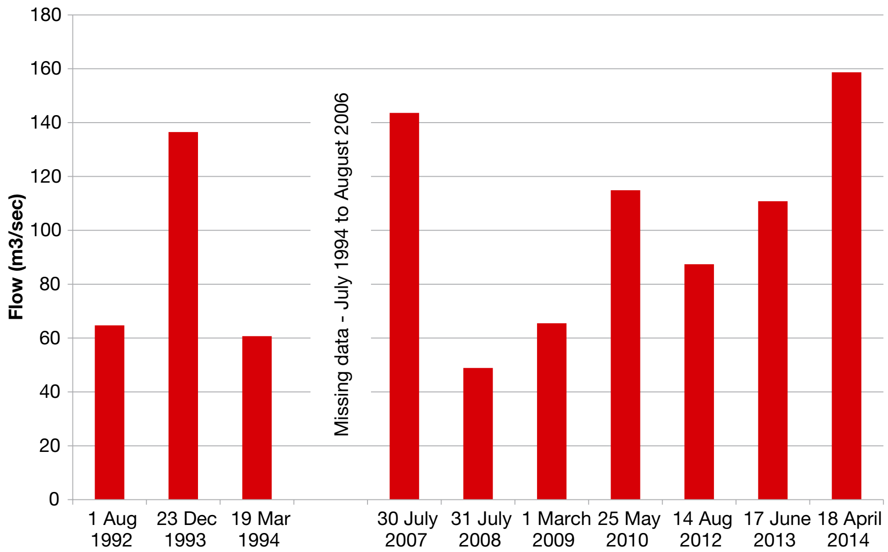

Figure 11. Ten highest flows in the Kauru River at Ewings since records began in November 1991

3.5 Riverbed morphology

The active channels of the Kauru and Kākaunui rivers are dynamic systems where flood events and sediment transport movement regularly cause changes in riverbed morphology (ORC, 2013). Changes in the longitudinal profile of the riverbed occur due to aggradation and degradation along the channel, and as a result of lateral bank erosion. Significant changes often occur as a result of extreme flood events, but small-scale, incremental changes can also occur over longer time-frames. Human activities, such as gravel extraction and physical works, can also result in significant morphological change, particularly near these works, but they also occur across the wider river system.

ORC undertakes work to describe these changes in morphology, using visual inspections, aerial and ground photography, and cross-section data. Reports summarising these investigations were published in February 2015, September 2013 and October 2010 (ORC, 2015, 2013, 2010).

3.5.1 Kākaunui River

A walkover of the Kākaunui River from the Kauru confluence to approximately 4km downstream of the Gemmells Crossing Road Bridge was completed by ORC staff in March 2015. Observations from this trip reinforced the findings of previous investigations, in particular that:

- the riverbed alternates between stable reaches with riparian plantings and limited bank erosion, and areas where there is limited bank vegetation and ongoing bank erosion
- some parts of the riverbed have experienced an increase in mean bed level (MBL), while other parts have experienced a decrease
- where decreases in MBL occur, these are generally larger than the increases
- there are numerous locations where bank erosion is occurring, and many of these are not captured by ORC's cross-section network
- at one cross-section (KA26), downstream of Gemmells Crossing, bank erosion of about 20m occurred over a 12-month period (October 2012 – October 2013).

A comparison between aerial photographs collected in 1957 and 2013 further highlights the dynamic nature of the Kākaunui River. In places, the fairway (the most active part of the riverbed) moved up to 200 m between 1957 and 2013 (Figure 14), while in the more stable reaches the fairway has remained in a similar position. This analysis also revealed that, between the Kauru River confluence and Gemmells Crossing, the river became less sinuous between 1957 and 2013 (i.e. it became straighter). In 1957, there were more backwaters in the Kākaunui River than in 2013, and, during this period, areas where gravel tends to accumulate (often referred to as beaches) reduced in size and/or changed positions (Figure 12, Figure 13).

A comparison of cross-sections, some dating back to 1985, also highlights the dynamic nature of the riverbed, and shows how the channel moved laterally in some locations, as well as becoming deeper (Figure 15).

Figure 12. Comparison of aerial photography illustrating changes in gravel beaches, aerial photography collected in summer 2013/2014 (left) and 1957 (right)

Figure 13. Kākaunui River looking downstream to Gemmells Crossing Road bridge (photograph taken 10 July 1978) a similar view taken in 2014 can be seen on the front cover

Figure 14. Comparison of the Kākaunui River fairway between 1957 and 2013 in the vicinity of the Fuchsia Creek Road bridge (aerial photograph collected in summer 2013/2014)

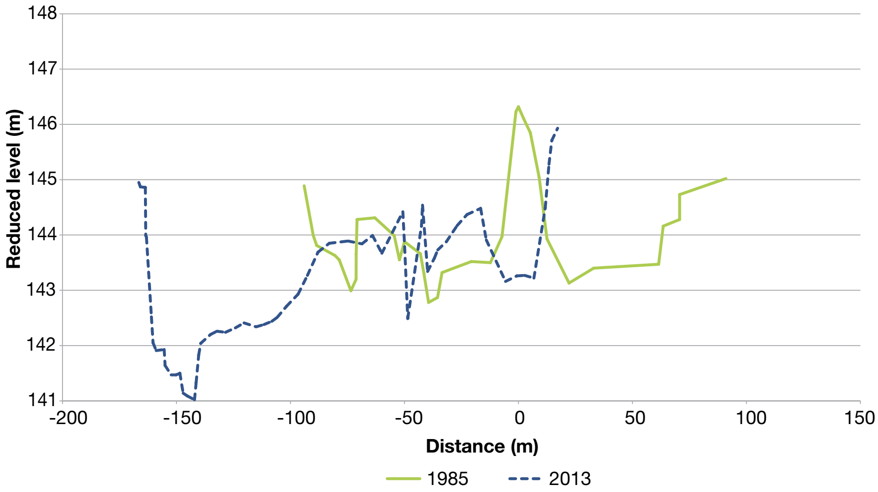

Figure 15. Kākaunui River cross-section KA8 (downstream of the Kauru River confluence), looking downstream. Between 1985 and 2013 the main channel moved about 100 m towards the true-left bank, and the deepest part of the channel lowered by 2 m.

Flood damage can be severe, given the rivers tendency to break out of the main channel and cross farmland, and the land immediately alongside the river is more likely to be affected by floodwater, sedimentation and erosion. Flooding can also cause disruption to the transportation network and damage to both private and public assets. A significant flood occurred in June 2013, which peaked at 689 cumecs at Mill Dam (Figure 9). This flood caused the Kākaunui River to overtop its banks onto the floodplain, and deposit gravel and silt well beyond the main channel (Figure 16). Bank erosion occurred at a number of locations between the Fuchsia Creek Road bridge and the mouth of the river. Another, larger flood occurred in April 2014, which peaked at about 800 cumecs at the hydrological site Kākaunui at Mill Dam (Figure 9). Although this is the largest flow that has occurred at this location since continuous records began in 1989, historical records of similar large flows do exist (OCB, 1988). As well as having an effect on the morphology of the Kākaunui riverbed, the April 2014 flood caused breaches of flood banks and again deposited gravel outside the main channel.

Figure 16. Kākaunui River overtopping its banks, (downstream of Gemmells Crossing) June 2013 event.

3.5.2 Kauru River

A walkover of the Kauru River from the Kauru Hill Road Bridge to the Kākaunui confluence was completed by ORC staff in March 2015. Observations from this trip reinforced the findings of previous investigations, in particular that:

- the riverbed is generally experiencing minimal change or a decrease in mean bed level.
- there are numerous locations where bank erosion is occurring, and many of these are not captured by ORC's cross-section network. Between September 2012 and October 2013, there were noticeable amounts (>1 horizontal metre) of bank erosion experienced at 11 of the 17 surveyed cross-sections (ORC, 2015). The largest amount of bank erosion observed at an ORC cross-section since records began in 1978 was about 110 m, about 700 m upstream of the Kākaunui Valley Road Bridge.
- sediment size decreases in a downstream direction, with larger boulders being present in the upper sections of the Kauru River.

A comparison of aerial photographs from 1957 and 2013 shows that the Kauru River is a dynamic system, and that the riverbed has changed its position within the floodplain at several locations. In some cases, the active fairway moved about 150 m between 1957 and 2013 (Figure 17). Between the Kauru Hill Road Bridge and Kininmont Ford, the channel increased in sinuosity between 1957 and 2013. Localised morphology of the Kauru River has changed over time and can be seen in cross-section changes that have been surveyed since 1978 (Figure 18).

These observations help to endorse the findings of ORC (2013) that sediment replenishment rates from the upper Kauru catchment are insufficient to maintain the profile of the surveyed reach, and that material is being eroded from the channel (in the upper section) and from the banks (lower section) during flood events, with this sediment then being re-worked downstream.

Figure 17. Comparison of the Kauru River fairway between 1957 and 2013 in the vicinity of Kininmont Ford (aerial photograph collected in summer of 2013/2014).

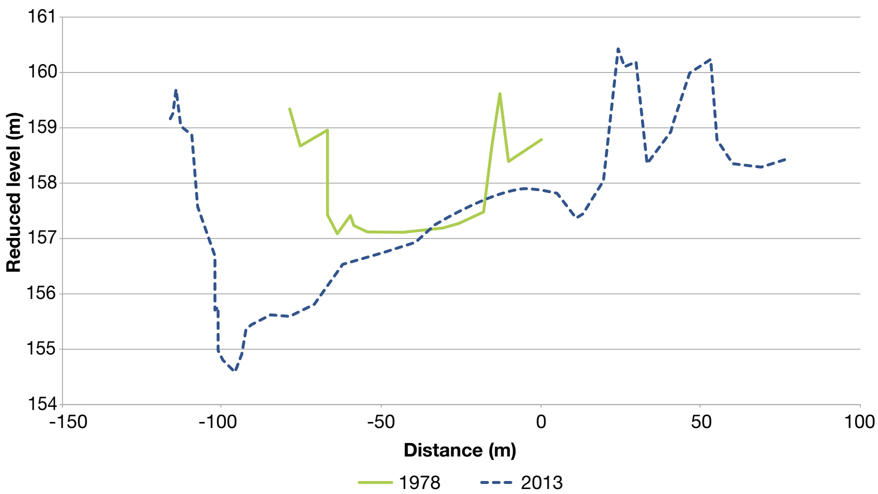

Figure 18. Kauru River cross-section K1 (upstream of the Kākaunui Valley Road Bridge, looking downstream). Between 1978 and 2013 the channel degraded by about 2.5 m and moved to the true-left bank by about 50 m.

The June 2013 flood peaked at 111 m^3/sec at the Ewings monitoring site. A flow of this magnitude can occur reasonably frequently. Figure 11 shows that this was the fifth largest flow observed in the Kauru River at the Ewings hydrological site since continuous records began in 1991. This flood caused a number of changes to the morphology of the Kauru riverbed, such as the main channel migrating from the true-right bank to the true-left bank upstream of the Kākaunui Valley Road Bridge and causing further damage to the bridge approach, as well as above Kininmont ford where the river bifurcated (split) and developed a second channel.

Another, larger flood occurred in April 2014, peaking at 159 m^3/sec (Figure 11). This is the largest flow that has occurred at this location since records began. The April 2014 flood event also had a noticeable effect on the morphology of the Kauru River at several locations: Gravel was deposited out of the main Kauru River channel near Kininmont ford, where bifurcation in the Kauru River had previously occurred; erosion of the true-left bank upstream of the Kākaunui Valley Road Bridge also occurred. Additional bank erosion was observed to occur at a number of locations between Kauru Hill Road and the confluence with the Kākaunui River. Although the April 2014 flood event was the largest since records began, the effects were mostly contained within the active channel and wider river fairway. There were limited effects across the wider floodplain. There are historical records of flood events in the Kauru River overtopping the river banks, resulting in sedimentation on adjacent farmland and bank erosion. Flooding can also cause disruption to the transportation network and damage to both private and public assets.

3.6 Riparian margins

The riparian margin is the area beside waterways that forms the interface between water and land. As noted in the introduction, more intensive use of the land that borders the Kākaunui and Kauru rivers has occurred in recent decades. In some parts of the catchment, farmland has encroached onto what was previously a more natural area of rough vegetation (Figure 3). This has resulted in a narrowing (or in some cases, complete removal) of the riparian margin which separates the active river fairway from land which is used for farming or which accommodates community infrastructure.

Previous ORC reports have identified that channel widening by bank collapse and erosion is now a common occurrence along much of the Kākaunui and Kauru rivers. The loss of primary agricultural land and physical property adjacent to eroding stream banks is very costly and the need for their protection against erosion has long been recognised.

Historically, the permanent removal of gravel from the river system has been used as a tool in an attempt to address bank erosion issues. The strategy identifies that gravel extraction, and other river management tools (such as the movement of gravel within the channel and spraying), should still be considered for river management purposes, where that is appropriate. However, a number of authors have identified that the most effective means of controlling river bank erosion is to establish a vegetative cover of strongly rooting plants (Slui 1991, Marden et al. 2005, ORC 2005, Phillips & Daly 2008). In general terms, vegetation roots increase bank stability by protecting soils against entrainment from flood flows, and root mass and density provide soil shear strength and thereby protect against gravity collapse of undercut banks.

Other indirect benefits of riparian plantings include a reduction in nutrient and fine sediment enrichment; shade, shelter and filtering qualities for the aquatic eco-system; and aesthetic and recreational value. If well managed, riparian margins can help to improve water quality, provide food and habitat for freshwater life, and improve diversity (ORC, 2005). A strong desire to see the form of the river include riparian plantings, particularly native species, was also identified by many individuals and groups during the development of the strategy.

3.7 Community setting

The Kākaunui and Kauru rivers fulfil a number of important roles within the community, at a local, district and regional scale. These roles include (but are not limited to) being:

- a source of water for irrigation, stock and people
- a source of gravel for roading and construction purposes
- for recreational purposes, including swimming and walking, fishing and hunting, boating, camping
- a habitat for native and introduced species
- for customary uses by local iwi, ranging from the use of water for ceremonial purposes, to maintaining the quality and quantity of water to sustain mahika kai populations and habitat.

3.7.1 Ecological values

Fish

The Kākaunui and Kauru rivers provide important habitat for a range of native (Appendix 9) and exotic freshwater species. The lower Kākaunui and Kauru rivers support the only known population of Lowland longjaw galaxias (Galaxias cobitinis), which is listed as ‘nationally critical’ (Goodman et al., 2014), the highest threat classification under the New Zealand threat classification system (Townsend et al., 2008).[9] They prefer a habitat of cool springs and streams made up of cobbles and gravels in braided-river environments such as those found in the lower Kauru River. The lowland longjaw galaxias require porous substrates so that they can burrow into the gravel during periods of low flow. Mechanical movement of sediment in the rivers can negatively affect the ability of the lowland longjaw galaxias to burrow into the substrate through compaction of the substrate by heavy machinery and reduced substrate size due to the extraction of larger particles (Dunn & O’Brien, 2006).

Brown trout (Salmo trutta) is an introduced species and is the most common fish in the area. Both the Kākaunui and Kauru rivers support a locally important brown trout fishery. The national angler survey suggests that angler effort in the Kākaunui catchment in recent surveys (2001/2002 and 2007-2008) has been much lower than in the

9 equivalent to that assigned to the Kakapo

1994/1995 survey (Table 3). The lower angler days may be due to factors such as high allocation (of flows), low flows, riparian management and declining water quality.

Table 3. Angler effort in the Kākaunui catchment (angler day's ± standard error) based on the national angler survey (Unwin, 2009)

River	Angler usage (angler days ± SE)		
	1994/1995	2001/2002	2007/2008
Kākaunui River	2040 ± 650	220 ± 110	890 ± 380
Kauru River			180 ± 180

The Regional Plan: Water for Otago[10] also lists many natural values for the Kākaunui River, including significant fish and macroinvertebrate diversity, trout spawning and rearing habitat and a significant presence of eels.

Birds

The wider river environment provides habitat for a range of exotic and native bird species (Appendix 9) that nest or feed in the river bed and its margins. Banded dotterel, black stilts, kingfisher, shining cuckoo and grey warblers use the Kākaunui and Kauru rivers permanently, while other species such as the white fronted tern and South Island oyster catchers use the river intermittently for foraging. As the river bed and margins become modified, the habitat for some birds becomes threatened. Human activities in and around the river bed may also disturb nesting birds.

3.7.2 Community values and feedback

To help to identify aspects of the river environment that are important to the local community, ORC consulted with a wide range of stakeholders in 2014 - early 2015 and in again in May/June 2015. These included landowners, Te Runanga o Moeraki, Kākaunui Ratepayers Association, Fish and Game, WDC and the Department of Conservation.

The values that the community and other stakeholder groups said they identified with the river environment and its form and function are summarised in the box below.

[10] Schedule 1A of the Regional Plan for Otago (2004), p. 267

Community river form and function 'values'

- That the ***function*** of the river continues to support social, cultural, spiritual, recreational, and farming activities – as well as continuing to provide for the taking of gravel as a resource
- That the ***form*** of the river includes riparian plantings (including both native vegetation and willows), weed control and fencing
- That the river channel is able to shift laterally within an identified riparian margin, but:
  - farmland beyond that margin is not eroded, and
  - main flood flows are kept in the channel.
- A range of views on the amount of human modification within the riverbed were expressed, ranging from:
  - no/limited engineering work or gravel extraction
  - some engineering work or gravel extraction
  - considerable engineering work or gravel extraction.

The full list of 'future form and function values' identified through the consultation process is included in Appendix 6.

3.7.3 Maori cultural values

The Kākaunui and Kauru rivers are significant to local iwi for mahika kai and other cultural values. The Kākaunui River was used by Kai Tahu in the past as a stopover location as they travelled north and south along the coast.

Water has an important place in ceremonial occasions and is particularly recognised where the cultural components of tapu and noa are at work. Water symbolises the spiritual link between the present and the past, as the never-ending source of life for generations that have gone before and those to follow.

Kai Tahu's priority is to maintain the properties of water that are necessary to ensure the sustainability of customary uses. Customary uses range from the use of water for ceremonial purposes to the maintenance of the quality and quantity of water to sustain mahika kai populations and habitats.

3.7.4 Gravel extraction

The removal of gravel from the riverbed of the Kākaunui and Kauru rivers has occurred for many decades (Figure 19), with extracted material generally used for roading and construction purposes. Gravel extraction typically occurs from locations where sediment naturally accumulates (for example, where there is a decrease in the gradient of the river, leading to a reduction in the velocity of flood flows), or in an attempt to mitigate issues such as bank erosion. In either case, extraction from the bed of the river will tend to increase the conveyance of water during flood events, by widening the channel and reducing the MBL at that location. It can also lead to a decrease in the sinuosity of the river channel, as bends are straightened in an attempt to reduce the effects of bank erosion.

Records provided by extractors to ORC show that approximately 46,000 m^3 of gravel was extracted from the Kākaunui and Kauru rivers between March 2006 and October 2013, equating to an average rate of about 6,150 m^3 per year. By comparison, ORC (2005) estimated that the total gravel-extraction volume from 1969-2005 in the lower part of the Kauru River alone was about 560,000 m^3, equating to an average rate of about 15,500 m^3 per year, with additional extraction occurring from the Kākaunui River. Consented gravel extraction volumes were increasing up until the early 2000s, peaking at over 100,000 m^3 in 2001.

Figure 19. Gravel extraction in the Kauru River below the Kākaunui Valley Road Bridge (November 2014)

Ongoing channel degradation can allow increased water velocities (particularly during flood events) to scour the river bed, deepening the channel, which can result in continued bed degradation. As the channel deepens, flood flows become confined within the channel and continue to scour the bed. This ongoing degradation decouples the channel from the floodplain and alters the floodplain catchment interactions (Fuller et al., 2014), examples of which are shown in Figure 15 and Figure 18. Deeper channels contain larger floods and concentrate flows, leading to more incised channels, potentially generating higher sediment transport rates (due to bank erosion and further removal of material from the riverbed). This process gives the appearance of more prominent gravel bars within the active channel due to the deeper channel. As the channel deepens and gravel bars become more prominent, pressure is often exerted by adjacent landowners to remove the obvious (but in fact non-existent) excess gravel accumulation, which in turn exacerbates the degradation trend (Fuller et al., 2014).

The sediment replenishment rates from the upper catchment of the Kākaunui and Kauru rivers are insufficient to maintain the profile of the surveyed reaches of both rivers. Both the Kākaunui and Kauru rivers are currently experiencing an overall trend of bed degradation and bank erosion, although there are localised areas where eroded material tends to accumulate. The perception that bed levels are increasing in the Kākaunui and Kauru rivers and that more gravel needs to be removed to manage this is incorrect. The reality is that there is localised build-up of gravel that makes the gravel resource appear larger than it actually is.

The permanent removal of gravel can also result in the undermining of river protection works and other assets (e.g. water intakes, bridges and roads), as well as degrading ecological values. Gravel extraction can have a negative effect on the local ecology, with the severity of effects dependent on the extraction methods used and the environment from which the gravel is being extracted. Gravel extraction activities can lead to a reduction in habitat heterogeneity/diversity, an increase in fine sediment, as well as bed compaction that can have a negative impact on the native and exotic animals residing in and on the banks of the Kākaunui and Kauru rivers (Dunn & O'Brien, 2006). The potential beneficial and adverse effects of significant gravel extraction are summarised in Table 4.

Table 4. Potential beneficial and adverse effects of gravel extraction (Canterbury Regional Council, 2015)

Potential beneficial effects	Potential adverse effects
Channel capacity increased, flood levels lowered	Disturbance of fish and bird habitat
Concentration of flow against riverbanks, resultant lateral erosion, and localised bed scour is minimised	Accidental discharge of fuels and lubricants from machinery
Stable channel alignment and optimum bed level is maintained	Disturbance of the natural meander patter and channel stability
Open gravel beaches can provide a good habitat for indigenous birds	Overall degradation of the riverbed
A renewable gravel resource for local construction may be utilised	Increased bank erosion
	Sediment is discharged, increasing turbidity and smothering habitat
	Temporary reduction in recreational access
	Mauri (life force) of the riverbed affected
	Disturbance of fish spawning sites
	Dust generation
	Reduced river bed heterogeneity

As part of the work undertaken for this strategy, natural gravel accumulation areas were identified and mapped, along with other areas where localised, small-scale gravel accumulation occurs. Areas with high community values, or where negative changes in river morphology (such as bed degradation and bank erosion) are occurring were also mapped. These areas are shown in Appendix 2. Commercial gravel extraction may be possible in the natural gravel accumulation areas, provided it can be shown to be sustainable and can be managed in such a way as to not have any negative effects on the river system.

River management profiles were created for the areas that have been identified as currently accumulating gravel (Appendix 2). A river management profile is a level that is set at a site which allows gravel to be removed when the gravel beach surface is above the profile and limits gravel extraction when levels drop below the profile. The river management profiles are to be used in conjunction with a series of conditions which are discussed in Appendix 2.

4. Legislative context

The manner and degree to which the issues in the Kākaunui and Kauru rivers can be managed by the community, stakeholders and local councils is influenced by the obligation, powers and restrictions set out in various statues. No legislation confers the exclusive power or the right to manage the Kākaunui and Kauru rivers to ORC or WDC. Whether through works or services, individuals are empowered to initiate their own measures provided they operate within the law. They are also allowed to develop and promote proposals for bank protection works, to apply for and hold the necessary resource consents and to privately fund works and services should they wish to.

The law provides for a range of methods that both councils and the community can use to manage the Kākaunui and Kauru rivers. These methods do not only relate to physical works, but also to planning, information, emergency preparedness and response. They can only be implemented after taking environmental effects into account (under the Resource Management Act (RMA)) and funding consideration (under the Local Government Act (LGA)). The latter includes consideration of the distribution of benefits between the community as a whole, any identifiable part of the community and individuals.

The Otago Regional Policy Statement (RPS) provides a high-level policy framework for the sustainable integrated management of Otago's resources, as well as giving effect to the requirements of the RMA (ORC, 2015). This includes the management of the values of water bodies, natural resource systems and the form and function of Otago's rivers, whilst still enabling communities to provide for their needs.

This strategy is concerned with the form and function of the Kākaunui and Kauru rivers. Any activities in or on the bed and banks of the two rivers need to be focused on maintaining or enhancing that form and function. The strategy is not a statutory document; rather it is intended to present the aspirations of the community and the various stakeholder agencies. However, the statutory processes which do influence river management activities[11] are more likely to be used effectively and efficiently if there is a general consensus on what is valued about the river, and commonly understood objectives. The strategy sets out the values identified by the community, and the outcomes they seek from managing river form and function, and will be used to inform resource consent decision-making.

11 Including the LGA and the RMA

5. Principles

The strategy provides a framework to guide activities and decision-making, based on an agreed set of principles. It is intended to help protect the recreational, cultural and ecological values of the Kākaunui and Kauru rivers, and to enable long-term sustainable use of the riverbed and its riparian margins.

ORC has developed the framework, in consultation with the local community and other stakeholders. The principles and associated strategic elements are outlined below, and these are intended to protect or enhance the important values and features of the river identified by the community and other stakeholders.

Principle 1: Ensure sustainable river management

Ensure that:

- there is recognition that certain river and catchment processes, such as flooding, bank and channel erosion and sedimentation, will occur naturally, and an understanding of the potential effects of those processes
- any practices undertaken limit exposure to negative natural-river and catchment processes
- there is an awareness and acknowledgement of the benefits and the risks (including the risk associated with 'super-design' events) that exist for activities such as farming that occur in areas prone to natural-river and catchment processes
- any negative effects of natural-river processes do not increase beyond their current levels, and are actively reduced where there is opportunity to do so
- activities are managed in a way that result in:
  - limited effects on assets during flood events
  - essential community infrastructure that is resilient (roads, bridges, water supply)
  - acceptable level of effects to farming caused by river processes
  - sustainable use of river resources.
- there is a recognition of the kaitiaki responsibilities of the Te Runanga o Moeraki.

Principle 2: Plan ahead

Ensure that:

- there is an adaptive approach to river management that will allow for the dynamic nature of the Kākaunui and Kauru rivers
- resources are used wisely to ensure that the location and form of community assets and essential infrastructure will result in a more resilient community
- the impacts of climate change and natural climate variability are considered so that future generations do not have to cope with the results of poor decisions made today
- the risk associated with natural-river processes are reduced over time by taking a broad-scale, adaptive approach over the longer term.

Principle 3: Maintain and enhance the natural environment

Ensure that:

- activities are managed in a way that results in:
  - a habitat that supports existing wildlife, fish, and suitable plant species[12]
  - a more visually appealing river system
  - the ability of the local community and visitors to access and enjoy the river is maintained and or enhanced
  - traditional and cultural use is enabled, maintained and enhanced.

6. River form and habitat enhancement

6.1 River corridor design and management

ORC has undertaken work to identify the location and width of the active fairway (or riverbed), as well as appropriate buffer zones, which together form a corridor within which the river would naturally lie. The widths of fairway and buffer zones were completed by assessing the appropriate meander form in relation to the nature and width of the river channel. The design channel has been drawn up using a consistent meander length or wavelength oscillation, while taking into account the existing channel location, channel areas and natural controls and restraints. This work has been undertaken in the Kākaunui River between Clifton Falls and the Kākaunui Estuary, and for the Kauru River between Kauru Hill Road Bridge and the confluence with the Kākaunui River (Williams, 2014). An example is shown in Figure 20, and a full set of river corridor maps is provided in Appendix 3.

The river fairway and corridor mapping provides guidance for multi-purpose river management, and for the design and implementation of management measures, protection works and in-channel design. When physical works or activities are being considered within the fairway or on the riparian margin, these should be undertaken with reference to the mapped fairway and buffer zones. Guidance for managing the river within this corridor, and across the wider floodplain is summarised in Figure 21.

[12] Many submitters, including representatives of Te Runanga o Moeraki, indicated a preference for native species, wherever possible. In some cases, a mix of native and exotics may be required to balance river management and biodiversity objectives. See also Appendix 8.

Figure 20. Kākaunui River mapped fairway deviating from the current channel alignment (aerial photography collected in the summer of 2013/2014).

ORC will work towards maintaining the Kākaunui and Kauru rivers to the mapped corridor lines in the lower reaches of both rivers where reasonable and practicable. The fairway management will be achieved through river-management processes such as sediment movement (i.e. cross-blading, bank reinstatement, targeted vegetation spraying, and in extreme cases, channel realignment). Keeping the fairways to the mapped lines will be undertaken as a pre-emptive process with the aim of limiting the degree of movement/deviation from these areas in flood events. This work will take into account the community values (as mapped in Appendix 4). Maintenance work undertaken in the Kākaunui and Kauru rivers (as discussed above) will be provided for through the budget set in the ORC Annual Plan.

In some locations, the mapped corridor crosses land that does not currently form part of the active channel of the Kākaunui and Kauru rivers (e.g. Figure 20). This is due to the fact that the mapped corridors show an 'envelope' within which the river would migrate under natural conditions. In many instances, they do not reflect the current position of the Kākaunui and Kauru rivers. In these situations, ORC will not actively move the fairway into these mapped areas; however, if the channel switches its location into these areas (e.g. in response to a large flood event), ORC may decide not to undertake work to reverse the new alignment if the channel still lies within the mapped corridor.

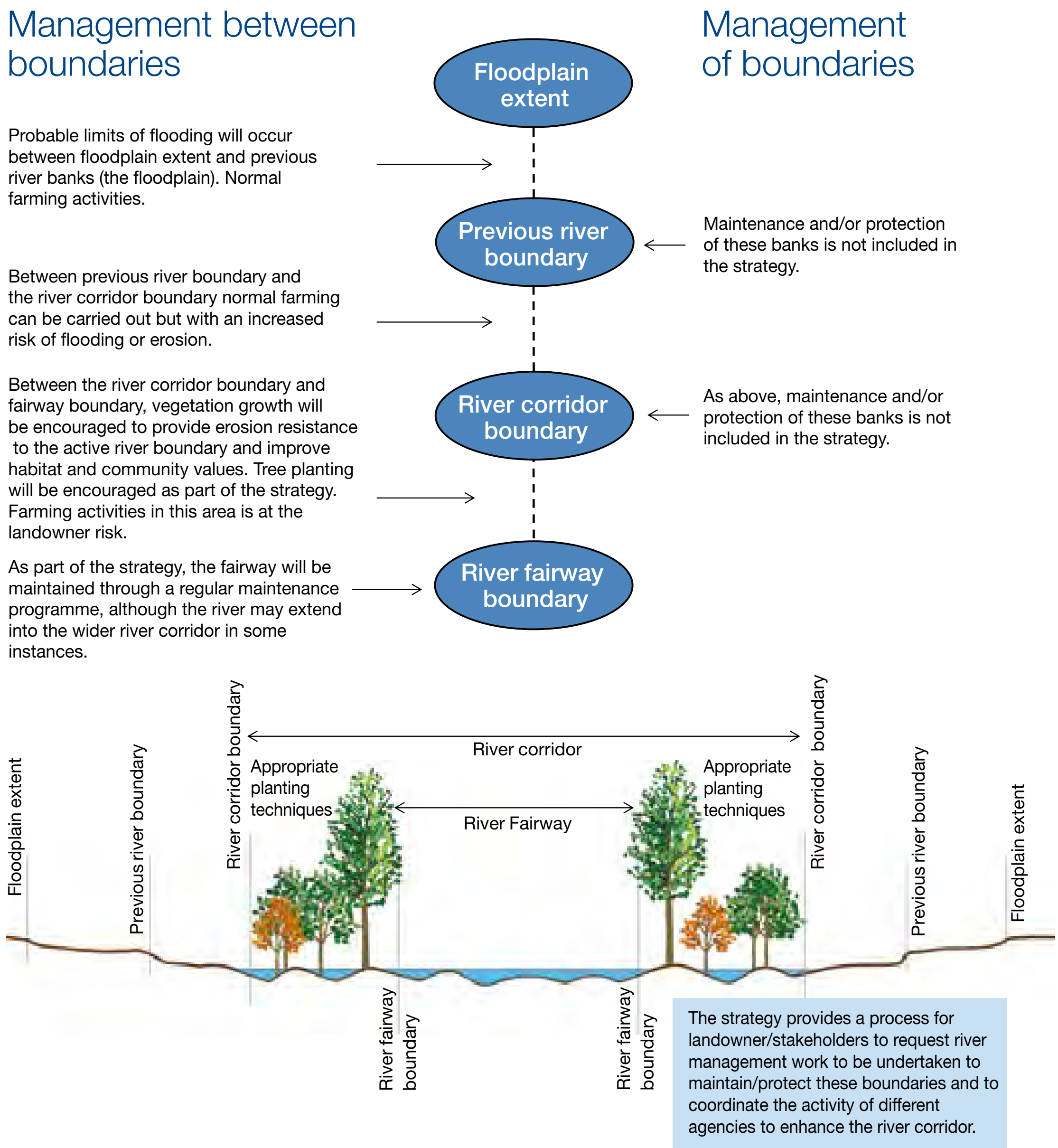

Figure 21. Policy diagram for management of river boundaries and appropriate land-use on floodplain areas of the Kākaunui and Kauru rivers

6.2 Riparian plantings

As identified in Section 3.6, careful management of riparian margins is key to achieving positive river management outcomes. In addition, one of the key values identified by the community was that they would like to see riparian plantings (including both native vegetation and willows) and associated weed control and fencing included in the strategy as a means of improving the amenity value, and to help to reduce the effects of erosion (Section 3.7.2). The principles identified in Section 5 reflect the importance of sustainable river management and enhancing the natural environment.[13]

Research (Slui, 1991; Phillips & Daly, 2008) shows that to achieve bank protection, the rivers riparian margins[14] should be planted in vegetation that assists with bank stabilisation. Planting these buffer areas would provide the banks of the rivers with greater stability and assist with limiting bank erosion, as well as providing vegetative cover to slow flood flows and limit the amount of sediment deposited out of the main channel, as well as providing habitat for aquatic life. The wider the area of buffer zone planting, the more effective this will be.

Willow species (particularly moutere and kemuti willow) are more suitable for planting close to the river margin, due to their rapid growth, ease of propagation and usefulness for vegetative groynes or bank-lining layering. Other vegetation can also be used, including poplars and alders on the relatively higher/drier land. Native vegetation can be used further back from the active river margin and can be useful, especially when part of other/wider riparian planting.

Development of the buffer areas can be undertaken as a staged approach, with planting of the active river margin occurring in areas where there is bank exposure as well as at possible river breakout locations. Planting of the back area can be undertaken where direct river attack (i.e. bank erosion) is less likely to occur and the native species will have time to become established. Buffer development is about establishing a wide and dense vegetated margin that can absorb river attack and provide habitat for aquatic life.

Planting of the banks of the Kākaunui and Kauru rivers is generally seen as a beneficial process in most locations. There are several methods to plant the banks of the two rivers with the best method being dependent on the environment where the planting is to take place (Appendix 8).

[13] in particular, Principle 1.1, 2.2, 2.4 and Principle 3

[14] i.e. the area that acts as a buffer between the active fairway and land used intensively for farming or other activities

7. Implementation

The objectives of the strategy are listed at the start of this document (in the overview section). The mechanisms that can be used to achieve, or implement, these objectives are shown in the following tables. These have been derived using the principles outlined in Section 5. The tables below highlight the actions that should be undertaken to maintain and enhance the values associated with the Kākaunui and Kauru rivers, as well as the key parties responsible for undertaking the listed actions.

In some cases, ORC has already undertaken work to help achieve objectives, and this work is described within this document (for example, mapping of natural-river corridors and identifying target profiles). It is noted that many of the actions listed below are voluntary, and will rely on interactions between the key stakeholders and the community to be successful. It is also noted that many of the activities will be ongoing, and progress will depend on funding, not only through the ORC Annual Plan process, but also from other agencies and the wider community.

ORC has prepared the strategy, with input from the local community, to help protect the recreational, cultural and ecological values of the Kākaunui and Kauru riverbeds, and to enable long-term, sustainable use of the land that borders the river. The objectives and actions listed below are intended to help achieve this, by guiding work programmes, decision-making and activities for the community, stakeholders and ORC. It is therefore recommended that people who live, work or play within the Kākaunui catchment consider, and give effect to the principles, objectives and actions listed in this strategy.

Due to the dynamic nature of the Kākaunui and Kauru rivers, parts of this strategy are likely to change as the rivers themselves change; this strategy must therefore be treated as a 'live' document (Section 2.3). This means that some sections and maps in the strategy may change in response to changes in the Kākaunui and Kauru rivers (e.g. areas of gravel accumulation may shift).

Objective 1 Recognise and characterise natural-river processes

Activity	How this can be done	Intended outcome	Who will lead it	Timing	Comment
1.1. Collect information about flood and erosion processes					
	Map, describe and report on changes in channel morphology	Improved understanding of natural river processes	ORC	Ongoing	Previous reports describing changes in channel morphology are available
	Identify locations where erosion is occurring	Avoid high-value assets in erosion-prone areas	ORC	Ongoing	Previous reports identifying areas of bank erosion are available
	Make information publicly available, including through the Natural Hazards Database	Improved decision-making around placement of assets and land-use activities	ORC	Ongoing	Information is currently available through the Natural Hazards Database
1.2. Identify the location of river corridors, within which the river will naturally meander					
	Determine the natural meander form of the river, considering the existing channel location, and natural controls and restraints	Improved decision-making around placement of assets and land-use activities	ORC	Complete	Maps included in Appendix 3

Objective 2 Equip the community to live with the effects of changes in river morphology

Activity	How this can be done	Intended outcome	Who will lead it	Timing	Comment
2.1. Asset management and land-use practices (e.g. fences, vegetation clearance, and irrigation structure placement) are undertaken in such a way that reduces the risk associated with natural river processes					
	Land-use practices and other activities have greater regard to natural river processes	A reduction in risk over time	Landowners	Ongoing	ORC to provide guidance and information through field-days and other community programmes
	Consider implementation of land-use controls through the District Plan in areas with greater erosion risk	No net increase in risk over time	WDC	Long-term (5-10 years)	Incorporate into future revisions of WDC District Plan
	Identify mechanisms to modify / protect roading assets that consider natural river processes	Roading infrastructure is resilient	WDC	Ongoing	ORC to provide information as necessary
2.2. Consider all available options to manage the effects of bank erosion, including structural and non-structural options					
	Less intensive use of riparian margins	A reduction in risk over time	Landowners	Ongoing	
	Planting of native and exotic species on riparian margins	Increased stability of riparian margins and riverbanks, improve habitat and community values	Landowners	Ongoing	ORC to provide support, as determined through the ORC Annual Plan process
	Produce guidelines for undertaking planting appropriate for river control and provision of habitat	Increased stability of riparian margins and riverbanks	ORC	Complete	Guidance included as Appendix 8
	Produce maps showing priority planting locations	Community requirements and natural river processes are considered before planting is undertaken	ORC	Ongoing	
	Proactive river management programme	Bank erosion and other river management issues addressed early	ORC	Ongoing	Maintenance work undertaken as provided for through the budget set in the ORC Annual Plan

Activity	How this can be done	Intended outcome	Who will lead it	Timing	Comment
2.3. Enable works that improve the conveyance of floodwater and 'train' the river within its natural corridor, without compromising features that are of high value to the community					
	Physical works by ORC to address existing river management issues	The Kākaunui and Kauru rivers are contained, as far as possible, within the natural river fairway/ corridor, and convey small to medium floods without overtopping	ORC	Ongoing	Locations and detail of work to be undertaken between October 2015 and 2018 included in Appendix 1
	Physical works by landowners and other agencies to address river management issues	The Kākaunui and Kauru rivers are contained, as far as possible, within the natural river fairway/ corridor, and convey small to medium floods without overtopping	Landowners	Ongoing	ORC to provide guidance on suitable river-management methods (including resource consent requirements) through field days and other community programmes
	Provide maps showing the location and importance of community/ stakeholder values	Works are undertaken in a manner that does not compromise features that are of high value to the community	ORC and the community	Complete	(Attached as Appendix 4.) These may be modified or adjusted as part of future reviews of this strategy

Objective 3 Enable sustainable gravel extraction

Activity	How this can be done	Intended outcome	Who will lead it	Timing	Comment
3.1. Identify areas where gravel accumulation can naturally occur.					
	Assess the natural characteristics of the river (including longitudinal profile, meander shape and effect of tributary inflows), and historical extraction activity to determine areas where gravel naturally accumulates	Consent applications to extract gravel are targeted to appropriate areas	ORC	Completed	Maps of natural gravel accumulation areas included in Appendix 2
	Provide maps showing the location and importance of community/stakeholder values	Extraction is undertaken in locations, and in a manner that does not compromise features which are of high value to the community	ORC and the community	Completed	(Attached as Appendix 4.) These may be modified or adjusted as part of future reviews of this strategy
3.2. Identify areas where permanent removal of gravel may have a detrimental effect on assets, riverbed morphology or community values					
	Assess the natural characteristics of the river to determine areas where sediment does not naturally accumulate, but is conveyed through a particular reach	Extraction does not occur in locations, or in a manner that would compromise features that are of high value to the community	ORC	Completed	Maps included in Appendix 2, and Appendix 4
3.3. Identify minimum bed levels / profiles, below which extraction will not occur.					
	Identify a 'target' river shape, that will allow for sustainable extraction rates, and also help to achieve identified community values	The volume of gravel extracted is sustainable	ORC	Completed for areas identified under 3.1. above	Maps and profiles included in Appendix 2

Objective 4 Promote activities that enhance the natural character and enjoyment of the river

Activity	How this can be done	Intended outcome	Who will lead it	Timing	Comment
4.1. Identify the location and characteristics of features that are of high value to the community					
	Community values obtained through consultation and clearly identified within the strategy	Consideration of community values when making decisions	ORC	Completed	Maps included in Appendix 4
4.2. Establish riparian plantings that serve a purpose, and are appealing					
	Produce guidelines for undertaking planting appropriate for river control and provision of habitat	Increased stability of riparian margins and riverbanks. Improved aquatic and terrestrial habitat.	ORC	Completed. See also 2.2 above.	Guidance included as Appendix 8
4.3. Provide access and habitat for fishing and white-baiting activities					
	Planting work that enhances fishing and white-baiting activities	The Kākaunui and Kauru rivers support game fish, native fish and whitebait species	Fish & Game, DoC	Ongoing	
	Consent conditions ensure that gravel extraction and physical works are undertaken in a way that does not damage habitat	The Kākaunui and Kauru rivers support game fish and whitebait species	ORC, WDC, extractors and landholders	Ongoing	See Objective 3 also
	Encourage the creation of additional public access points	River-access opportunities are increased	ORC, WDC, landowners	Ongoing	
4.4. Adequate pest and weed control activities					
	Landowners (including LINZ) and other stakeholders work collaboratively to manage pest species	The Kākaunui and Kauru river fairways and riparian margins are relatively free of pest species	Landowners, stakeholders, ORC	Ongoing	
4.5. Discourage dumping, and arrange the regular collection of rubbish					
	Collection of rubbish by contractors, signs warning of penalties for rubbish dumping	Improved visual amenity and enjoyment of recreational areas	WDC	Ongoing	
4.6. Protect and enhance the natural character of the Kākaunui and Kauru rivers					
	Promote and encourage local restoration initiatives such as bank planting, and wetland restoration	Riparian margins are planted / restored, look visually appealing, and provide aquatic and terrestrial habitat	Community, with support from other agencies	Ongoing	

Appendix 1. ORC river-maintenance work within the Waitaki Special Rating District

Seven locations within the river corridor have been identified as requiring work to maintain the fairway within its natural position (as mapped in Appendix 3) and/or to ensure the adequate conveyance of floodwater.[15] These locations are shown on Figure 22 and Figure 23. These priority locations have been determined using the latest available information (September 2015) about specific locations that are experiencing river management issues. ORC intends commencing work at these locations during the 2015/16 financial year, and funding has been provided through the long term plan process to complete work at these locations within the next three years (i.e. by 2017/18). Ongoing maintenance may also be required at some of these locations into the future.

Priority will be given to work at locations B, D, and E (respectively, downstream of Gemmells Crossing, at the Kākaunui/Kauru confluence, and upstream of the confluence, as shown on Figure 23). Subsequent work is scheduled to take place at locations A, D and F.[16] ORC will work with other agencies, including gravel extractors, landowners and WDC where possible to reduce cost and maximise gain. This list and the need to undertake work at particular locations may change into the future, in response to flood events and to other river management issues that the community may identify through the process outlined in Section 2.3.

The river management work (outlined below) that is scheduled to take place in the Kākaunui and Kauru rivers will need to consider the following:

- The principles outlined in Section 5.
- The location and width of the natural river corridor and active fairway, as described in Section 6, and other natural river processes as described in the strategy.
- The objectives and associated activities listed in Section 7. In particular objective 2 (equip the community to live with the effects of changes in river morphology) and activity 2.3 (enable works that improve the conveyance of floodwater and 'train' the river within its natural corridor, without compromising features which are of high value to the community).
- The ecological, community and Maori values discussed in Section 3.6.

The increased program of work in the Kākaunui River by ORC will result in increased costs for the Waitaki Special Rating District (SRD). It is noted that river morphology and riparian management strategies are also to be developed for the Shag and Waianakarua rivers in the 2016/17 year. Revenue from rates within the SRD is projected to increase from $260,000 in 2015/16 to $420,000 in 2018/19, in order to fund additional in-stream work required to meet community river management expectations.

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15 Note that riparian management/planting work is not described here. As outlined in the overview section, it is intended that subsequent versions of the strategy will include further guidance and plans for undertaking planting on riparian margins, for river management purposes and for habitat enhancement.

16 Direct intervention by ORC is less likely at the 7th site (C), as described below

The dynamic nature of these three rivers and the inability to predict the timing or consequences of future flood events in the Waitaki District means there is a risk that this additional funding for river management work may still be insufficient. It is noted that all ratepayers within the Waitaki District contribute funding towards the Waitaki SRD.[17]

The anticipated budget for river management operations (physical works) in the Waitaki SRD until 2018/19 is shown in Table 5 below. This shows that $244,000 is budgeted for this work during the 2015/16 year, up from $104,000 the previous year. As noted above, this budget is not solely for the Kākaunui and Kauru rivers and includes other rivers in the Waitaki District, including the Shag and Waianakarua rivers.

Table 5. ORC river management budget for the Waitaki District

Year	ORC river management (operations) budget
2014/2015	$104,000
2015/2016	$244,000
2016/2017	$308,000
2017/2018	$316,000
2018/2019	$324,000

Planned river maintenance work - Kākaunui River

A. Kākaunui/Waiareka

Work will be completed at this location to limit the amount of bank erosion occurring on the true left bank. A secondary channel will be created across the gravel beach which will allow floodwater to flow downstream without cutting into the true left bank as much as previously. Gravel will also be redistributed across the beach and contoured to a suitable channel shape. It is noted that there are a number of important community values at this location, which will need to be considered and protected as part of any works undertaken.

B. Downstream of Gemmells Crossing

Work was undertaken at this location previously in February 2015. Additional work to be undertaken at this location will involve maintenance of existing bank protection as well as moving gravel to form bunds to protect the banks from further erosion.

C. Robbs Crossing

There is minimal work to be undertaken at Robbs Crossing, however gravel extraction will be utilised to manage the channel where applicable.

[17] The river management rate is currently collected from 12,500 rating units across that part of the Waitaki District which lies within the Otago Region, at a rate of 0.0000577cents per $1 of capital value

D. Kākaunui/Kauru confluence

In the lower reaches of the Kauru River (below the Kākaunui Valley Road bridge) work will be undertaken to pull the steep gravel edge back towards the true left bank as well as moving gravel to create a graded channel which will remove the existing deep cut channel.

E. Upstream of the Kākaunui/Kauru confluence

Work to be undertaken at this location will involve moving gravel across the beaches to create a wider channel to better convey flood flows as well as planting of the river banks to limit bank erosion on the true right bank. Spraying of vegetation present in the river fairway will assist in keeping the channel to the mapped fairway and will reduce the pressure of flood flows against the river banks.

Planned river maintenance work - Kauru River

F. Upstream and downstream of Kininmont Ford

There is minimal work to be undertaken currently at Kininmont Ford, however gravel extraction or movement will be utilised to manage the channel where applicable.

Figure 22. Priority locations for operations work – lower catchment

Figure 23. Priority locations for operations work – upper catchment

Appendix 2. Gravel accumulation areas and river management profiles

There are a number of areas within the Kākaunui and Kauru riverbeds where gravel tends to accumulate. These areas can change position in response to flood events, land use, and sediment inputs. Currently there is a reasonably extensive area of natural gravel accumulation near the confluence of the Kākaunui and Kauru rivers, and another at Robbs Crossing, as mapped in Figure 24. Commercial gravel extraction may be possible in these areas, provided it can be shown to be sustainable, will meet the values and principals outlined in this strategy, and can be managed in such a way as to not have negative effects on the river system.

Areas identified as having community values of high significance which may be negatively affected by gravel extraction, or where extraction will likely have negative effects on riverbed morphology have also been identified (shaded yellow in Figure 25).[18] In these areas, large-scale gravel extraction is generally not appropriate, unless there are exceptional circumstances. These reaches include the Kauru River upstream of the Kākaunui River Bridge, and the Kākaunui River upstream of the Kauru confluence, and downstream to below Gemmells Crossing Bridge.

Sections of river where small-scale gravel accumulation may occur in localised areas have also been mapped (shaded green in Figure 25). Gravel may accumulate on smaller pocket beaches (often found on the inside of meander bends) but is generally not available in significant quantities.

When gravel extraction or other river management work is being considered within the river corridor, it should be undertaken with reference to the information provided in this strategy. This includes the mapped fairway and corridor lines (Appendix 3), the areas mapped in Figure 24 and Figure 25, and the river management profiles created for particular areas (Figure 26 to Figure 41).

[18] It is noted that other sections of the river (outside those shaded yellow) also have a wide range of important community values which should be considered when assessing proposed gravel extraction activities.

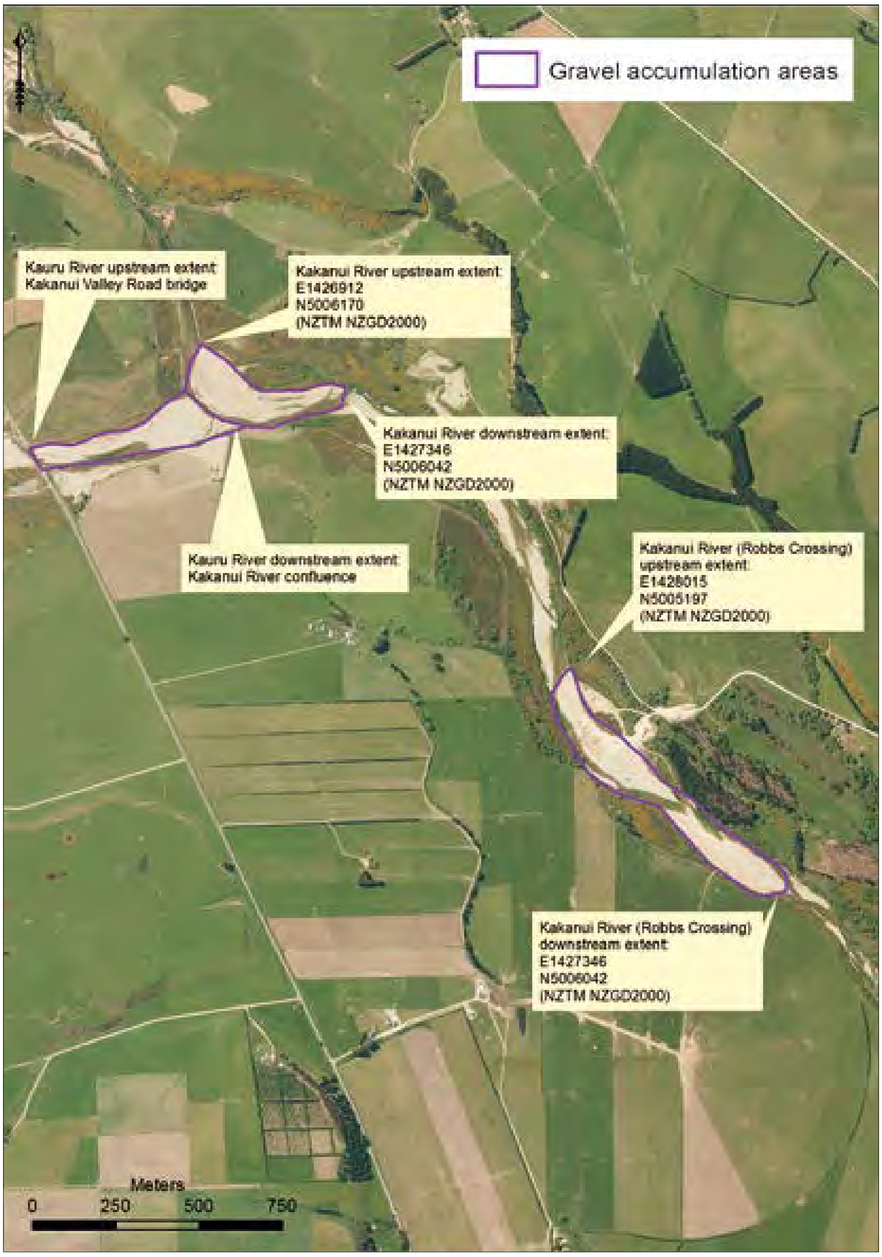

Figure 24. Areas where gravel tends to naturally accumulate in the Kākaunui and Kauru rivers; near the Kākaunui / Kauru confluence, and at Robbs Crossing (outlined in pink). The upstream and downstream extents are also identified.

Figure 25. Areas of natural gravel accumulation (pink); areas where community values could be significantly affected by gravel extraction or where changes in river morphology such as bed degradation and bank erosion are occurring (yellow); and areas where small-scale, localised gravel accumulation may occur (green).

River-management profiles have been created for parts of the river identified as natural gravel accumulation areas, as shown in Figure 24. These profiles help to define the preferred form of the riverbed at particular cross-section locations, as shown on Figure 42. They are intended to guide gravel extraction and other river management work (eg, cross-blading, spraying) in these areas. The profiles have been set at a level that allows gravel to be removed when the beach surface is above the profile and limits gravel extraction when levels drop below the profile.

The river-management profile levels were set by assessing historic river changes upstream, at and downstream of, the three areas using the maximum and minimum MBL (collected over the whole cross-section record), longitudinal profiles, the location of the mapped river fairways/buffer zones and the local river morphology.

In order to guide the riverbed shape towards these river-management profiles, a series of conditions would apply to gravel extraction consents in these areas.[19] These are as follows:

3. Extraction of material can only occur across the whole beach (extraction area) where the MBL of the latest survey for that location is above the long-term average.
4. Extraction can only occur between the mapped fairway lines where gravel has accumulated above the management profile.
5. Extraction cannot occur below the long-term average MBL in areas outside of the mapped fairway lines
6. Any extraction activities must take into account the local river morphology, community values, and enhance the natural character/amenity of the area.

Currently, the river-management profiles are only set in areas where gravel is accumulating. These areas may move into the future and therefore river-management profiles will need to be calculated for areas outside of the current mapping. This approach will provide certainty to anyone wanting to extract gravel from the Kākaunui and Kauru rivers and prevent the excessive removal of gravel from the river system.

[19] along with the current suite of conditions used to manage gravel extraction consents

Kākaunui River management profiles

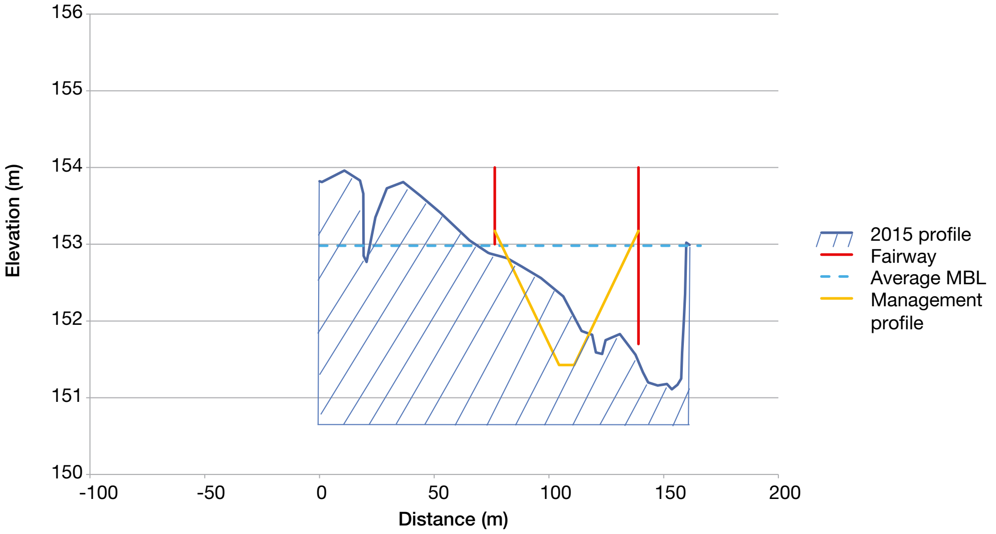

Figure 26. River management profile Kākaunui 1, looking downstream

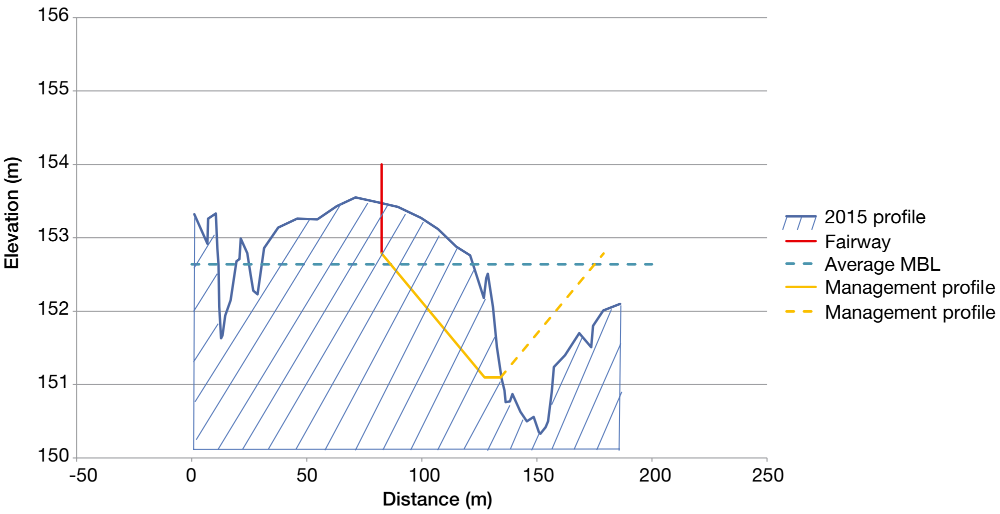

Figure 27. River management profile Kākaunui 2, looking downstream

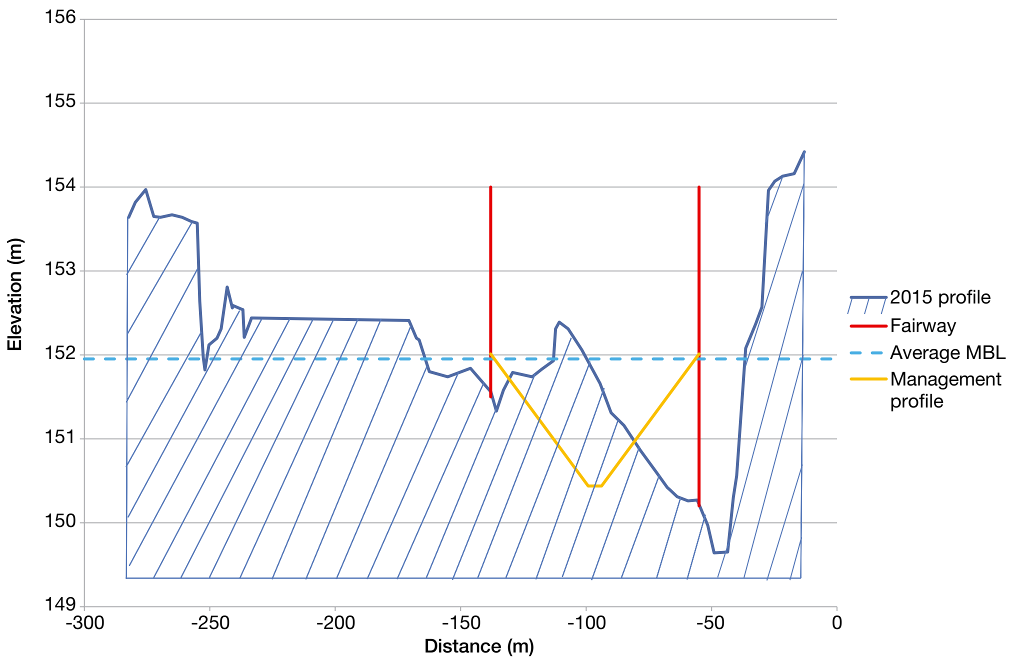

Figure 28. River management profile KA 11, looking downstream

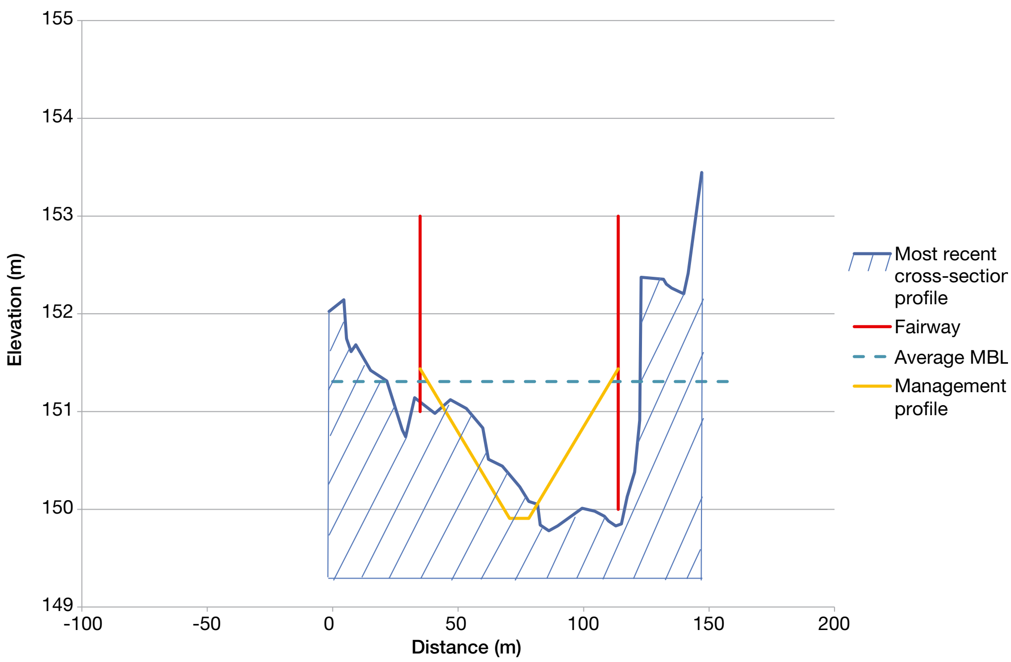

Figure 29. River management profile Kākaunui 3, looking downstream

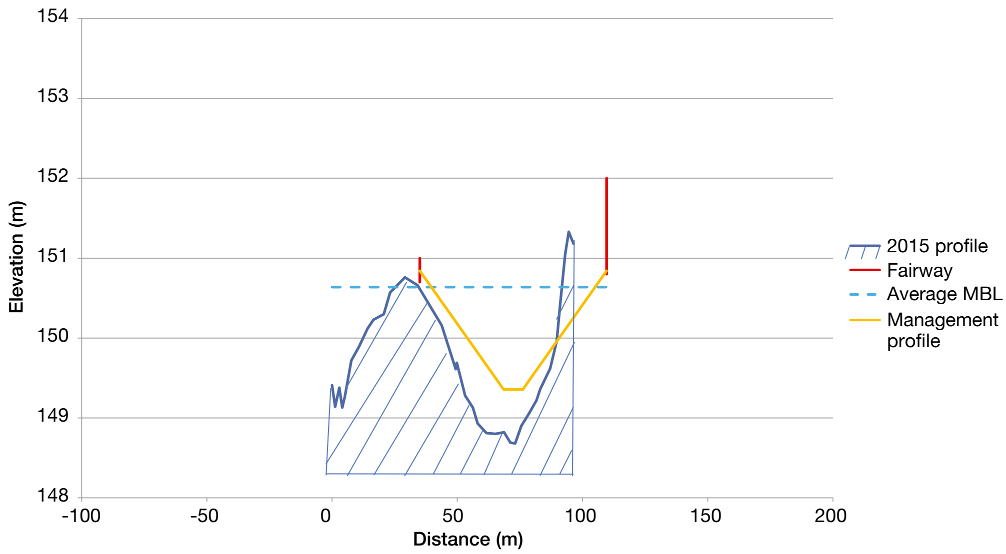

Figure 30. River management profile Kākaunui 4, looking downstream

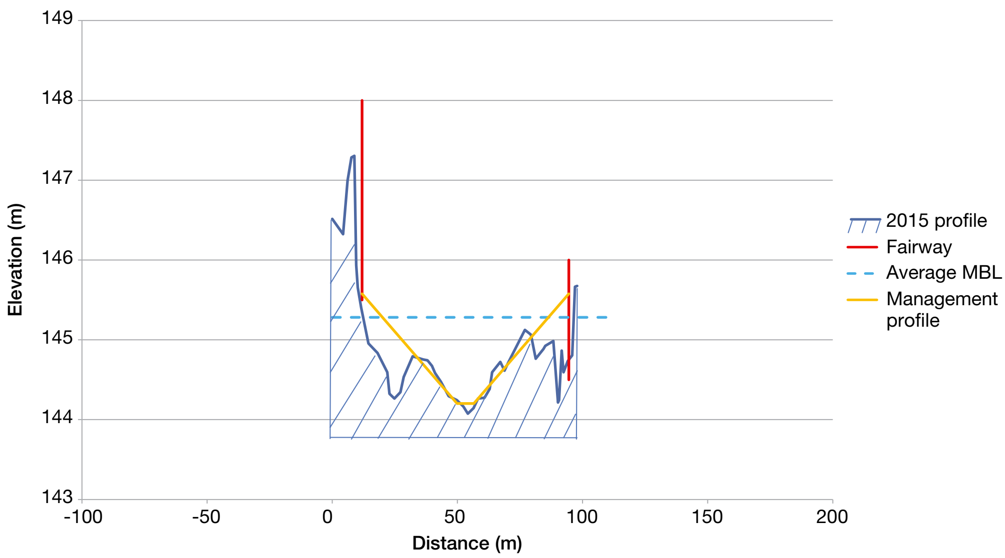

Figure 31 River management profile Kākaunui 5, looking downstream

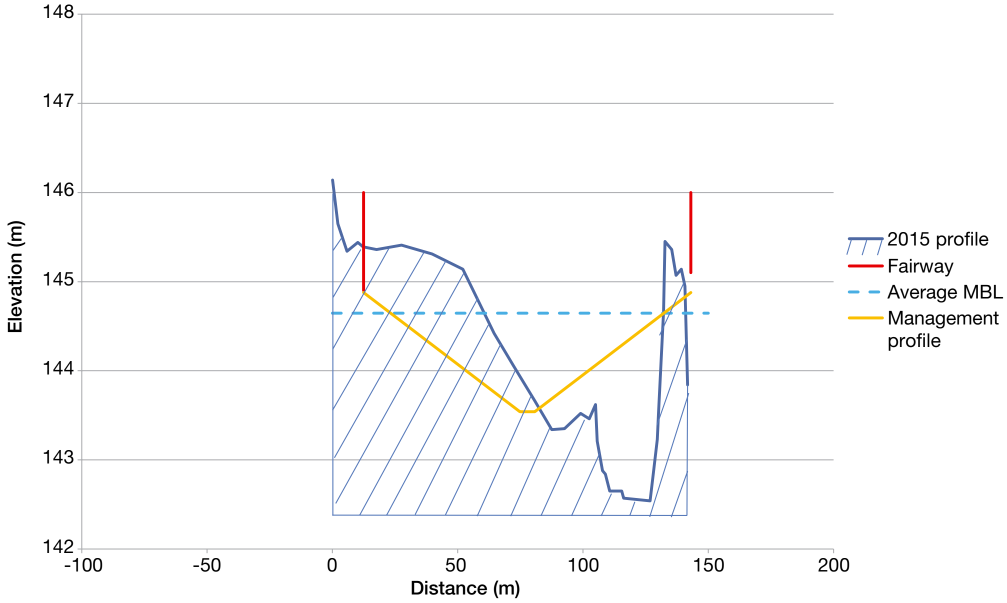

Figure 32. River management profile Kākaunui 6, looking downstream

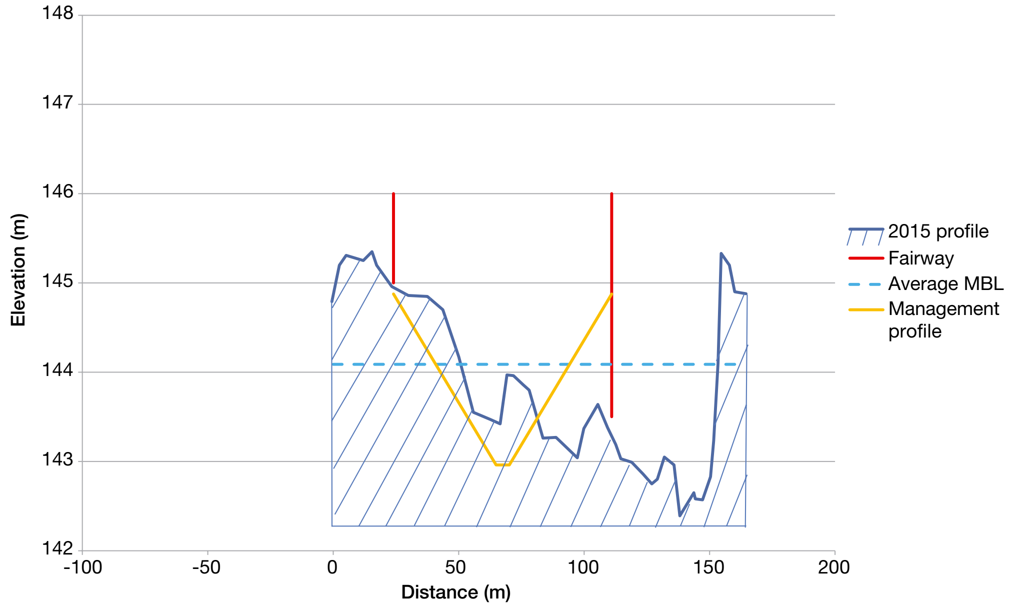

Figure 33. River management profile Kākaunui 7, looking downstream

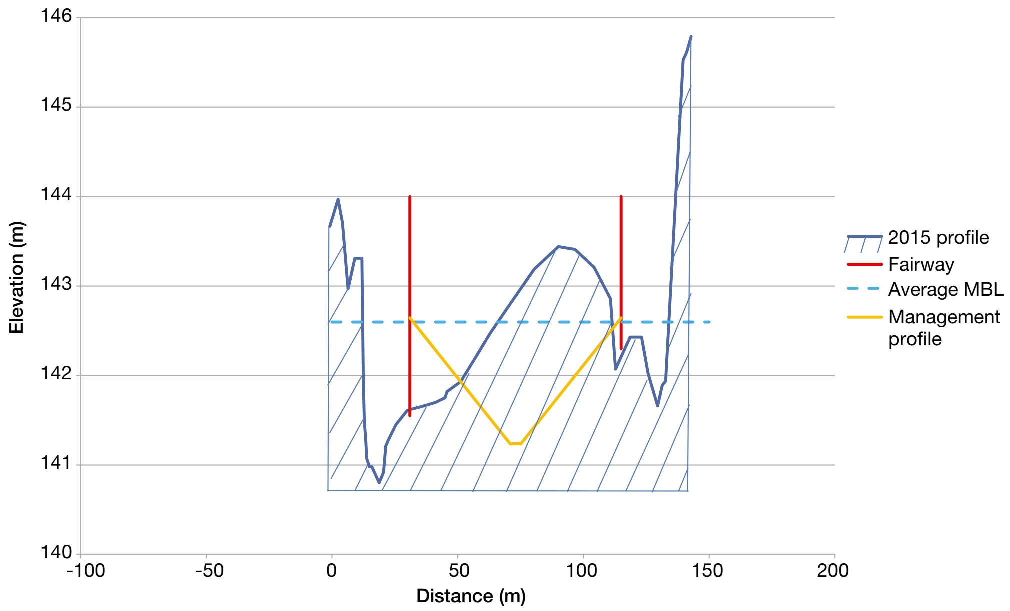

Figure 34. River management profile Kākaunui 8, looking downstream

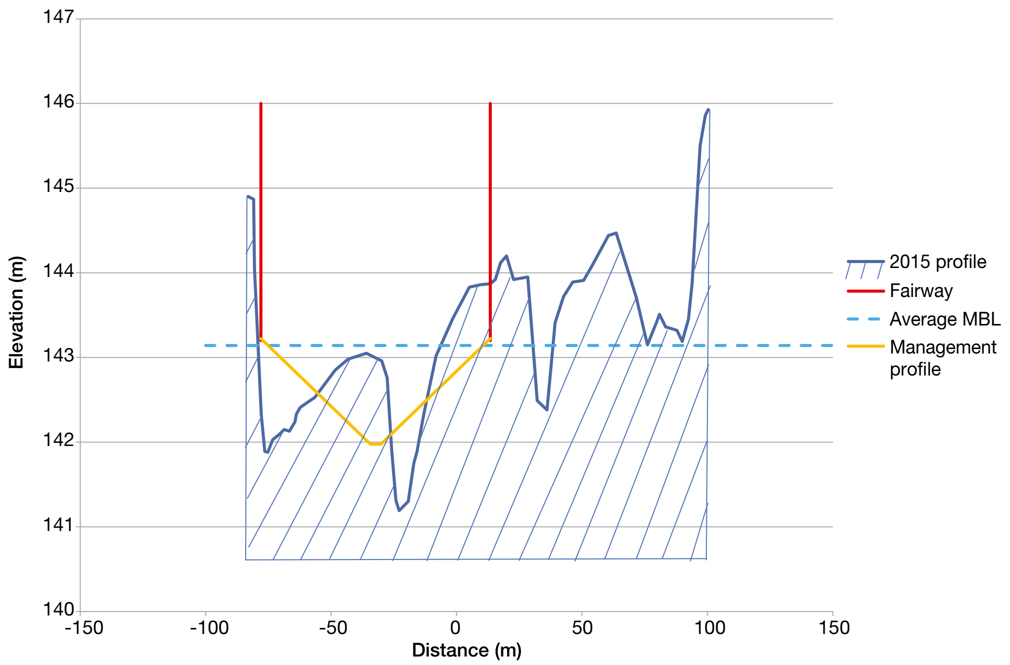

Figure 35. River management profile KA 8, looking downstream

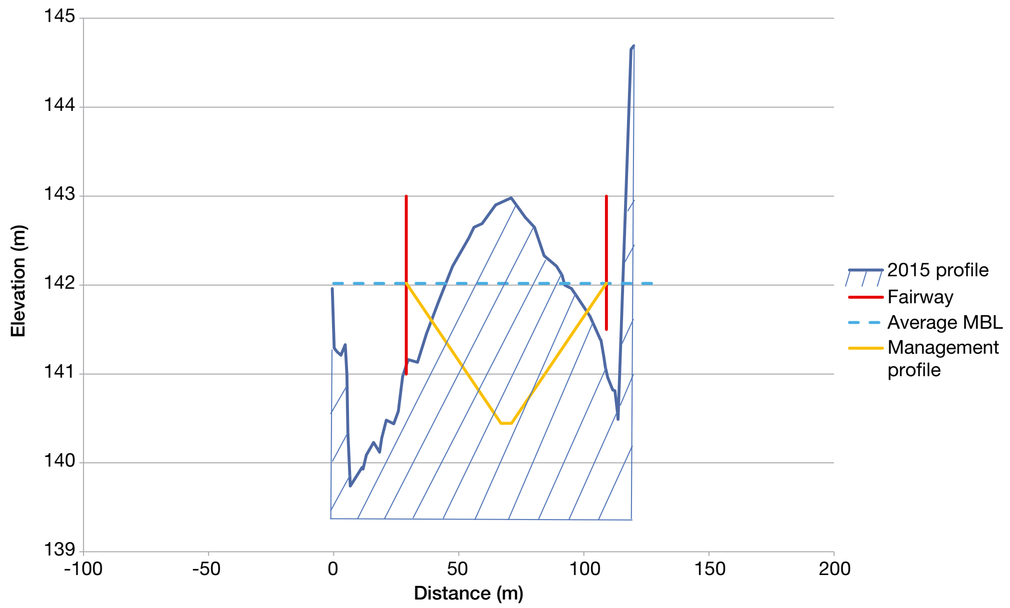

Figure 36. River management profile (Kākaunui 9) looking downstream

Kauru River management profiles

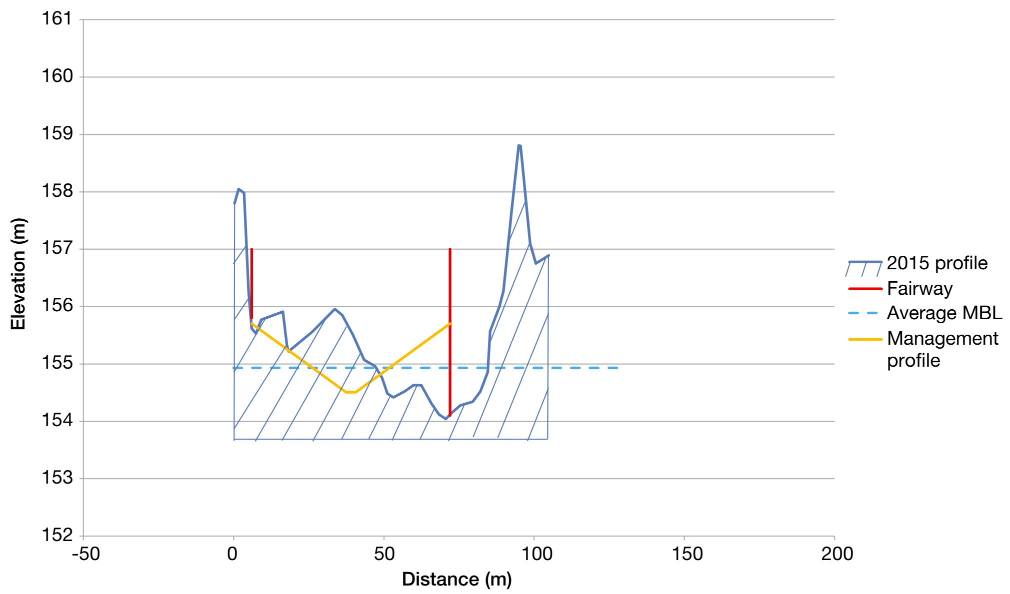

Figure 37. River management profile Kauru 1, looking downstream

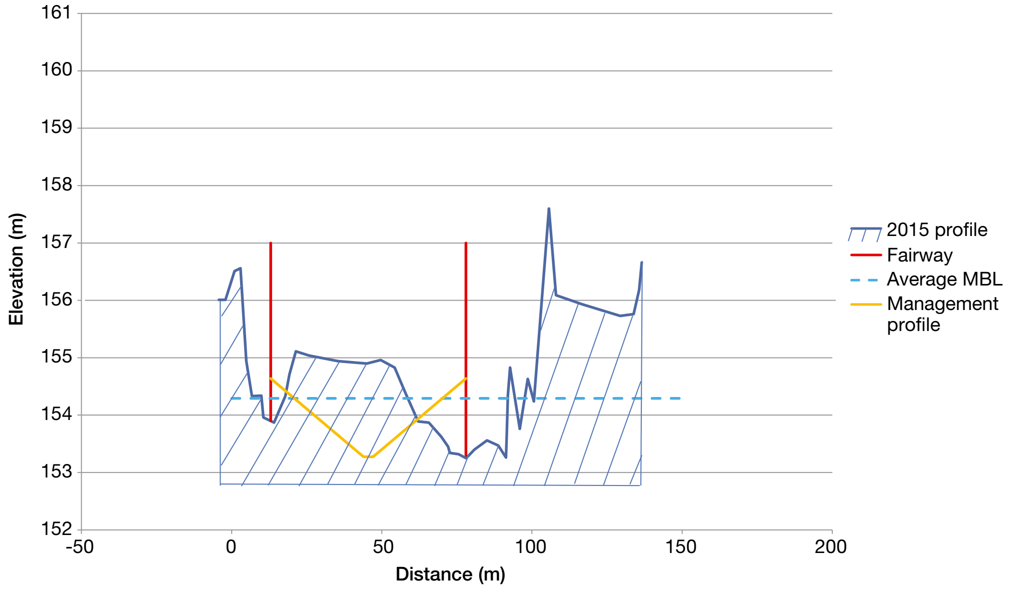

Figure 38. River management profile K1 B, looking downstream

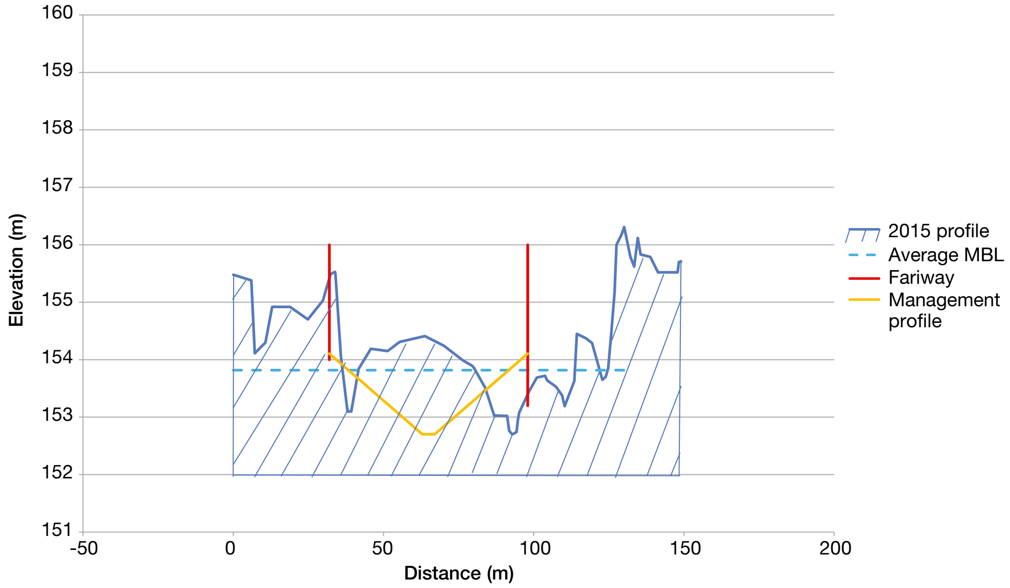

Figure 39. River management profile (Kauru 2) looking downstream

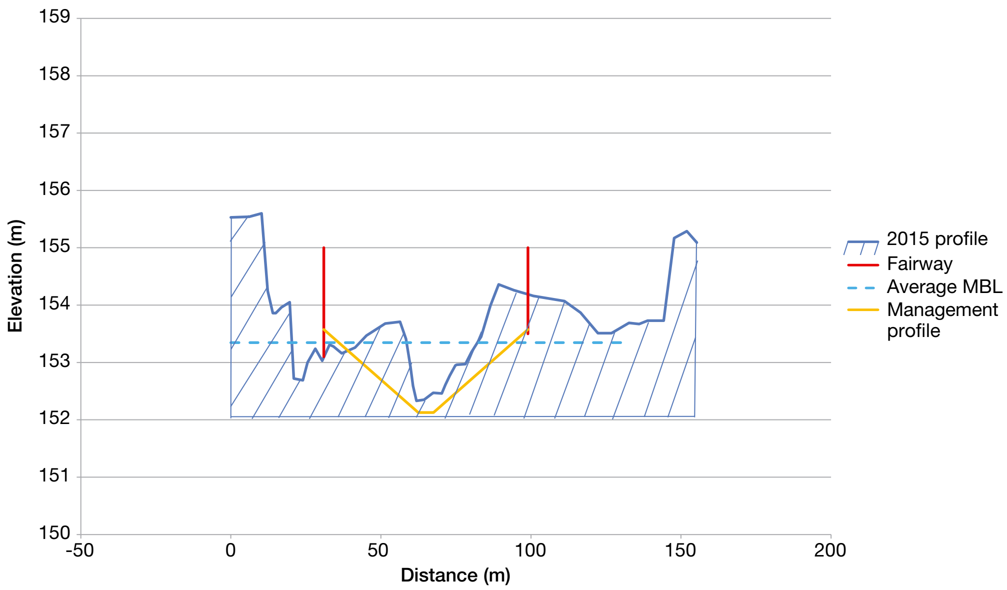

Figure 40. River management profile (Kauru 3) looking downstream

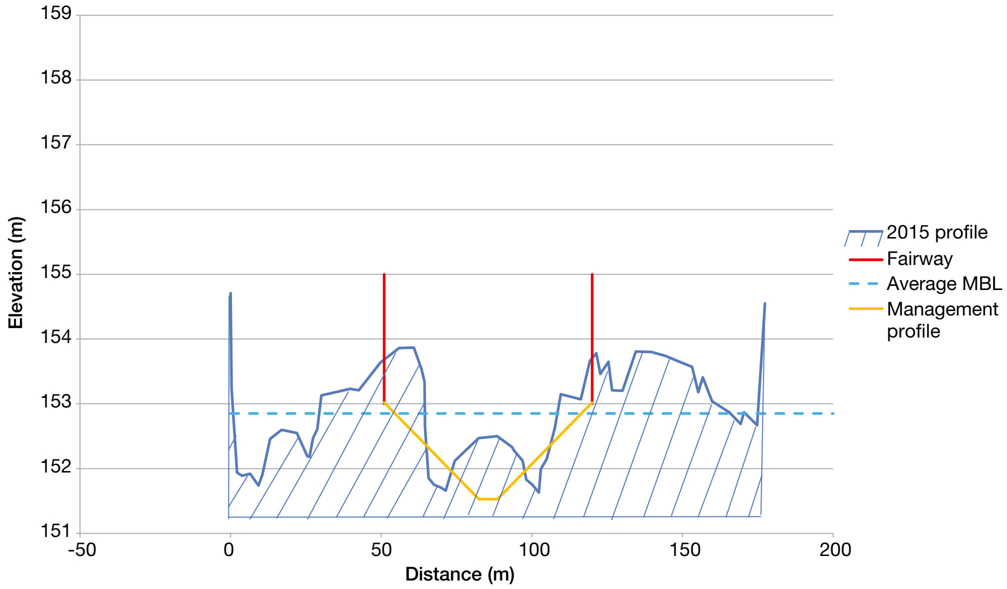

Figure 41. River management profile (Kauru 4) looking downstream

Figure 42. Areas in the Kākaunui and Kauru rivers with management profiles (aerial photography collected in 2013/2014)

Appendix 3. River corridor: Maps

The river fairway and corridor mapping provides guidance for multi-purpose river management, and for the design and implementation of management measures, protection works and in-channel design. When physical works or activities are being considered within the fairway or on the riparian margin, these should be undertaken with reference to the mapped fairway and buffer zones. The method used to define the river corridor is explained in Section 6.

Figure 43. Kākaunui River fairway and corridor Map 1 (aerial photography collected in the summer of 2013/2014)

Figure 44. Kākaunui River fairway and corridor Map 2 (aerial photography collected in the summer of 2013/2014)

Figure 45. Kākaunui River fairway and corridor Map 3 (aerial photography collected in the summer of 2013/2014)

Figure 46. Kākaunui River fairway and corridor Map 4 (aerial photography collected in the summer of 2013/2014)

Figure 47. Kākaunui River fairway and corridor Map 5 (aerial photography collected in the summer of 2013/2014)

Figure 48. Kākaunui River fairway and corridor Map 6 (aerial photography collected in the summer of 2013/2014)

Figure 49. Kākaunui River fairway and corridor Map 6 (aerial photography collected in the summer of 2013/2014)

Figure 50. Kākaunui River fairway and corridor Map 7 (aerial photography collected in the summer of 2013/2014)

Figure 51. Kākaunui River fairway and corridor Map 8 (aerial photography collected in the summer of 2013/2014)

Figure 52. Kākaunui River fairway and corridor Map 9 (aerial photography collected in the summer of 2013/2014)

Figure 53. Kauru River fairway and corridor Map 1 (aerial photography collected in the summer of 2013/2014)

Figure 54. Kauru River fairway and corridor Map 2 (aerial photography collected in the summer of 2013/2014)

Figure 55. Kauru River fairway and corridor Map 3 (aerial photography collected in the summer of 2013/2014)

Appendix 4. Mapped community values

The maps in this section show the location of important values associated with the riverbed and riparian margins, as identified by the community and other stakeholders. The community consultation process is outlined in Section 3.6, Appendix 5 provides a summary of public submissions and Appendix 6 provides actual comments and summarised feedback from landowners and stakeholders.

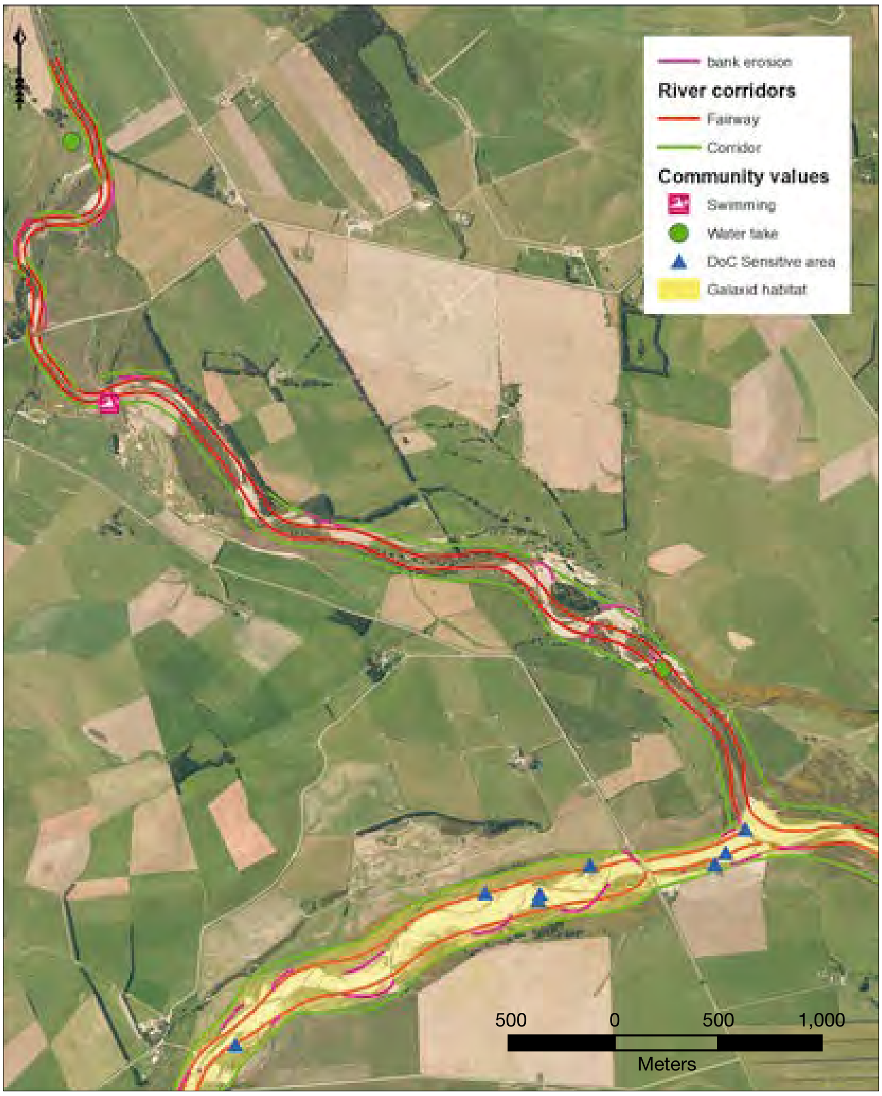

Figure 56. Mapped community values in the Kākaunui River Map 1 (aerial photography collected in the summer of 2013/2014)

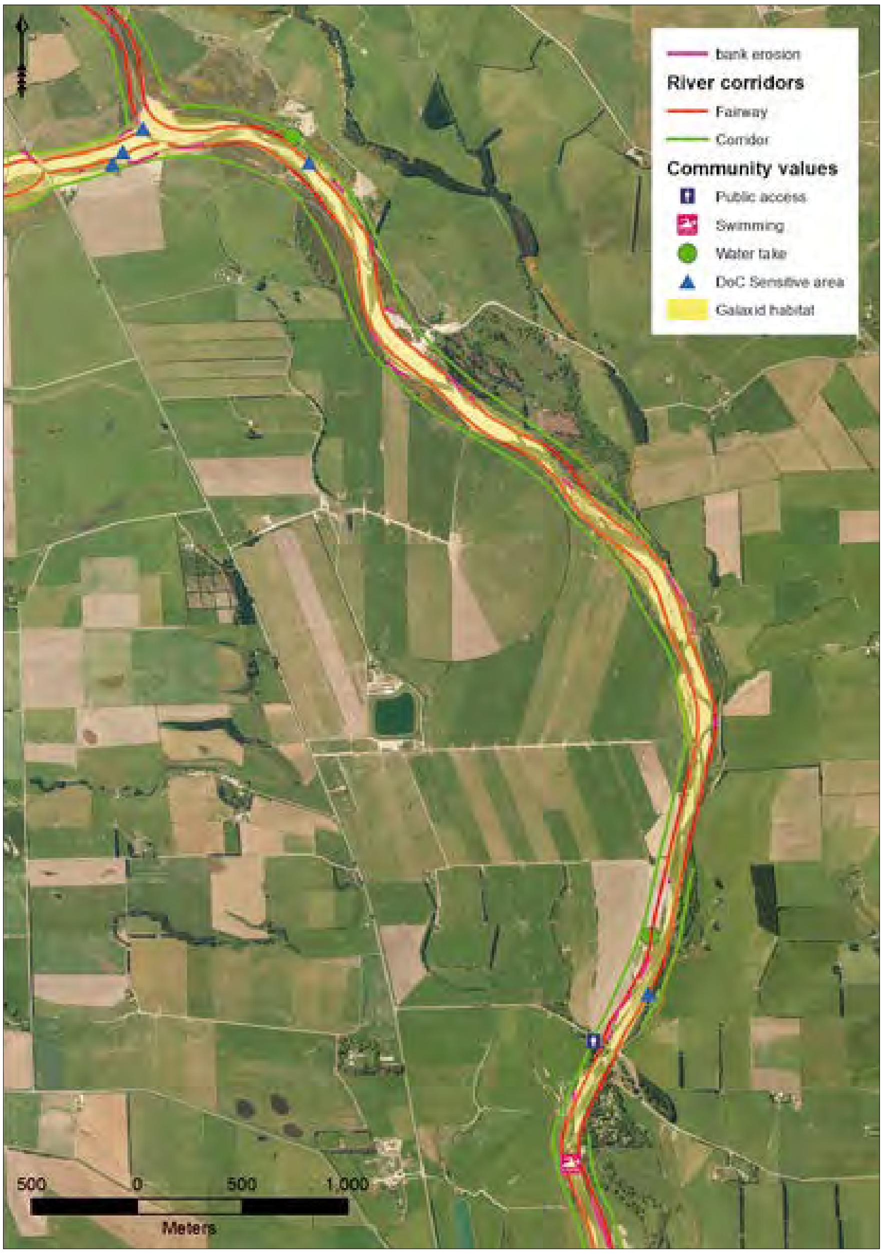

Figure 57. Mapped community values in the Kākaunui River Map 2 (aerial photography collected in the summer of 2013/2014)

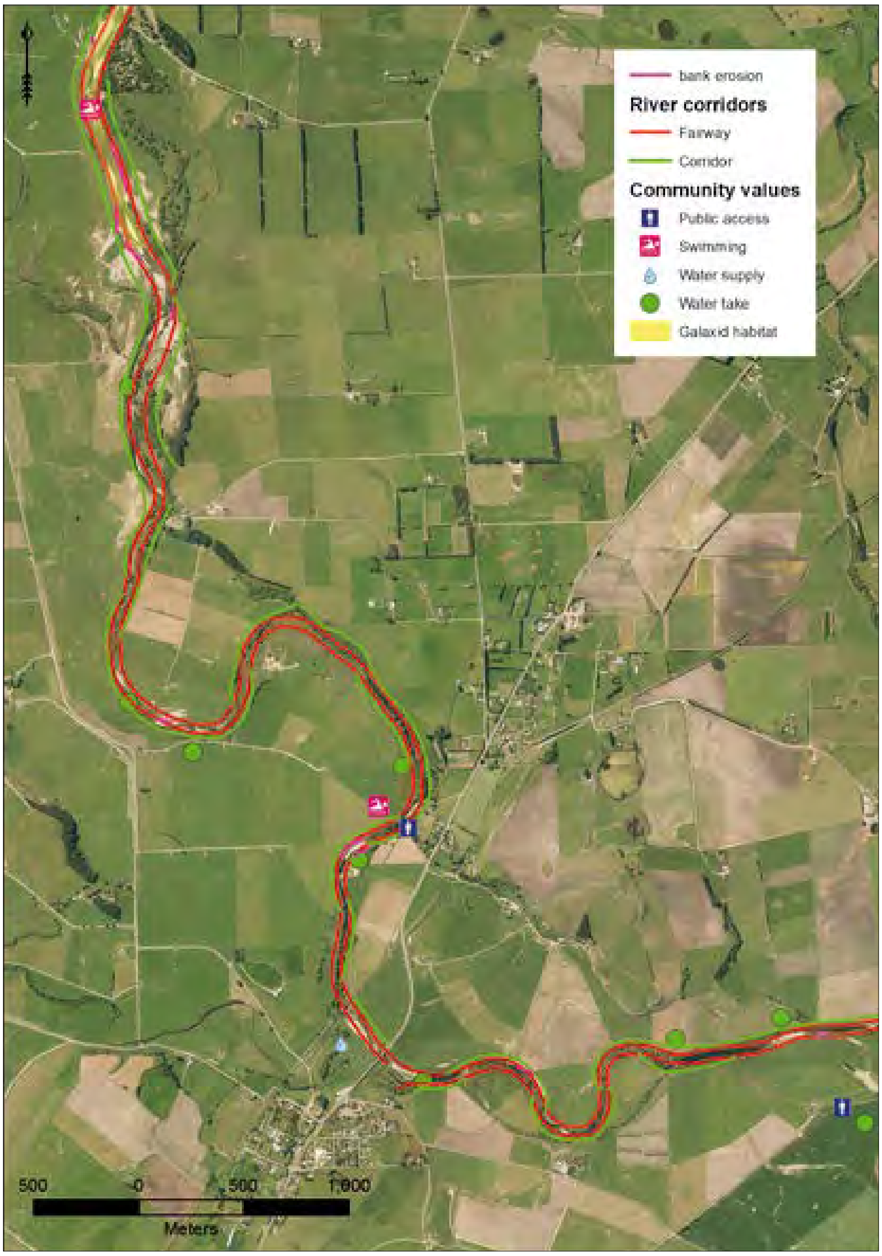

Figure 58. Mapped community values in the Kākaunui River Map 3 (aerial photography collected in the summer of 2013/2014)

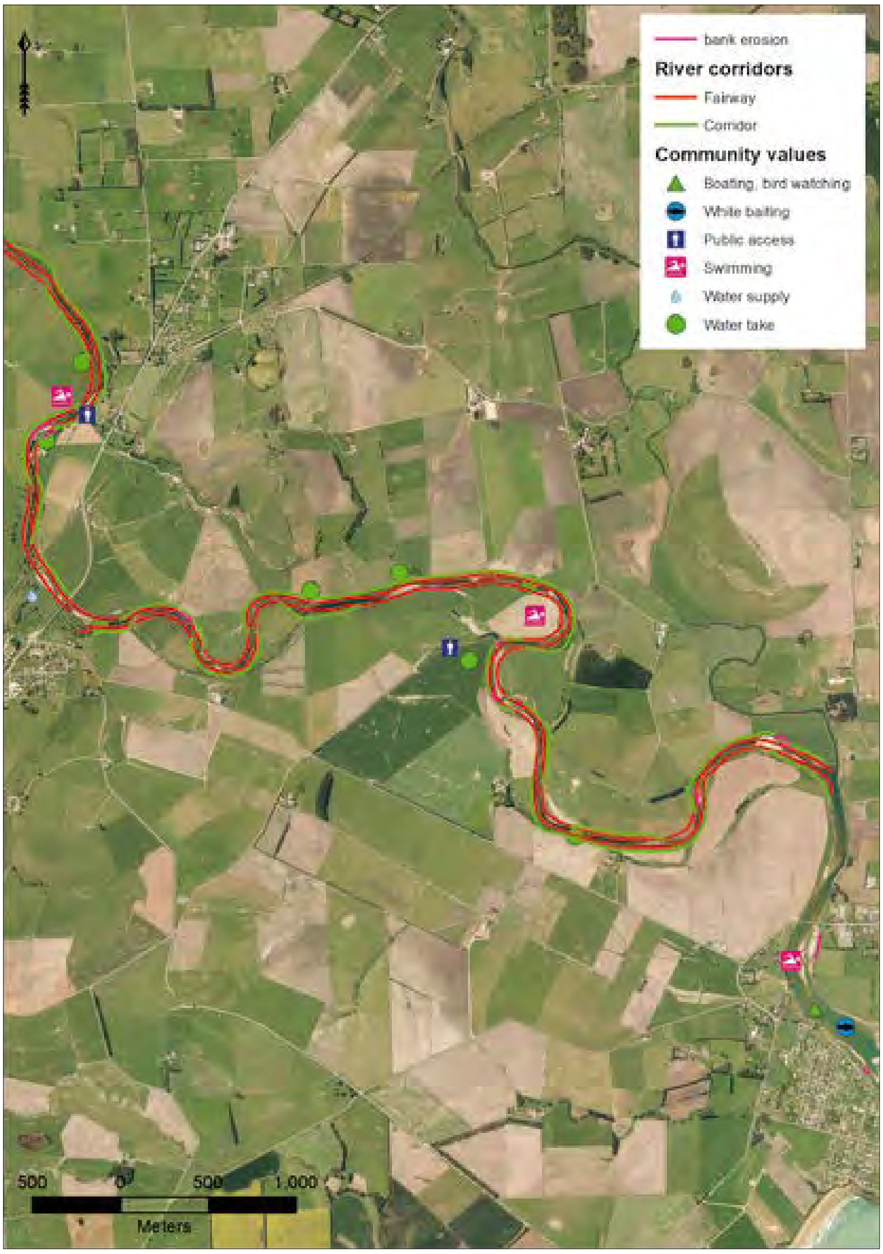

Figure 59. Mapped community values in the Kākaunui River Map 4 (aerial photography collected in the summer of 2013/2014). Note that the Coastal Marine Area boundary extends upstream as far as the Kākaunui Bridge.

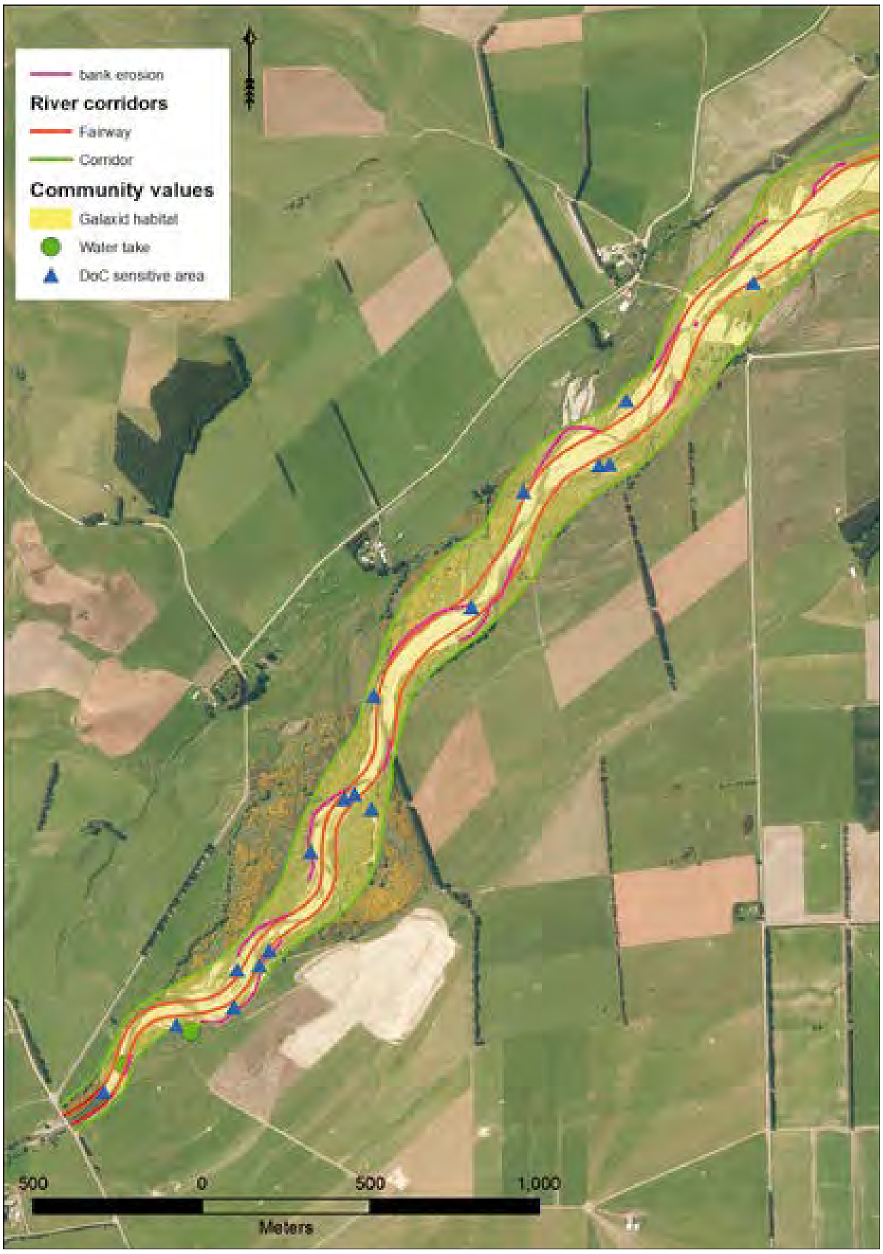

Figure 60. Mapped community values in the Kauru River Map 1 (aerial photography collected in the summer of 2013/2014)

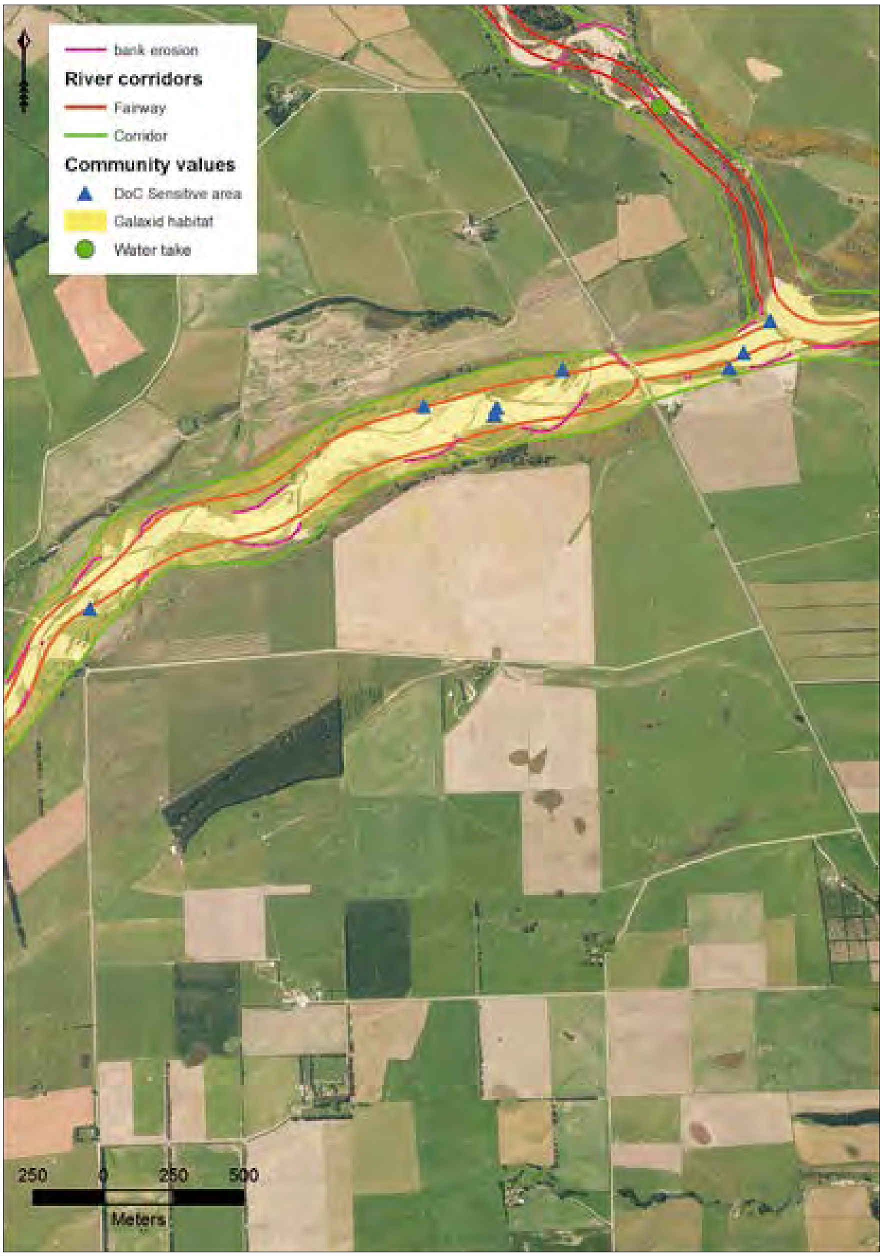

Figure 61. Mapped community values in the Kauru River Map 2 (aerial photography collected in the summer of 2013/2014)

Appendix 5. Community values – public submissions

The community consultation in May/June 2015 included an opportunity for the public to submit on their concerns, as well as a chance to state what they valued about the river and what they would like the strategy to achieve. A diverse range of views and concerns were put forward; some people were concerned that there has been insufficient, or too much, gravel extraction occurring, while others were more concerned with the quality of the water, riparian planting, wildlife habitat, bank erosion, inefficiency of the consenting process, and the mapped river fairways/buffer zones. Numerous submitters emphasised that they were unhappy with the current ORC consenting process for gravel extraction and works on the bed and banks of rivers. There was minimal objection to the proposal to identify buffer zones next to the Kākaunui and Kauru rivers (as discussed in Section 6), although some submitters questioned the width and location of the fairway and buffer zones. There was discussion about what vegetation would work best for the buffer zones (i.e. natives or willows). Several submitters stated that they would like to work collaboratively with the ORC and gravel extractors to complete work in the beds and banks of the Kākaunui and Kauru rivers. A wider catchment approach to management of the Kākaunui and Kauru rivers was discussed in the feedback, as was the use of wetlands and backwaters to mitigate the effects of flooding. One submitter stated that the Kākaunui River had become straighter, less braided and more channelised in recent years. Additional values that were not collected in the initial feedback process (Appendix 6) were also highlighted, such as the river's heritage.

Appendix 6. Community values - feedback from landowners and stakeholder groups

As discussed in Section 3.7.2, discussions were held with landowners and stakeholders in 2014-early 2015. The consultation was framed around two particular topics: i) what concerns they have about the form and function of the Kākaunui and Kauru rivers, and ii) how they would like the rivers to look in the future.

This section provides specific comments, and summarised feedback from landowners, ORC staff, iwi, DoC and Fish & Game, in response to these questions, grouped under four key headings. Some of the key points raised by the community and stakeholders are shown in Figure 62 to Figure 65.

1. The ability of the river to support social, spiritual, recreational and economic values

- A river that returns to being an asset rather than a liability to adjacent landowners (it doesn't cost $$$ in floods).

Want to pass on stories and teach – landscapes – see and understand. Ngai Tahu is a mahinga kai based culture. Children – if they don't have the experience of interacting with the river - you lose a whole cultural identity – if you lose the pieces of the puzzle kids will never be able to play with the puzzle. It's as much about passing on the knowledge as it is as food itself.

- Variety of different habitat – must have variety! Mix of features. Good to have pool or two so we can still have a swim.
- Why does the river need to be modified for just one group – it should be looked after for everyone.
- Good access to the river. Access for elderly. Struggle at Mill Dam at moment but we find a way. Maintain the access points.
- We can ring up and ask – we respect the farmer's property rights.
- A river good for recreational use and clean swimmable water and possibly drink from. Designated areas for recreational activities.
- Supports food gathering
- Amenities: Car parking/toilets provided
- More river use/activities – boats/kayaks
- Access along whole of river – walking.

Characteristics of river differs across length – spawning habitat protected

- Good water quality (in aquifer and surface) and good access – good life supporting capacity and current use – no detrimental effects
- Supports future growth
- Domestic water supplies in Kauru/Windsor – headwaters - supported
- Stock water supplies supported
- No salt water infiltration into groundwater.

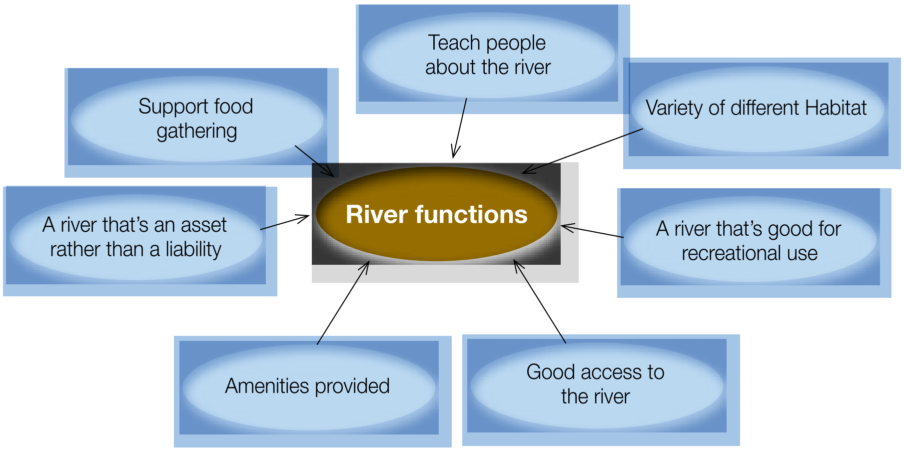

Figure 62. Key points discussed through the consultation relating to river functions.

2. River form: riparian plantings, vegetation and fencing

Like to see more native riparian planting on banks. No willows – natives!

- Lots of infrastructure but no planting.
- Lot of faith in ORC scientists! Would like to say the plantings have function – something tangible. Assurance from ORC technical staff that it serves a purpose.
- Natives plants will help species in the water – and will also get cultural materials (e.g. flax). Access currently – if we want them we'll find them! But don't want to spend petrol to travel for materials and food.
- Iwi see it as: cleans the river. Acts as a filter.

Many views that the riverbanks should be planted with vegetation, managed, with healthy strong trees, willows often mentioned, but also natives and planting for beautification as well as erosion protection.

- Ensuring there is no vegetation in the centre of the river.
- Trees (mix of willows and natives) – planting at right place for river management and naturalised (not straight rows)
- Good shading/habitat/stable banks
- Blue/green corridor – between mountains and sea – wildlife corridor
- Fenced by ORC.

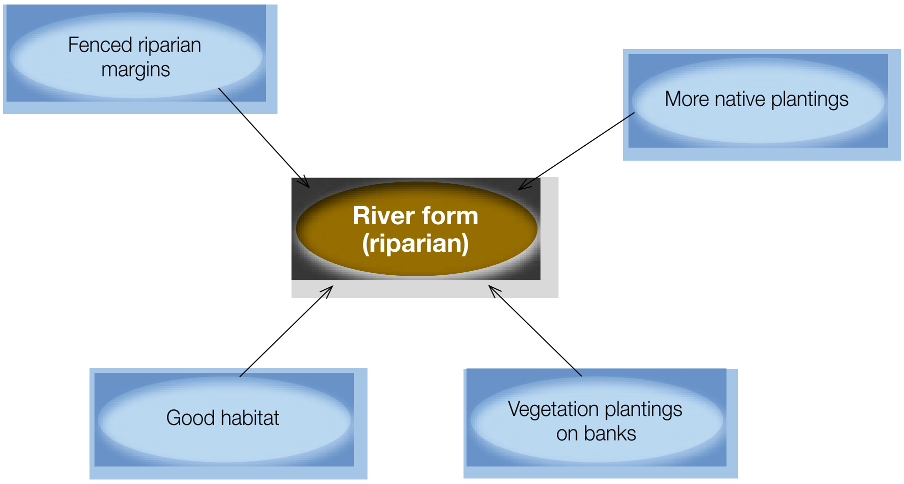

Figure 63. Key points discussed through the consultation relating to river form (riparian margins).

3. River form and function: human modification

3.1 - Responses favouring no/limited engineering work

River straightening etc – completely oppose. It should look natural. Natural is change – let the river do what it naturally does.

- Riffles clean the water – go downstream of riffle.
- It is hard for Whānau to know what is achievable. Everyone hashad a play in the river already. Reduced flows, gravel taken, flood banks constructed. Is anything doable? Not asking to turn back the clock but how far can we go? Explore what is feasible.
- Understand that farmer makes investment in dairy farm – but we are not prepared to have more engineering work.
- Not asking for bridges and other constructions to be removed but not any further engineering.
- A clean slow flowing river.

Clean, nice braids, happy river, has 'mojo' back, happy, filled with life

- Good flow in summer – more natural variation (history of extraction – minimum flow regime)
- Rocks clear of algae (early 2000)
- Abundant fish life
- Water crystal clear.

3.2 – Responses favouring some engineering work

- A river that stays within its banks and on course. Some variation on when this should be expected - at normal events, at high flows, in most flood events.

A deeper river channel that sits below the adjacent land.

- A meandering river within a reasonable channel.

3.3 – Responses favouring considerable engineering work

- Would look like Leith – water stays in channel all time – all floods – farm to edge – no erosion
- Not river 'management' – river 'control' – so river predictable.
- Good bridge/road access and river management.

3.4 – Responses wanting to 'turn back the clock'

- No farms/farmers.

Estuary – not green in summer – open during low flows – connected to the sea.

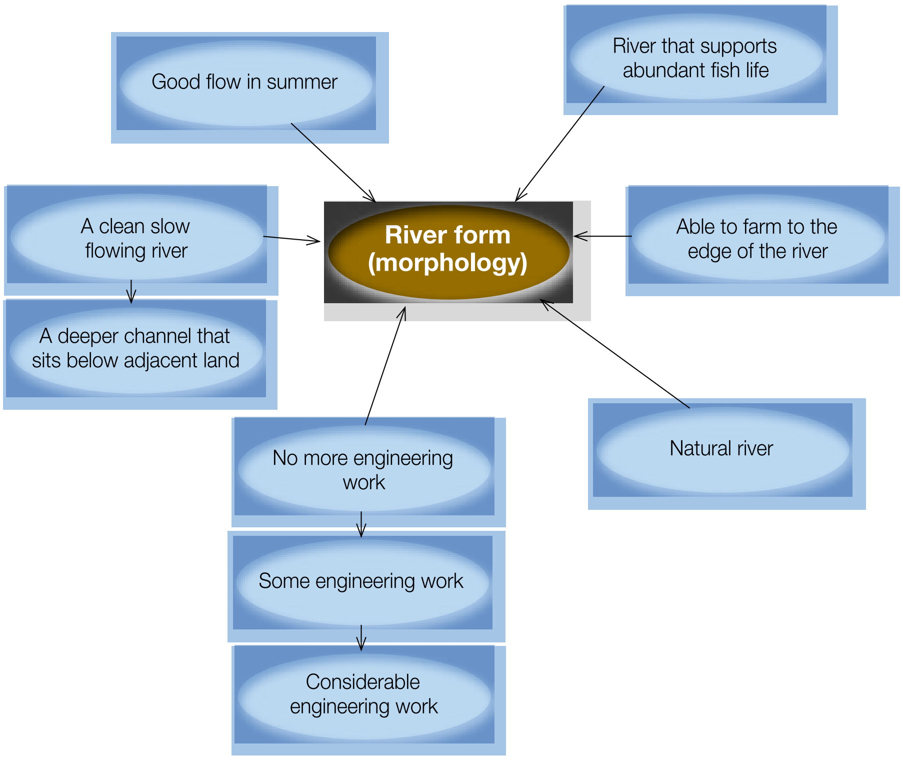

Figure 64. Key points discussed through the consultation relating to the Kākaunui and Kauru rivers form (morphology).

4. The Kākaunui and Kauru riverbeds as a gravel resource

Understand where the whitebait actually live and how they have survived regardless of activities in the river over time.

- Ensuring that there is a sustainable gravel resource for use by the community.
- Being able to act on a global consent.
- Geological formation? Kauru has basalt – quite unique
- Valuable gravel resource – aggregate – available for commercial/community use.
- There has to be a change in thinking and direction from ORC Engineering Staff to take into account the devastation and damage that is occurring during every current flood event. If this requires a change at policy level or governance level within ORC then please list this as one of the main objectives of this review – to make the overall system manageable.

It was mentioned previous ORC river engineers including David Knowles had a **practical approach to managing these rivers and was able to react with targeted extraction and bank reinstatement after each event enabling better management of difficult areas in the river and a common sense approach to extraction over all years – not just the wet ones.**

- This is a low cost, practical, easy to manage approach to doing something positive with the problems and issues that we now have with both extraction and bank reinstatement being possible and largely being organised between the gravel extractor and the landowner – **all we require is consent to be able to undertake this type of work.**
- It is hard enough to get even low volume extraction consent at present (some taking a number of years) let alone obtaining consent to re-channel rivers closer to the centre line and to extract gravel from below water level to be able to achieve this. In the practical world this work isn't hard to do – just difficult and expensive to get consent for. Part of this would also include reinstating eroded banks as was carried out in past decades usually with long term success.

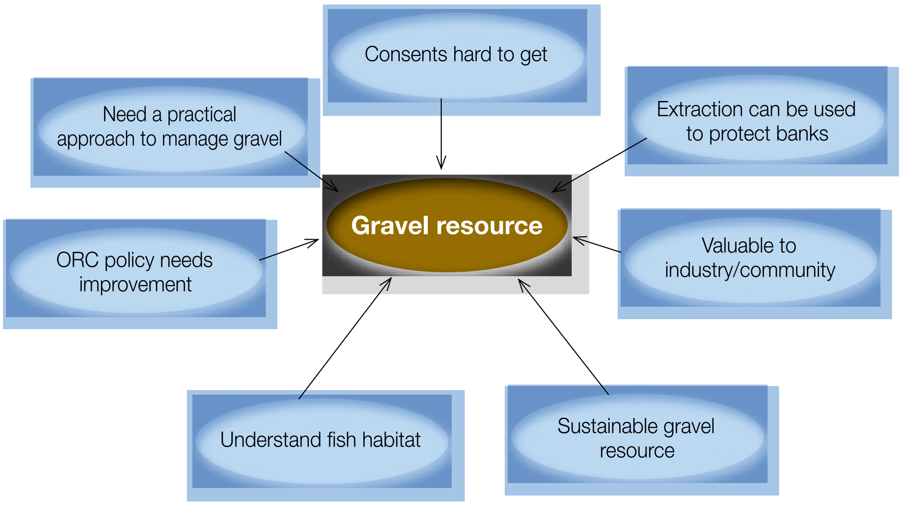

Figure 65. Key points raised through consultation relating to using the riverbed as a gravel resource

Appendix 7. Longitudinal profiles

Rivers generally increase in size (width/depth) and flow downstream as they receive additional flow from tributary waterways. This is the case with the Kākaunui and Kauru rivers, which change from small waterways in the Kākaunui Mountains to larger rivers close to the coast/confluence.

The longitudinal profiles of the Kākaunui and Kauru rivers display the typical concave shape, with steeper areas in the upper catchment and a shallower profile closer to their termination (Figure 66, Figure 67). The longitudinal profiles vary over time in response to several factors, including: discharge, sediment (size and location), flow resistance, velocity, width, depth and slope (Leopold et al., 1964). The longitudinal profile of the Kākaunui and Kauru rivers will change over time due to the factors listed above. It is difficult to describe what the 'natural form' of the longitudinal profile of the two rivers is; however, events causing negative changes (e.g. excessive gravel removal) in the longitudinal profile should be discouraged.

Sediment accumulates in channels, due to several factors, such as where a change to a shallower grade allows velocities to slow down; this allows sediment to drop out of suspension where it rests on the bed of the channel and adjacent berm areas. The main section of the Kauru River where shallower grades allow sediment to become deposited is downstream of the Kākaunui Valley Road Bridge, to the confluence with the Kākaunui River. In the Kākaunui River, areas of natural gravel accumulation occur at the confluence with the Kauru River, and at Robbs Crossing.

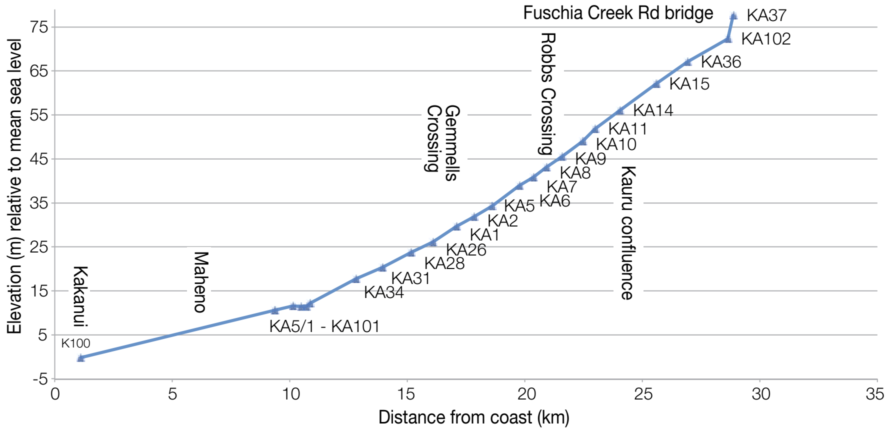

Figure 66. Longitudinal profile of the Kākaunui River (using the 2012 survey)

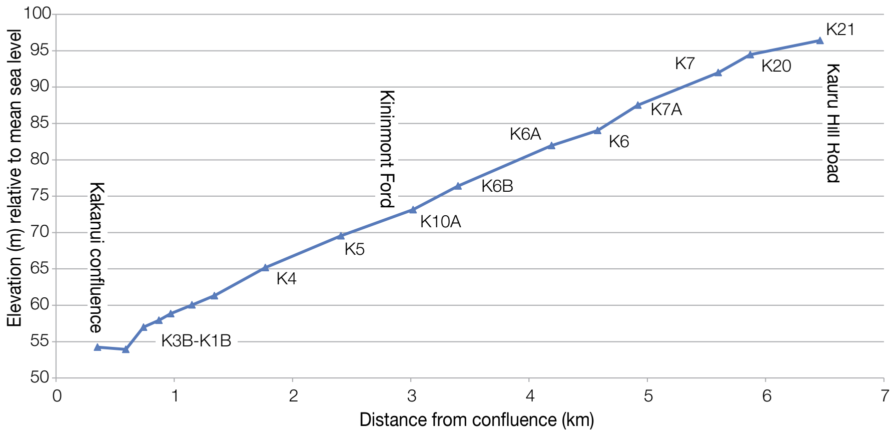

Figure 67. Longitudinal profile of the Kauru River (using the 2013 survey)

Appendix 8. Planting guide

Benefits of riparian planting[20]

The benefits of well-planned and well managed riparian planting areas on farms are considerable, and include:

- increasing the quality and health of waterways
- increasing the ability to filter nutrients before they reach waterways – Nitrogen, Phosphorus, and bacteria/viruses e.g. E.Coli
- reducing sediment runoff
- reducing soil erosion of banks in waterways
- providing shade, which reduces waterway temperatures and shelter for stock
- minimising stock losses as animals are excluded by fences from riparian strips
- increasing biodiversity – aquatic life, native plants, birds and insects
- improving recreational opportunities (e.g. fishing)
- enhancing and beautifying the river margins.

Using trees to stabilise stream banks[21]

Exotics

The most effective trees for stream bank erosion control are exotic willows and poplars. These are planted as stakes (less than 1 m high) or poles (1.5 – 3 m in height). Avoid invasive spreading species, such as crack willow, weeping willow, silver poplar and all non-sterile tree and shrub willows. Before planting fast growing trees, consider their longer-term maintenance needs.

Winter is the best time to plant these species before stakes or poles sprout new growth. Plant about a third of the length below ground. On waterlogged ground, you can force them in by hand. On firm ground, you may be able to sharpen poles at one end and drive them in with a rammer or use a post auger. Stakes can be planted by putting them into a hole made with a length of reinforcing rod or similar. The most important thing is to make sure stakes and poles are firmly planted.

Guide to planting willow poles

Storage

It is recommended that poles are planted as soon as possible following delivery. Poles can be stored for a few weeks in water, stand up in a water trough or pond/creek. The bottoms of the poles should be kept wet to keep them alive and absorbing water. Poles should be stored away from stock.

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[20] Adapted from KCCP planting guide (2015)

[21] Adapted from ORC (2005)

Planting

Poles should ideally be planted on the outside of river bends, or sections of river where erosion is occurring. Plant poles in rows with 2 – 3 m spacing between them. Poles need to be planted 300-500 mm deep. Try and plant down to ground water level. Either a crow bar, post-hole borer or tractor forks/digger with a spike can be used to make a hole in the ground that the pole can be dropped into, and then packed firm.

Looking after plantings

Fence planting off from stock to protect plants; plant protectors can also be purchased and can help give protection. It is recommended that poles are watered the day after planting and at least once a week during dry weather until they are established.

To stabilise banks:

- ✓ pair-plant along straight reaches – one tree on one bank, one tree on the opposite bank, five to seven meters apart.
- ✓ plant at two to three metre spacing at critical points, such as the outside of the bends where erosion is the greatest.
- ✘ avoid planting on the inside of bends – soil builds up rather than erodes here, so trees will trap sediment and force current against the outer bank.
- ✘ avoid planting narrow channels where trees might impede floodwaters.

By the time trees are four- or five-years old, there will be a solid mass of roots along the bank. At 10 to 20 years, trees can be thinned to 10 to 12 metre spacing, but no wider. If you use sleeves on poles to protect the willows and poplars, sheep can be grazed around the trees from the time they are planted.

Natives

Planting natives for bank stability will enhance the natural biodiversity of your riparian margin and provide habitat for invertebrates and birds. While exotic tree species are proven to stabilise banks, new research shows that native trees, such as ribbonwood, cabbage tree and pittosporum species, are suitable for bank stabilisation. These species are deep rooting, with a good root spread. Planting native species alongside exotics will help to maintain a mostly native planting on your banks. When planting natives for bank stabilisation, plant at 1.5 – 3 metre spacing.

Appendix 9. Threat status of native fish and birds

Table 6. Native fish present in the Kākaunui and Kauru rivers, with their threat status (Goodman et al. 2014)

Super-category	Threat Status	Common name	Scientific name
Threatened	Nationally critical	Lowland longjaw galaxias	*Galaxia cobitinis*
	Nationally vulnerable	Lamprey	*Geotria australis*
At risk	Declining	Longfin eel	*Anguilla dieffenbachia*
		Torrentfish	*Cheimarrichthys fosteri*
		Koaro	*Galaxias brevipinnis*
		Inanga	*Galaxias maculatus*
		Canterbury galaxias	*Galaxias vulgaris*
		Bluegill bully	*Galaxias hubbsi*
		Redfin bully	*Gobiomorhus huttoni*
Not threatened		Shortfin eel	*Anguilla australia*
		Upland bully	*Gobiomorphus breviceps*
		Common bully	*Gobiomorphua cotidianus*
		Giant bully	*Gobiomorphus gobioides*

Table 7. Native birds present in the Kākaunui and Kauru rivers, with their threat status (Robertson et al., 2012)

Super-category	Threat Status	Common name	Scientific name
Threatened	Nationally critical	Black stilt	*Himantopus novaezelandiae*
	Nationally vulnerable	Banded dotterel	*Charadrius bicinctus bicinctus*
At risk	Declining	White fronted tern	*Sterna striata striata*
		South Island pied oystercatcher	*Haematopus finschi*
Not threatened		New Zealand kingfisher	*Todiramphus sanctus vagans*
		Shining cuckoo	*Chrysococcyx lucidus lucidus*
		Grey warbler	*Gerygone igata*

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Strategy Overview

Morphology and Riparian Management

Shag/Waihemo River

Why have a Morphology and Riparian Management Strategy?

A morphology and riparian management strategy will ensure future generations can continue to enjoy Otago's beautiful landscape.

Otago Regional Council (ORC) engaged the community, including local iwi, to ensure their values and beliefs are represented in the strategy in a way that enhances the natural ecology of the area.

Ko te wai te ora ngā mea katoa
Water is the life giver of all things

More Information

The full Morphology and Riparian Management Strategy is available online. Access the strategy for the Shag/Waihemo river here:

www.orc.govt.nz/ShagWaihemoRiver-MRMS

Contact

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www.orc.govt.nz/contact-us

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Otago Regional Council

Objectives

Recognise and characterise natural river processes

- Collect information about flood and erosion processes
- Report on changes in channel morphology
- Provide information to the community
- Identify the location of river corridors within which the river will naturally meander

Promote activities that enhance natural character and enjoyment of the river

- Encourage the establishment of riparian plantings that are practical and appealing
- Provide access and habitat for sustainable fishing and white-baiting activities
- Support pest and weed control activities
- Discourage dumping, and arrange regular collection of rubbish
- Provide maps showing the location and characteristics of features that are of high value to the community

Equip the community to live with the effects of changes in river morphology

- Promote land-use practices and placement of assets that reduce the risk of changes in riverbed morphology
- Consider all options to manage the effects of bank erosion, including structural and non-structural options
- Enable works to improve the conveyance of floodwater and 'train' the river within its natural corridor, without compromising the features that are of high value to the community and iwi

Enable sustainable gravel extraction

- Identify areas where gravel accumulation can naturally occur
- Identify areas where permanent removal of gravel may have a detrimental effect on assets, riverbed morphology or community values
- Identify minimum bed levels/profiles, below which extraction must not occur

More Information

Access the strategy for the Shag/Waihemo river here: www.orc.govt.nz/ShagWaihemoRiver-MRMS

Ko te wai te ora ngā mea katoa
Water is the life giver of all things

Otago Regional Council

Actions

Native Plantings on Riparian Margins

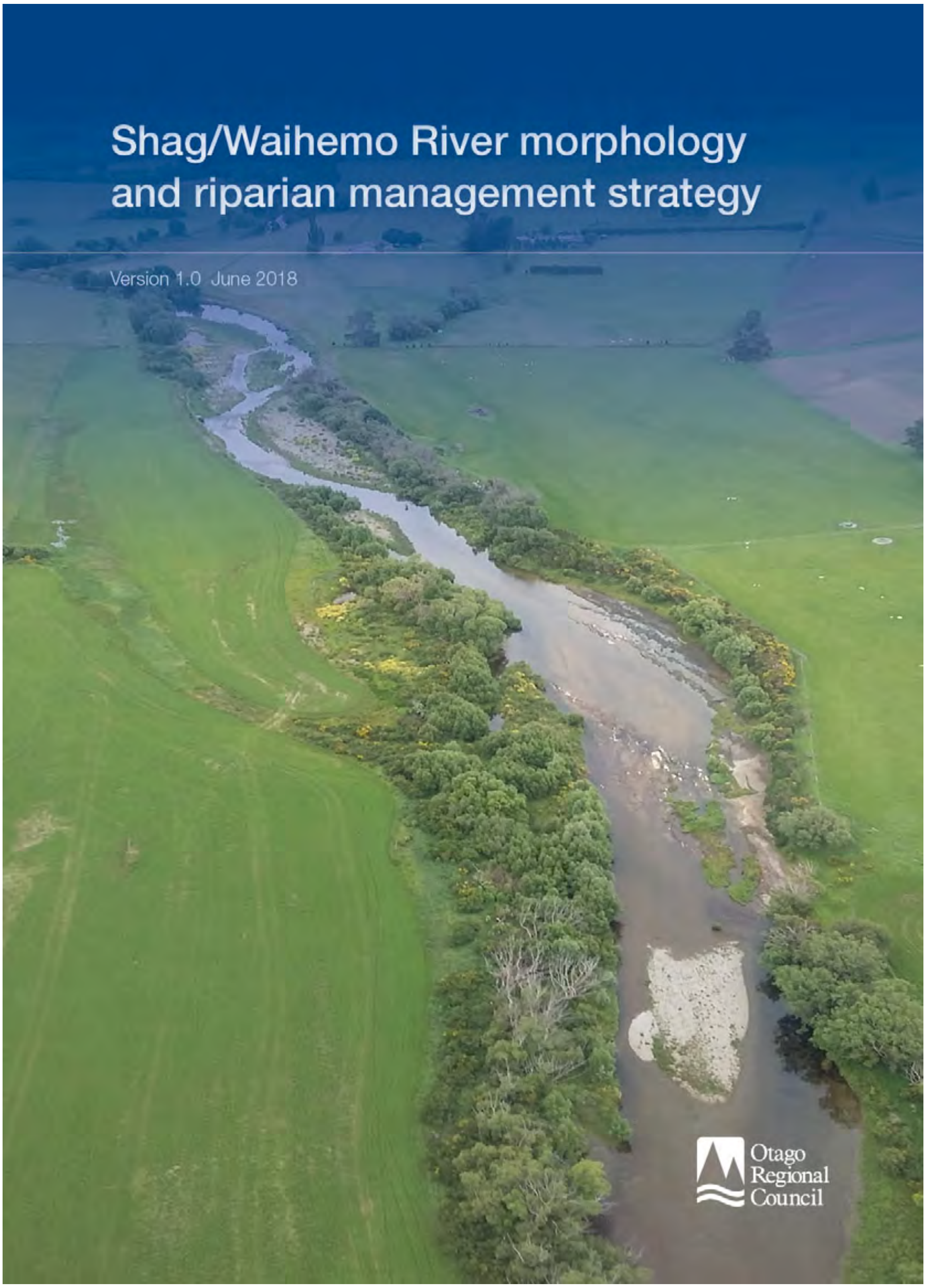
- Increase stability of riparian margins and riverbanks
- Improve habitat and community values
- Improve appearance of the river margins

Physical Works on Flood Conveyance

- Convey flood water within the natural fairway (or riverbed) without overtopping
- Re-alignment of the channel
- Maintenance of fairway
- Works do not compromise features that are of high value to the community and iwi

Gravel Extraction Management

- Continued morphological studies to ensure sustainable gravel-takes
- Moving sediment from an accumulating gravel beach onto an adjacent eroding bank
- Maintain channel shape to mitigate bank erosion and flooding
- Extraction will not compromise features that are of high value to the community and iwi


Shag/Waihemo River morphology
and riparian management strategy
Version 1.0 June 2018
Otago
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Overview

The Shag River/Waihemo morphology and riparian management strategy has been prepared by the Otago Regional Council (ORC), with input from the local community, to help protect the recreational, cultural, spiritual and ecological values of the Shag River/Waihemo riverbed, and to enable long term sustainable use of the land that borders the river. The strategy, as summarised in the two diagrams overleaf, is intended to help achieve this by guiding work programs, decision-making, and activities for the community, stakeholders, iwi and ORC. It is therefore recommended that people who live, work, or play within the Shag River/Waihemo catchment consider, and give effect to, the principles, objectives, and actions listed in this strategy.

The strategy is not a statutory document; rather it is intended to present the aspirations of the community, iwi and the various stakeholder agencies. However, the statutory processes that do influence river management activities[1] are more likely to be used effectively and efficiently if there is a general consensus on what is valued about the river, and commonly understood objectives.

The strategy is intended to be a living document, which will evolve in response to new information, changes in the environment, the needs of the community and iwi, and the work of the ORC and other stakeholders. The strategy will be reviewed regularly, and this process will involve landowners with property alongside the river, other stakeholders, and ORC[2] working in partnership with iwi, and will help to set priorities and work programmes for all of these groups. The strategy document will also record progress made towards achieving the stated objectives. It is intended that version 2 of the strategy will include further guidance and plans for undertaking planting on riparian margins, for river management purposes, and for habitat enhancement.

[1] Including the Local Government Act (in regards to funding considerations), and the Resource Management Act (in regards to environmental effects)

[2] In particular, staff with responsibilities for river and waterway management and natural hazards

Mana Whenua

Mana Whenua literally means 'the people with mana over the land' and refers to the whānau (families), hapū (sub-tribe) or iwi (tribe) of a particular area who are recognised as holding the traditional rights and responsibilities within that area to manage and govern natural resources.

Ngāi Tahu[3] is the iwi that is Mana Whenua in Otago. Te Rūnanga o Ngāi Tahu (the iwi authority) is made up of 18 Papatipu Rūnaka. Located predominantly in traditional coastal settlements, Papatipu Rūnaka are a focus for whānau and hapū who have Mana Whenua status within their area. Te Rūnanga o Moeraki and Kāti Huirapa Rūnaka ki Puketeraki are the two Papatipu Rūnaka of Ngāi Tahu who are Mana Whenua of the Waihemo catchment.

Kāi Tahu – Treaty Partner

Te Tiriti o Waitangi (the Treaty of Waitangi) is the founding document for New Zealand, the basis on which the partnership between Māori and the Crown was established. The Kāi Tahu rakatira Karetai and Korako signed the Treaty at Pukekura (Taiaroa Head) on 13 June 1840. Kāi Tahu considered that the Treaty bound the whole tribe of Kāi Tahu irrevocably to an agreement which imposed responsibilities on both signatories, the Crown and Kāi Tahu. The Otago Regional Council has an established relationship with Kāi Tahu based on the treaty partnership. Partnership between the ORC and Kāi Tahu embodies the principles of the Treaty of Waitangi in decision making and local environmental management.

[3] In the south of the South Island, the local Māori dialect uses a 'k' interchangeably with 'ng'. The preference is to use a 'k' so southern Māori are known as Kāi Tahu, rather than Ngāi Tahu. In this document, the "ng" is used for the iwi in general, and the "k" for southern Māori in particular.

Shag River/Waihemo morphology and riparian management strategy - overview

Purpose

- To provide guidance to landowners, stakeholders, iwi and the community for good decision-making and appropriate activities within the riverbed and on the riparian margins of the ShagRiver/Waihemo.

Vision

- The long-term sustainable use and enjoyment of the Shag River/Waihemo and its riparian margins.

Functions

Appropriate guidance and active engagement to empower good decision-making. Ensure activities are undertaken in a sustainable and appropriate manner.

Understand natural river processes and morphological characteristics, and the potential effects of those on the river and its margins.

The wise use of resources to:
- Manage the risk to property and assets
- Enable sustainable gravel extraction
- Protect and enhance community values
- Improve community resilience.

A shared vision of the river's values and features to be utilised, preserved and enhanced.

Shag River/Waihemo morphology and riparian management strategy - overview

Objectives & associated activities (these are further refined in Section 8 - implementation)

1. To recognise and characterise natural river processes.	**2. To equip the community to live with the effects of changes in river morphology.**	**3. To enable sustainable gravel extraction.**	**4. To promote activities that enhance natural character and enjoyment of the river.**
Collect information about flood and erosion processes Report on changes in channel morphology Provide information to the community Identify the location of river corridors, within which the river will naturally meander	Promote land-use practices and the placement of assets that reduce the risk associated with changes in riverbed morphology. Consider all available options to manage the effects of bank erosion, including structural and non-structural options. Enable works that will, where necessary, improve the conveyance of floodwater and 'train' the river within its natural corridor, without compromising the features that are of high value to the community and iwi.	Identify areas where gravel accumulation can naturally occur Identify areas where permanent removal of gravel may have a detrimental effect on assets, riverbed morphology or community values Identify minimum bed levels/profiles, below which extraction will not occur	Provide maps showing the location and characteristics of features that are of high value to the community Encourage the establishment of riparian plantings that are practical and appealing Provide access and habitat for fishing and white-baiting activities Support pest and weed control activities Discourage dumping, and arrange the regular collection of rubbish

Contents

1. Introduction

Changes in the morphology (physical form) of riverbeds occur as a result of natural processes that are often uncontrollable, and also from human intervention. The Shag River/Waihemo riverbed is an integral part of the wider Shag River/Waihemo catchment (Figure 1). The Shag River/Waihemo riverbed is part of a dynamic river system, and has experienced changes in morphology in recent decades. These changes will have occurred in response to naturally occurring flood events, as well as gravel extraction activities and historic river management decisions. Changes to riverbed morphology have included degradation[4] and sedimentation within the main channel and significant bank erosion in places (Figure 2). In some cases, these changes have negatively affected the values placed upon the river by the community, iwi and stakeholders (landowners, Fish & Game New Zealand, Department of Conservation (DOC), Waitaki District Council (WDC), and residents).

Land alongside the river channel is often referred to as the ‘riparian margin’. More intensive use of the land that borders the river has occurred in recent decades, with valuable farmland replacing what was previously rough vegetation. As a result, changes in the position and form of the riverbed can cause issues for landowners and other river users. The Shag River/Waihemo is valued as a recreational, commercial, and cultural resource e.g. picnicking, swimming, fishing, and farming.

The Otago Regional Council (ORC) has proposed the Shag River/Waihemo morphology and riparian management strategy (‘the strategy’) to help provide guidance (for all users of the river) for good decision-making and appropriate activities on the riverbed and riparian margins of the Shag River/Waihemo. The strategy has a vision of long-term sustainable use and enjoyment of the Shag River/Waihemo riverbed and its riparian margins. It is also important when undertaking activities within the riverbed and on the riparian margins of the Shag River/Waihemo that people recognise, and allow for, the traditional, spiritual, and cultural values of local iwi.

The strategy’s key objectives are to:

- Recognise and characterise the natural river and catchment processes that occur in the Shag River/Waihemo
- Equip the community to understand, and live with, the effects of changes in river morphology
- Enable sustainable gravel extraction
- Promote activities that enhance the natural character and enjoyment of the river.

The strategy is also intended to guide the nature and extent of land-use, so that the negative effects of morphological changes in the riverbed do not increase and, where possible, are progressively reduced. It provides a framework for decision-making, so that activities undertaken by people occur in such a way that the results are:

  - A visually appealing river system

[4] The term ‘degradation’ in this case refers to the wearing down of the channel by the erosive action of water.

- A habitat that supports existing wildlife, fish, and preferred plant species
- Limited effects on assets as a result of flood events
- Resilient infrastructure (roads, bridges, water supply)
- Continued use of the river for recreational activities.

Many of the actions listed in this strategy are voluntary and will rely on interactions between the key stakeholders, iwi and the community to be successful. It is therefore recommended that people who live, work, or play in the Shag River/Waihemo catchment consider, and give effect to, the principles, objectives, and actions listed in the strategy.

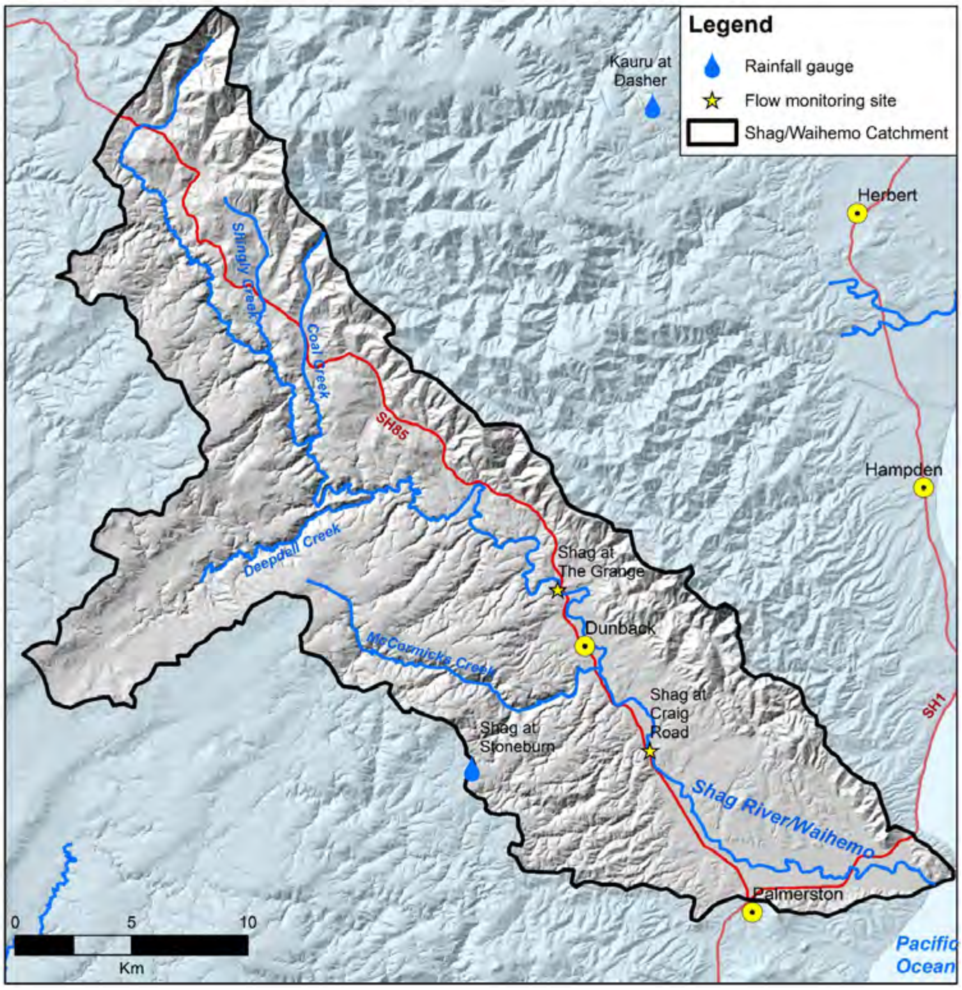

Figure 1. Shag/Waihemo River catchment boundary, showing main tributaries and the reach of the river to which this strategy applies.

Figure 2. Example of changes in channel morphology, bank erosion downstream of Munro Road (looking upstream)

1.1. Report outline

Section 2 describes the scope of the strategy; while Section 3 summarises the natural environment within which it sits and Section 4 summarises the community values associated with the river[5]. Section 5 describes the legislative context within which the strategy has been defined and will operate. Section 6 outlines the strategy's guiding principles and core components. Section 7 outlines the work that ORC has undertaken to help define an appropriate and sustainable river form for the riverbed and riparian margins and summarises the methods that the various parties (ORC, stakeholders, iwi and the community) have designed to meet the strategy's key objectives.

A series of appendices are included at the end of this document:

- Appendix 1 describes the physical river management work to be undertaken by ORC in the next three years, which will also assist in achieving the strategy's objectives.
- Appendix 2 contains a guide on planting on river banks.
- Appendix 3 contains the mapped river corridors (the active fairway, and buffer zones).
- Appendix 4 contains the mapped community values for the Shag/Waihemo River
- Appendix 5 provides a summary of the public feedback received in 2016 regarding the initial proposal of the strategy.
- Appendix 6 contains the Cultural Values Report provided by Aukaha.

[5] as determined by landowners, stakeholders, iwi and members of the public during community consultation in October 2016, and April 2017.

2. Scope

2.1. Study reach

The geographical scope of the strategy is the reach of the Shag River/Waihemo between the river mouth and the village of Waynes (Figure 3). Activities that occur in the upper catchment of the Shag River/Waihemo and in other tributary streams may have an effect on the study reach. The upper reaches and tributary streams were not investigated in this report as most concerns previously raised by the community were located in the study reach as well as the steeper upper catchment topography limiting management opportunities. The focus was therefore on this location. Other areas in the Shag River/Waihemo catchment may also experience problems and issues associated with river processes; however, these are not examined here.

2.2. Risk

The strategy has a focus on the risks and effects associated with changes in riverbed morphology (including channel degradation and bank erosion, sedimentation, and flooding) in the study reach of the Shag River/Waihemo. However, it is acknowledged that heavy rainfall events may lead to a range of other risks, including widespread flooding and surface runoff.

There are several other environmental issues and hazards in the Shag River/Waihemo catchment. These include natural hazards such as seismic activity, as well as water quality and quantity issues. While numerous other issues do exist, this strategy is primarily concerned with the negative effects of changes in river form on the values associated with the Shag River/Waihemo. Guidance and regulations relating to other issues can be obtained from the ORC.[6]

[6] www.orc.govt.nz. For example, The Otago Natural Hazards Database (http://hazards.orc.govt.nz/intramaps/mapcontrols/nhdb/index.html) , the Water Info website (https://www.orc.govt.nz/managing-our-environment/water/water-monitoring-and-alerts) and the Regional Plan: Water (https://www.orc.govt.nz/plans-policies-reports/regional-plans/water).

Figure 3. Map showing the reach of the Shag RIver/Waihemo, to which this strategy applies (Shag/Waihemo catchment outlined)

2.3. Strategy development

The strategy is intended to be a living document, which will evolve in response to new information and changes in river morphology,[7] the needs of the community, and the work of the ORC, iwi and stakeholders. It will be reviewed regularly as part of council's annual and long-term planning process, or in response to large flood events. The review process will involve landowners with property alongside the river, other stakeholders, iwi and ORC staff with responsibilities for river and waterway management and natural hazards. The review is proposed to monitor the effectiveness of the strategy, the workability of its stated objectives, and to note progress towards achieving those objectives. It will also help ORC to set priorities when considering funding and undertaking river-maintenance work in the rivers concerned.

Before the review process, ORC will arrange and facilitate a workshop with iwi, the local community and invited stakeholder groups. This will consist of two parts:

- An opportunity for participants to present to the group any issues they face as to changes in channel morphology or riparian management; work they have undertaken or would like to see undertaken; or to discuss, question or suggest changes to the strategy itself.
- A facilitated process to coordinate activity and work towards achieving the principals and objectives outlined in the strategy.

[7] Including additional understanding gathered during future flood events

3. Environmental setting

The natural and social settings of the Shag River/Waihemo catchment are described in this section, with particular focus on the special characteristics that give rise to the risks associated with changes in riverbed morphology.

3.1. Geological setting

The Shag River/Waihemo parallels the Waihemo fault system (Forsyth, 2001). The geology of the Shag River/Waihemo catchment (Figure 4) is dominated by varying grades of quartzofeldsparthic sandstone interbedded with mudstone and igneous rocks of the Dunedin volcanics group. This generally takes the form of greywacke deposits on the true right side of the catchment, argillite on the true left of the catchment, and igneous rocks to the south of the Waihemo fault system (Forsyth, 2001).

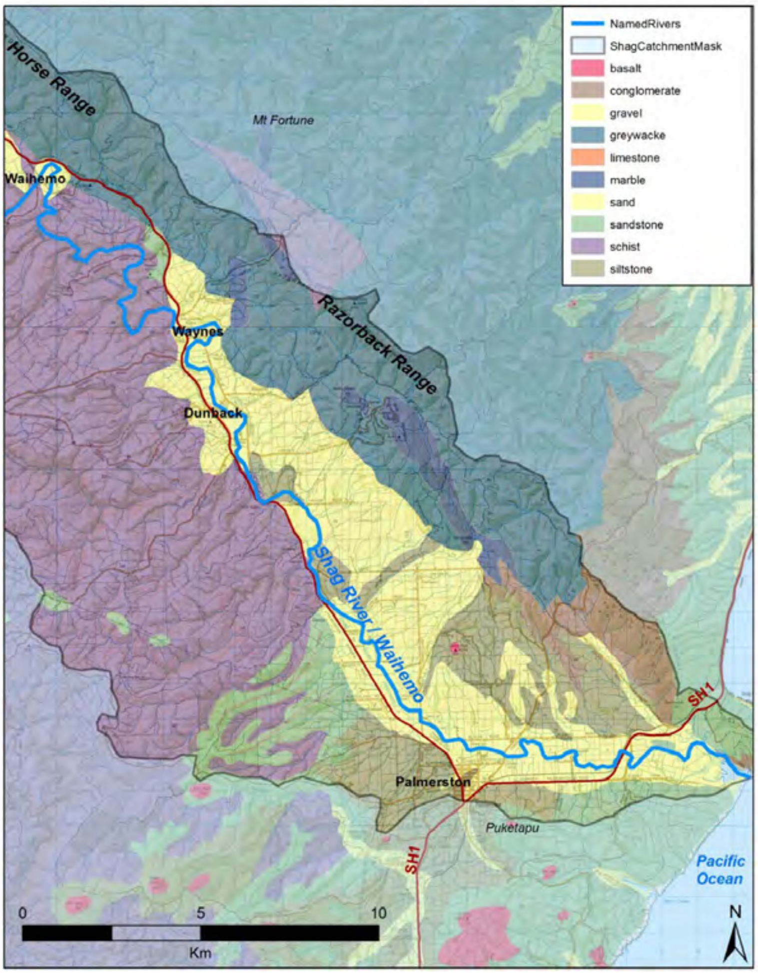

Figure 4. Geological map showing the Shag River/Waihemo catchment

3.2. Geographical setting

The Shag River/Waihemo catchment is located on the east coast of the South Island) Te Waipounamu) in the Waitaki District. The catchment area of the Shag River/Waihemo is 544 km^2 and is bounded by the Taieri Ridge to the south and the Kakanui Mountains to the north. The highest point in the catchment is Kakanui Peak at 1528 m above mean sea level. The main tributaries of the Shag River/Waihemo include Deepdell Creek, McCormicks Creek, Coal Creek and Shingly Creek (ORC, 2014[2]). The topography of the Shag River/Waihemo catchment is diverse with high altitude mountains in the upper catchment to flat grassland in the valley bottom (Figure 5).

Figure 5. **Topography of the Shag River/Waihemo upper catchment and flat grassland (photograph taken December 2016)**

Agricultural grassland is the dominant land use throughout the Shag River/Waihemo catchment (ORC, 2014[1], 2014[2]). The upper catchment of the Shag River/Waihemo is dominated by tussock grassland and low producing grassland, most of the lower catchment contains high producing grassland and some cropping (ORC, 2014[1]). Exotic forestry is the next largest land use covering 11 % of the catchment (ORC, 2014[1]).

The Shag River/Waihemo begins on the southern slopes of Kakanui Peak where it flows south west to the valley bottom and then heads in a south easterly direction towards the township of Palmerston where it then heads east where it meets the Pacific Ocean south of Shag Point/Matakaea.

3.3. Meteorological setting

The Shag/Waihemo catchment is located on the east coast of the lower South Island, within the Waitaki district. Flood events within the Otago east coast catchments such as the Shag River/Waihemo are generally caused by persistent rain bearing easterlies, with continual rainfall over days saturating the soil, leading to rapid runoff. Generally, these types of events occur in late summer to late autumn, although they can occur at any time (ORC, 2015).

The nearest long-term automatic rain gauges are located at Stoneburn and The Dasher (Figure 1). Annual average and peak daily-rainfall intensities for these sites are listed in Table 1.

Table 1. Annual average and maximum observed daily rainfall total for rain gauges in the Shag River/Waihemo catchment

Hydrological monitoring site (rain)	Annual average rainfall (mm)	Maximum daily rainfall (mm)	Date of peak 24 hr rainfall
Shag River at Stoneburn (1985-2017) (missing record in 1987,1988 and 1996)	619	124	26 May 2010
Kauru at the Dasher (1953-2017) (missing record in 1995)	801	199.5	12 Jan 2002

3.4. Hydrological setting

Information on river flow in the Shag River/Waihemo is available from two long term monitoring sites. The Grange and Craig Road recorders have been operating since 1989 and 1993 respectively. The five largest flows on record for these sites are shown in Figure 6. The Shag River/Waihemo (at the Craig Road monitoring site) can rise rapidly during flood events, with a rate of rise greater than 1.5 m per hour observed. Average gauging velocities observed at these sites range from 0.04 to 1.2 m per second with velocities likely to be higher in the steeper, more confined sections of the Shag River/Waihemo.

Table 2. Summary of hydrological information for sites within the Shag River/Waihemo catchment

Hydrological monitoring site (river flow) (date record commences)	Maximum observed flow (m^3/sec) (date occurred)	Average Annual maximum (m^3/sec) (excluding years with gaps)	Median flow (m^3/sec)
Shag at the Grange (Oct 1989 to date)	428 (Mar 1993)	111	0.6
Shag at Craig Road (Sept 1993 to date)	433 (Dec 1994)	118	0.7

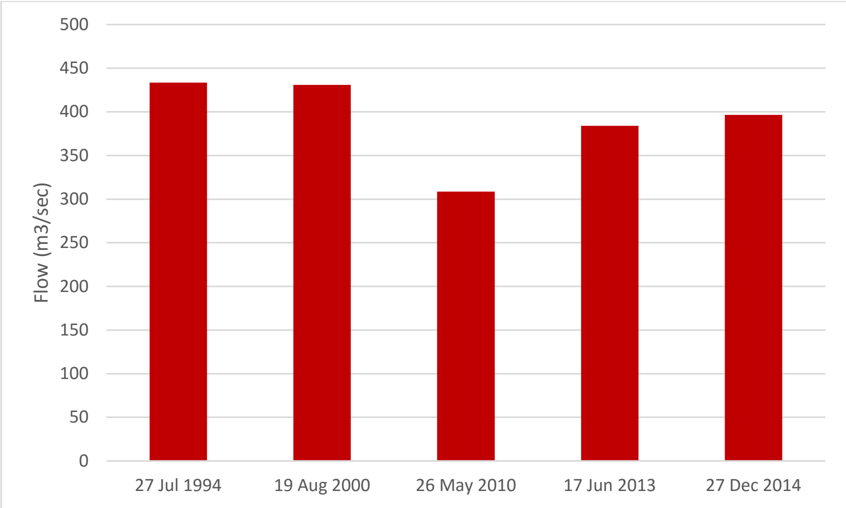

Figure 6. Five highest flows in the Shag River/Waihemo at the Craig Road recorder since records began in September 1993.

3.5. Flooding

Changes in the morphology of the Shag River/Waihemo channel are, in part, driven by the hydrological characteristics of the river, including the magnitude and frequency of flood flows.

The Shag River/Waihemo has experienced large flood events in the past, with the December 1994 being the largest on record at the Craig Road recorder. The Shag River/Waihemo has a history of flooding including the inundation and erosion of rural farm land as well as inundation of several houses (ORC, 2002). The June 1980 flood event washed away the Switchback Road bridge (comments following air inspection over North Otago on Saturday 7 June 1980, OCB).

The effects of flooding also affect any infrastructure located on the floodplain of the Shag River/Waihemo such as roads, bridges, power lines, and irrigation equipment (ORC, 2014[2]).

The mapped inundation area is shown in Figure 7 below, areas where historic flooding has occurred include the area known as “The Loop” near Waihemo, low lying areas of Waynestown, low lying areas around Dunback and most of the Dunback Domain (ORC, 2002). Land around McLew Road bridge can become inundated during flood events (Figure 8), downstream of Craig Road the floodplain narrows with inundation occurring on land adjacent to the river (ORC, 2002). The floodplain widens downstream of Meadowbank where land on either side of the river can become inundated (ORC, 2002) (Figure 9). Flooding in the lower reaches of the Shag River/Waihemo, near Bushey can be affected by tidal influences (ORC, 2002). The mapped flood hazard area for the Shag River/Waihemo is shown in Figure 7.

Recorded at the grange (8 km upstream of McLew Road bridge, the most upstream cross section location): winter 1990, late 1993/early 1994, winter 1994 and winter 2000.The maximum flood recorded was approximately 428 m3 in December 1993.

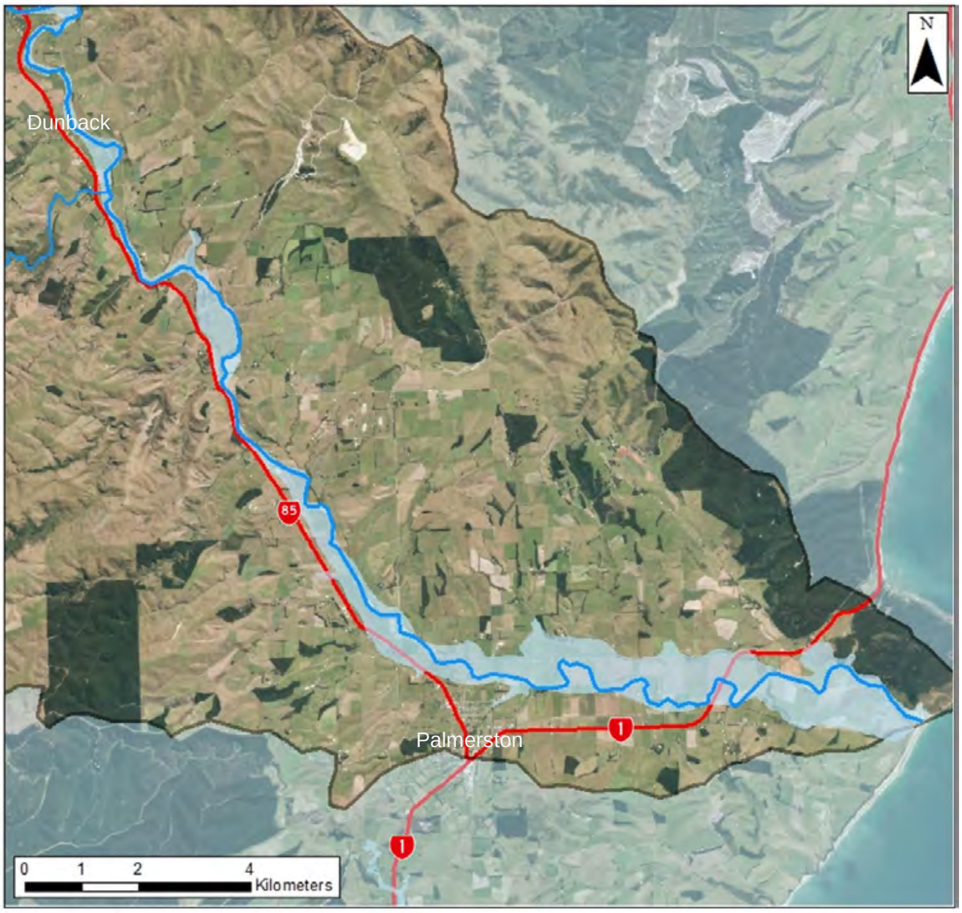

Figure 7. **Shag/Waihemo River flood hazard extent (ORC, 2002).**

Figure 8. Shag River/Waihemo in flood, looking downstream to McLew Road bridge (June 17, 2013)

Figure 9. Shag River/Waihemo in flood, looking downstream at the Horse Range Road bridge (June 17, 2013)

3.6. Riverbed morphology

The active channel of the Shag River/Waihemo is a dynamic system where flood events and sediment transport regularly cause changes in riverbed morphology. Changes in the longitudinal profile of the riverbed occur due to aggradation and degradation along the channel, and as a result of lateral bank erosion. Significant changes often occur as a result of large flood events, but small scale, incremental changes can also occur over longer timeframes. Human activities such as gravel extraction physical works on the bed and banks of the river and land use change can also result in significant local and distant changes to the morphology of the river system.

ORC undertakes work to describe these changes in morphology using visual inspections, aerial and ground photography, and cross-section analysis. Reports summarising these investigations were published in 2004, 2009, and 2014 (ORC, 2004[1], 2009, 2014[2]).

The ORC 2014 report noted that between 2009 and 2013 there was an increase in mean bed level (MBL)[8] at 16 of the 22 surveyed cross-sections on the Shag River/Waihemo between McLew Road and Horse Range Road (ORC, 2014[2]). A decrease in MBL was observed at 6 cross-sections. The ORC (2014[2]) report suggests that in the short term the Shag River/Waihemo is showing signs of changing from a state of overall degradation to one of aggradation/stability. The ORC (2014[2]) report also states that while there may be some short-term aggradation/stability, the river has not returned to a state of excess gravel accumulation and that it is still experiencing bank erosion and channel incision. The ORC (2004[2]) report states the river was previously more sinuous with a much wider gravel bed.

A comparison between aerial photography collected in 1947, 2006 and 2014 further highlight the dynamic nature of the Shag/Waihemo River (Figure 10, Figure 11). Mid-channel and point bar features were more abundant along the length of the channel in 1947 and appear significantly reduced in 2005 and 2014. In some instances, this channel form change has enabled land to become farmable.

A comparison of cross-sections dating back to late 1970's and early 1980's also highlights the dynamic nature of the river and shows how the channel moved laterally in some locations (Figure 12), became more confined and deeper in other locations (Figure 13), and increased bed levels at others (Figure 14).

[8] MBL represents a 'horizontal straight line across the channel, positioned so there is as much bed above the line as below it' (Griffiths, 1979).

Figure 10. Shag/Waihemo River – top 1947, middle 2006, bottom 2014

Figure 11. Shag/Waihemo River – top 1947, middle 2006, bottom 2014.

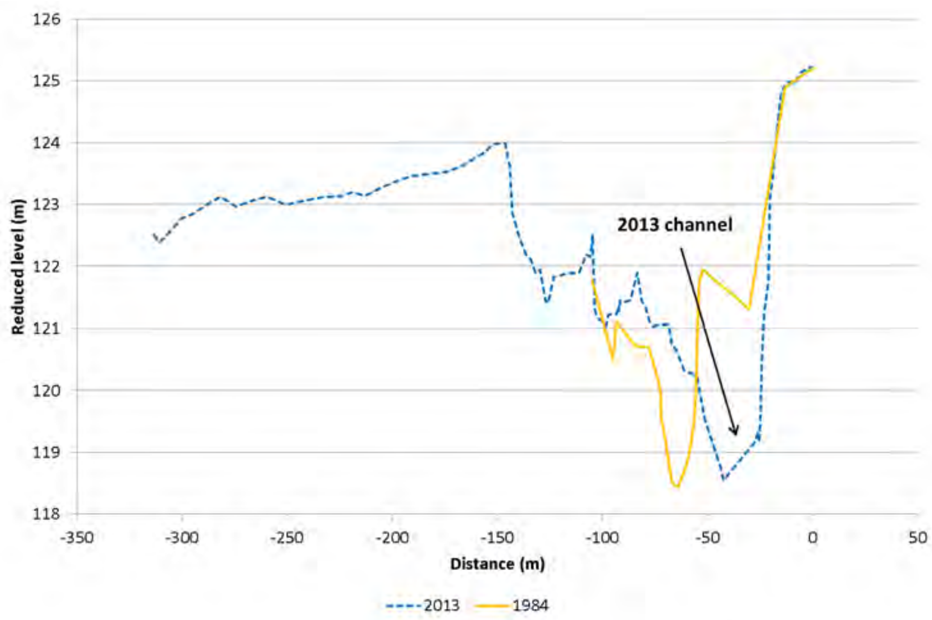

Figure 12. **Shag River/Waihemo cross-section S28, looking downstream**

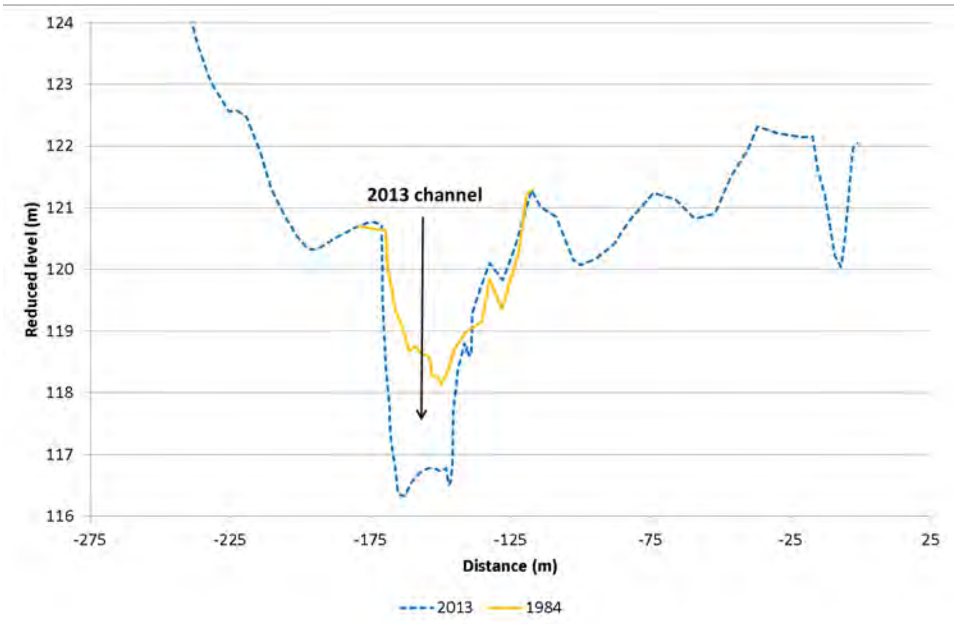

Figure 13. **Shag River/Waihemo cross-sction S27, looking downstream**

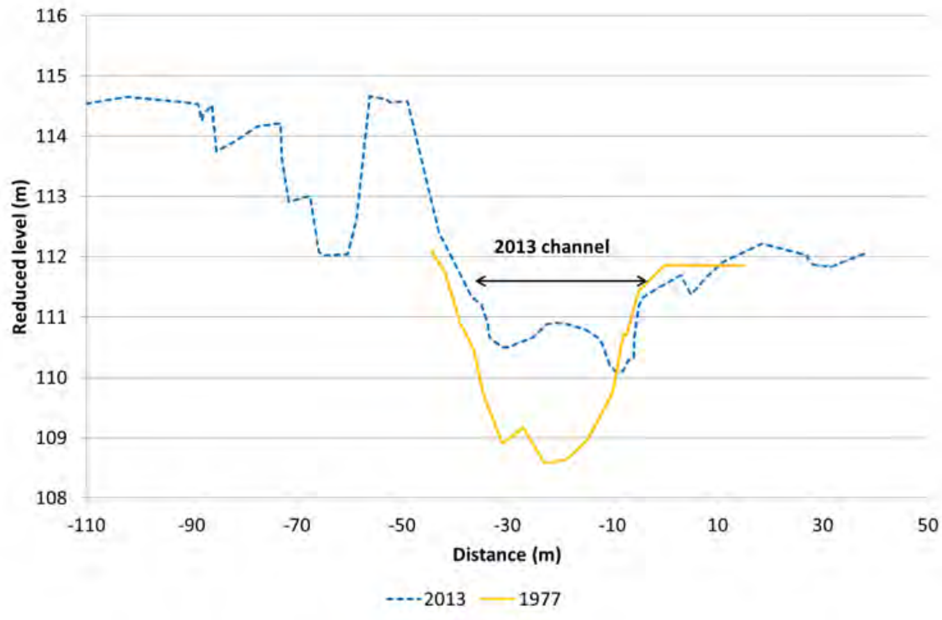

Figure 14. Shag River /Waihemo cross-section S20a, looking downstream

3.7. Riparian margins

The riparian margin is the area beside waterways that forms the interface between water and land. As noted in the introduction, more intensive use of the land that borders the Shag River/Waihemo has occurred in recent decades. In some parts of the catchment, farmland has encroached onto what was previously a more natural area of rough vegetation (Figure 10, Figure 11). This has resulted in a narrowing (or in some cases, complete removal) of the riparian margin that separates the active river fairway from land that is used for farming, or which accommodates community infrastructure. Previous ORC reports have identified that channel widening by bank collapse and erosion are processes that continue to occur in the Shag River/Waihemo (ORC, 2014[2]). The loss of primary agricultural land and physical property adjacent to eroding stream banks is very costly and the need for their protection against erosion has long been recognised.

Historically, the permanent removal of gravel from the Shag River/Waihemo system has been used as a tool in an attempt to address bank erosion issues. This strategy identifies that gravel extraction and other management tools (such as the movement of gravel within the channel and spraying) should still be considered for river management purposes, where that is appropriate. However, a number of authors have identified that the most effective means of controlling river bank erosion is to establish a vegetative cover of strongly rooting plants (Slui 1991, Marden et al. 2005, ORC 2005, Phillips & Daly 2008). In general terms, vegetation roots increase bank stability by protecting soils against entrainment from flood flows, and root mass and density provide soil shear strength, thereby protecting against gravity collapse of undercut banks.

Other indirect benefits of riparian plantings to limit bank erosion include: trapping nutrients and fine sediment, shade, shelter, filtering qualities for the aquatic ecosystem, as well as aesthetic and recreational value. If well managed, riparian margins can help to improve water quality, provide food and habitat for freshwater life, and improve diversity (ORC, 2005).

4. Values

Information on the values that the iwi, community and stakeholders have for the Shag River/Waihemo was collected through collaboration, community meetings and a feedback process (Appendix 5 and 6). The Shag River/Waihemo fulfils a number of important roles within the community at a local, district, and regional scale. These roles include, but are not limited to:

- A source of water for irrigation, stock and people.
- Bank erosion, gravel movement, new plantings.
- For recreational purposes, including: swimming, whitebaiting, walking, fishing, and hunting.
- A habitat for native and introduced species.
- Mana Whenua values including kiatiakitanga, mahinga kai, ki uta ki tai and mauri.

The below sections discuss the ecological, community, Māori cultural and historical values that are held for the Shag/Waihemo River.

4.1. Ecological values

Wetlands

The Waihemo Scenic Reserve is an area (14.5 ha) of saline swamp at the mouth of the Shag River (ORC3, 2004) it is believed to have some significant wetland values and has been classified as a regionally significant wetland (Figure 15). The saltmarsh is a scarce wetland type that supports a community with glasswort (Sarcocornia quinqueflora), jointed rush (Juncus articulatus) and Atriplex spp. The shag/Waihemo river mouth and estuary is highly valued by Kāi Tahu for cultural and spiritual beliefs, values and uses, including mahika kai and waahi taoka. An important area for wildlife habitat it also supports recreational fisheries for whitebait/īnanga (Galaxias spp.) and brown trout (Salmo trutta), as well as habitat for flounder (Rhombosolea sp.), mullet and stargazer. The area also contains archaeological sites. The Otago Regional Council has recently commissioned a study of the water quality and ecological state of the estuary. Any results9 and relevant implications from this investigation will be included in future versions of this strategy.

[9] See www.orc.govt.nz/plans-policies-reports/reports-and-publications for any upcoming technical reports on the estuary.

Figure 15. The Waihemo scenic reserve (aerial photography 2016).

Fish

Shag River supports a high diversity of freshwater fish species. Thirteen native species and two introduced fish have been recorded within the catchment, and there is also anecdotal evidence that suggests that both rainbow trout and the occasional salmon have been observed in the Shag River.

Native fish values of the Shag River

The Shag River supports a diverse community of native fish, including short and longfin eel, bluegill bully, common bully, redfin bully, upland bully, torrentfish, īnanga, koaro, lamprey, smelt, black flounder, Taieri flathead galaxias and brown trout (NZ Freshwater Fish Database). Many of these species have cultural significance and are Taonga species recognised in the Ngai Tahu Claims Settlement Act. Of these species, longfin eel, bluegill bully, redfin bully, torrent-fish, īnanga and koaro are classified as “At Risk and Declining” in the most recent threat classification for freshwater fish while lamprey and the Taieri flathead galaxias are classified as “Threatened, and Nationally Vulnerable” (Goodman et al. 2014). The ammocoete (Juvenile) of lamprey are very susceptible to gravel extraction. The macrophtalmia (stage when it looks like an adult) is also susceptible to gravel extraction during the period it migrates to the sea.

The lower river is very popular with white baiters, whitebait season occurs during the mid-August to end of November. The whitebait fishery is supported primarily due to the availability of a healthy īnanga spawning habitat located in close proximity to the railway bridge, State Highway One. The limiting factor on the quality of this spawning habitat is the occasional deposition of sediment which smothers the stream-bank vegetation during times of flood events.

Spawning and incubation periods are an important consideration when undertaking river works. Spawning success is dependent on adequate river flows and appropriate substrate. Gaps should be present between coarser gravels, where the sedimentation of finer particles is limited. For brown trout, this period extends from the start of May, until the end of September (Central South Island Fish and Game Council, pers.comm., 27 June). Reed environments and the incubation process are sensitive to physical disturbance and silt deposition during these periods.

Sports fishery

The river supports a regionally important brown trout (Salmo trutta) fishery (Otago Fish and Game Council, 2017); brook char (Salvelinus fontinalis) have also been recorded in a tributary in the upper catchment (ORC, 2014[1]).

Table 3, presents angler effort on the Shag River, recorded during National Angler Surveys conducted in 1994/95, 2001/2002, 2007/08 and 2014/15. Overall angler usage is relatively low, but relatively stable over the past 15years.

Table 3. **Angler effort in the Shag River/Waihemo catchment (angler days standard error) based on the national angler survey (Unwin, 2016)**

River	Angler usage (angler days $^{+}/_{-}$ SE)			
	1994/1995	2001/2002	2007/2008	2014/2015
Shag River/Waihemo	1060 $^{+}/_{-}$ 290	890 $^{+}/_{-}$ 310	750 $^{+}/_{-}$ 260	800 $^{+}/_{-}$ 280

Schedule 1 of the Regional Plan: Water

Schedule 1A of the Regional Plan: Water for Otago (RPW) outlines the natural and human use values of Otago's surface water bodies (ORC, 2004[3]). The Shag River (Waihemo) is identified as having the following values:

- Large water body supporting high numbers of particular species, or habitat variety, which can provide for diverse life cycle requirements of a particular species, or a range of species.
- Access within the main stem of the catchment through to the sea or lake unimpeded by artificial means such as weirs and culverts.
- Plant, boulder, gravel, sand, silt, rock bed composition of importance to resident biota.
- Absence of aquatic pest plants identified in the Pest Plant Management Strategy for the Otago Region.
- Presence of indigenous fish species threatened with extinction.
- Significant presence of trout and eel
- Significant habitat for Taieri flathead galaxias, koaro and lamprey.

The significance of these values is that Schedule 1AA identifies the Shag River as providing habitat for the (Taieri) flathead galaxias, and the koaro and lamprey.

Birds

The Shag River/Waihemo estuary is important habitat for birdlife with ten species of bird utilising the estuary for feeding, roosting and breeding (Ryder 2005). Native and endemic birds that have been recorded within the estuary are: Eastern bar-tailed godwit, Caspian tern, pied stilt, White-fronted tern, Royal spoonbill, banded dotterel. Red-billed gulls and Variable oyster catchers occupy both the beach and estuary.

Of these species Caspian tern, white-fronted tern and the Banded are considered Threatened and Nationally Vulnerable while red-billed gull, Eastern bar-tailed godwit, royal spoonbill are At Risk and Declining and the Variable oyster catcher is categorised as Recovering (Robertson et al. 2016).

The wider river environment provides habitat for a range of exotic and native bird species that nest or feed in throughout river bed and its margins. The river also supports locally and regionally important water fowl habitat and hunting opportunities (Otago Fish and Game Council, 2015); for species such as mallard ducks, black swan, Canada goose.

Mana Whenua Values

Ngā Rūnanga hold strong positions regarding riparian management and protection of the fish species in the Waihemo, especially in regard to mahinga kai. This includes the use of native taonga species for riparian planting, planting that provide habitat for mahinga kai species, protection of native spawning fish, protection of disturbed fish, allowing passage for migration and minimising sedimentation in the river. For more information on these positions see appendix 6.

4.2. Community

To help identify aspects of the wider river environment that is important to the local community, ORC undertook consultation in 2016 and 2017. This included consultation with landowners, Otago Fish and Game Council, Department of Conservation (DOC), the Waitaki Branch of Forest and Bird and Waitaki District Council (WDC).

Values that the community and other stakeholder groups identified with the Shag/Waihemo River environment have been summarised around community river form and function 'values' as summarised in the box below. More information on these values that have been identified through the consultation process are included in Appendix 5.

Community river form and function 'values'

- That the function of the river continues to support social, cultural, spiritual, ecological, recreational, and farming activities.
- That the form of the river includes riparian plantings (including willows but with more of a focus on native plantings), weed control and fencing.

4.3. Mana Whenua Values

To understand the cultural importance of the wider river environment to the local iwi, ORC have worked in partnership with Kati Huirapa Runaka ki Puketeraki and Te Rūnanga o Moeraki with Aukaha (formerly KTKO).

Values identified have been summarised in the box below. More information on Mana whenua values and perspectives on freshwater, association with the lower Waihemo, Ngā Rūnanga aspirations relevant to the strategy, issues for Ngā Rūnanaga relevant to the strategy and recommendations that have been identified through the consultation process are included in Appendix 6.

Mana Whenua Values

Ko te wai te ora ngā mea katoa. Water is the life giver of all things

- Kaitiakitanga is the responsibility of Mana Whenua to ensure that the life-supporting capacity (mauri) of the natural resources of their takiwā is sustained.
- Mahinga Kai literally means "food workings" and refers to the places where food is gathered or produced, the traditions and collection methods associated with gathering natural resources for cultural use and the resources themselves.
- 'Ki uta ki tai' a holistic culturally based 'mountains to the sea' natural resource management framework.
- Mauri or life force of all things living and non-living must be protected.

4.4. Historical

There are several historic features alongside the Shag/Waihemo river. Including two connected railway lines known as the Dunback and Makareao Branches which operated alongside the Shag River between 1885 and 1986 (Leitch & Scott, 1998). Built to access a shingle deposit and a limeworks, they shared their first 11 km and both reached 15 km long. Remnants of the line are still visible including, bridges, abutments, culverts, some railway gates and mile/kilometre pegs, and some rails remain. No bridges remain beyond Inch Valley; the 15-span trestle bridge crossing the Shag River on the Makareao Branch was demolished in the mid-1990s. Situated over McCormicks creek (a small tributary of the Shag near Dunback) is the McCormicks bridge (Figure 16). Built in 1869, the stone arch bridge is made of local schist and was installed to service the increased traffic during the goldrush (Heritage New Zealand, 2009). The historic route to the goldfields passed through Palmerston and the Shag Valley. Just north of Dunback is the Waihemo grange historic Otago station homestead, built in the 1860s (Heritage New Zealand, 2011).

Located at the Shag river mouth is Onewhenua at Matakaea Historic Reserve (Figure 17), a Maori archaeological and early settlement site of national importance. It has been discovered the area was used for moa hunting in c.1350 (DOC, 2009). The Waitaha people (ancestors of Ngāi tahu Wahānui) had settlements there where they hunted moa and harvested coastal resources (KTKO, 2005).

Figure 16. McCormicks Bridge, from SH85 between Palmerston and Dunback. (Copyright Heritage New Zealand, Taken by Jonathan Howard, April 2015).

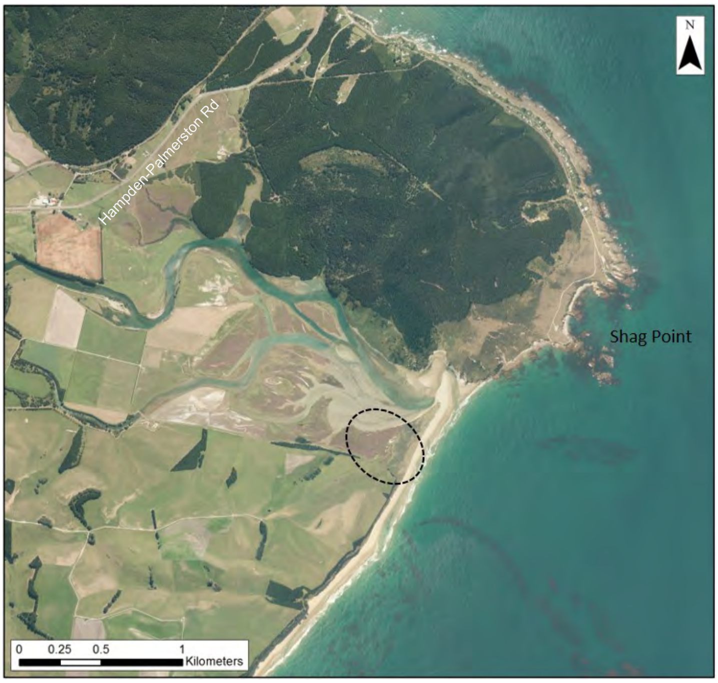

Figure 17. Onewhenua at Matakaea, Recreational Reserve (aerial photography collected in 2014).

4.5. Gravel extraction

Sediment in the Shag River/Waihemo is sourced from slope instability in the upper catchment, the reworking of bed and bank material, and from post-gold mining tailings (ORC, 2014[2]). Gold mining operations currently and historically occur within the Shag River/Waihemo catchment. Historic gold extraction activities mostly occurred in Deepdell Creek between 1890 and 1946 (Black *et al*. 2004). It has been estimated that discharged mine-tailings contributed 100 times more sediment to Deepdell Creek than would naturally occur over the same period (Black *et al*. 2004). Most of the mine tailings have been moved through the Shag River/Waihemo system since gold mining ceased in the Deepdell Creek catchment in 1946 (Black *et al*. 2004) and the river now displays a more natural form (ORC, 2009). Current gold mining activities occur at Macraes Flat with the existing mining activities discharging water and contaminants into waterways in the Shag River/Waihemo catchment such as Deepdell Creek and Tipparary Creek (ORC, 2014[1]).

The removal of gravel from the riverbed of the Shag River/Waihemo has occurred for many decades, with extracted material generally used for farm laneways, roading, and construction. Gravel extraction typically occurs from locations where sediment accumulates e.g. where there is a decrease in the gradient of the river, leading to a reduction in the velocity of flood flows, or in an attempt to mitigate issues such as bank erosion. In either case, extraction from the bed of the river will tend to increase the conveyance of water during flood events by widening the channel and reducing the MBL at that location. It can also lead to a decrease in the sinuosity of the river channel, as bends are straightened in an attempt to reduce the effects of bank erosion.

Gravel extraction rates have previously exceeded the natural replenishment rates of the Shag River/Waihemo (ORC, 2004[2], 2009). High rates of gravel extraction may have led to bed degradation and bank erosion in some areas of the Shag River/Waihemo (ORC, 2004[1], 2004[2], 2009, 2014[2]). In 2004 the ORC presented a report which recommended "no further consents be issued for gravel extraction in the Shag River/Waihemo catchment (ORC, 2004[2]). In 2008, the ORC reviewed and modified the management plan to allow limited extraction to occur between Switchback Road and Horse Range Road for river management or hazard mitigation purposes (ORC, 2010). Gravel that is removed from the Shag River/Waihemo system in excess of the natural replenishment rate can lead to issues at downstream locations, such as undermining of river protection works and other assets (e.g. water intakes, bridges, and roads) as well as increased bank erosion and bed degradation. It is important to recognise that gravel beds are still of value to a wide range of species and perform critical ecological functions. River morphology reports and the monitoring of gravel extraction by the ORC, is used to ensure sustainable gravel extraction in the long term, which balances river management requirements and instream values (see ORC 2008 and 2013).

Gravel extraction within the study reach has been occurring over several decades. Significant commercial extraction occurred during the 1980s and reduced in the 1990s due to high rates of channel degradation (ORC, 2004[1], 2004[2]). Between 1977 and 2003 about 285,000 m^3 of gravel was extracted (ORC, 2004[1]) at an average annual extraction rate of 10,950 m^3. In 2004 a report was presented to the ORC Service Committee with the recommendation "that future consented gravel takes are unsustainable and should cease until future studies indicate that such takes are again sustainable" (ORC, 2004[1]), this recommendation was endorsed and gravel extraction ceased on the Shag River/Waihemo. The ORC Natural Resources Committee considered a report in 2008 that enabled limited gravel extraction to occur between Switchback Road and Horse Range Road for the purpose of river management or hazard mitigation (ORC, 2010). Since 2004 the consented extraction of gravel from the Shag River/Waihemo has decreased significantly with ORC records indicating that there has been no consented extraction between this time and 2017.

Ongoing channel degradation can allow increased water velocities (particularly during flood events) to scour the river bed, deepening the channel, which can result in continued bed degradation. As the channel deepens, flood flows become confined within the channel and continue to scour the bed. This ongoing degradation decouples the channel from the floodplain and alters the floodplain catchment interactions (Fuller *et al.*, 2014). Deeper channels contain larger floods and concentrate flows, leading to more incised channels, potentially generating higher sediment transport rates (due to bank erosion and further removal of material from the riverbed). This process gives the appearance of more prominent gravel bars within the active channel due to the deeper channel. As the channel deepens and gravel bars become more prominent, pressure is often exerted by adjacent landowners to remove the obvious (but in fact non-existent) excess gravel accumulation, which in turn exacerbates the degradation trend (Fuller *et al*., 2014).

The sediment replenishment rates from the upper catchment of the Shag River/Waihemo are insufficient to maintain the profile of the surveyed reaches. The Shag River/Waihemo is currently experiencing a short-term trend of stability (no large-scale aggradation or degradation) however it is still experiencing long-term degradation and ongoing bank erosion (ORC, 2014[2]).

The permanent removal of gravel can also result in the undermining of river protection works and other assets (e.g. water intakes, bridges and roads), as well as degrading ecological values. Gravel extraction can have a negative effect on the local ecology, with the severity of effects dependent on the extraction methods used and the environment from which the gravel is being extracted. Gravel extraction activities can lead to a reduction in habitat heterogeneity/diversity, an increase in fine sediment, as well as bed compaction that can have a negative impact on the native and exotic animals residing in and on the banks of the Shag River/Waihemo. Over-extraction of gravel can remove potential spawning sites and limit spawning success within the catchment, due to the removal of aggregate and reduction in the size of gravels. This in turn can limit the success of the fishery and recreational opportunities.

The potential beneficial and adverse effects of significant gravel extraction are summarised in Table 4.

Table 4. **Potential beneficial and adverse effects of gravel extraction (Canterbury Regional Council, 2015)**

Potential beneficial effects	***Potential adverse effects***
• Channel capacity increased, flood levels lowered • Concentration of flow against riverbanks, resultant lateral erosion, and localised bed scour is minimised • Stable channel alignment and optimum bed level is maintained • Open gravel beaches can provide a good habitat for indigenous birds • A renewable gravel resource for local construction may be utilised • * Mauri (life force) of the riverbed affected	• Disturbance of fish and bird habitat • Accidental discharge of fuels and lubricants from machinery • Disturbance of the natural meander pattern and channel stability • Overall degradation of the riverbed • Increased bank erosion • Sediment is discharged, increasing turbidity and smothering habitat • Temporary reduction in recreational access • Mauri (life force) of the riverbed affected • Disturbance of fish spawning sites • Reduced river bed heterogeneity • Dust generation

*Consultation with Auhaka in 2017 indicated 'Mauri (life force) of the riverbed affected' also needed to be added to the Potential beneficial effects side of the table

4.6. Groundwater

The lower Shag Valley has a shallow unconfined gravel aquifer occupying the recent and late quaternary alluvium that lies over a low permeability mudstone layer (Cameron et al, 2003). A deeper confined aquifer lies beneath this in a quartz gravel layer. The aquifer has a limited extent both horizontally and vertically, defined by the geology which in turn is altered by the complex Waihemo fault system.

The aquifer is highly interactive with the Shag River, predominantly being recharged by the river and local rainfall. The Otago Regional Council has recently instigated an investigation into the surface water and groundwater interaction. Results[10] and reports from this investigation will be incorporated into future versions of this strategy.

[10] See www.orc.govt.nz/plans-policies-reports/reports-and-publications for any upcoming technical reports on the groundwater of the lower Shag Valley.

5. Legislative context

The manner and degree to which the issues in the Shag River/Waihemo can be managed by the community, iwi, stakeholders and local councils is influenced by the obligation, powers and restrictions set out in various statues. No legislation confers the exclusive power or the right to manage the Shag River/Waihemo to ORC or WDC. Whether through works or services, individuals are empowered to initiate their own measures provided they operate within the law. They are also allowed to develop and promote proposals for bank protection works, to apply for and hold the necessary resource consents, and to privately fund works and services should they wish to.

The law provides for a range of methods that both councils and the community can use to manage the Shag River/Waihemo. These methods do not only relate to physical works, but also to planning, information, emergency preparedness and response. They can only be implemented after taking environmental effects into account (under the Resource Management Act (RMA)) and funding consideration (under the Local Government Act (LGA)). The latter includes consideration of the distribution of benefits between the community as a whole, any identifiable part of the community, and individuals.

The Otago Regional Policy Statement (RPS) provides a high-level policy framework for the sustainable integrated management of Otago's resources, as well as giving effect to the requirements of the RMA. This includes the management of the values of water bodies, natural resource systems and the form and function of Otago's rivers, whilst still enabling communities to provide for their needs.

This strategy is concerned with the form and function of the Shag River/Waihemo. Any activities in or on the bed and banks of the Shag River/Waihemo need to be focused on maintaining or enhancing that form and function. The strategy is not a statutory document; rather it is intended to present the aspirations of the community, iwi and the various stakeholder agencies. However, the statutory processes that do influence river management activities[11] are more likely to be used effectively and efficiently if there is a general consensus on what is valued about the river, and commonly understood objectives. The strategy sets out the values identified by the community, and the outcomes they seek from managing river form and function, and will be used to inform resource consent decision-making.

[11] Including the LGA and the RMA

6. Principles

The strategy provides a framework to guide activities and decision-making, based on an agreed set of principles. It is intended to help protect the recreational, cultural, and ecological values of the Shag River/Waihemo, and to enable long-term sustainable use of the riverbed and its riparian margins.

ORC has developed the framework, in partnership with iwi and in consultation with the local community and other stakeholders. The principles and associated strategic elements are outlined below, and these are intended to protect or enhance the important values and features of the river identified by the community and other stakeholders.

Principle 1: Ensure sustainable river management

Ensure that:

- There is recognition of the kaitiaki responsibilities of Mana Whenua through clear and consistent communication between Manawhenua and the ORC.
- There is clear and consistent communication between the ORC and other parties.
- There is recognition that certain river and catchment processes, such as flooding, bank and channel erosion and sedimentation, will occur naturally, and an understanding of the potential effects of those processes.
- Any practices undertaken limit exposure to negative natural-river and catchment processes.
- There is an awareness and acknowledgement of the benefits and the risks (including the risk associated with ‘super-design’ events) that exist for activities such as farming that occur in areas prone to natural-river and catchment processes.
- Any negative effects of natural-river processes do not increase beyond their current levels, and are actively reduced where there is opportunity to do so.
- Activities are managed in a way that result in:
    - Limited effects on assets during flood events
    - Essential community infrastructure that is resilient (roads, bridges, water supply)
    - Acceptable level of effects to farming caused by river processes
    - Sustainable use of river resources
    - There is recognition of the kaitiaki responsibilities of the local iwi

Principle 2: Plan ahead

Ensure that:

- Cultural use by Mana Whenua is enabled, maintained and enhanced by clear and consistent communication between Mana Whenua and the ORC
- There is clear and consistent communication between the ORC and other parties
- There is an adaptive approach to river management that will allow for the dynamic nature of the Shag River/Waihemo
- Resources are used wisely to ensure that the location and form of community assets and essential infrastructure will result in a more resilient community
- The impacts of climate change and natural climate variability are considered so that future generations do not have to cope with the results of poor decisions made today
- The risk associated with natural-river processes are reduced over time by taking a broad-scale, adaptive approach over the longer term.
- Decision making considers ecological life cycles and temporal variation in river flows.

Principle 3: Maintain and enhance the natural environment

Ensure that:

- Cultural use by Mana Whenua is enabled, maintained and enhanced by clear and consistent communication between Mana Whenua and the ORC.
- There is clear and consistent communication between the ORC and other parties.
- Activities are managed in a way that results in:
    - A habitat that supports existing wildlife, fish, and suitable plant species[12]
    - A more visually appealing river system
    - The ability of the local community and visitors to access and enjoy the river is maintained and/or enhanced
    - Traditional and cultural use is enabled, maintained and enhanced.
    - The consideration of ecological cycles and flow variation.

[12] While native species would be the preferred option and used wherever possible, in some cases a mix of native and exotics may be required to balance river management and biodiversity objectives. See also Appendix 2.

7. River form and habitat enhancement

7.1. River corridor design and management

ORC has undertaken work to identify the location and width of the active fairway (or riverbed), as well as appropriate buffer zones, which together form a corridor within which the river would naturally lie. The widths of fairway and buffer zones were completed by assessing the appropriate meander form in relation to the nature and width of the river channel. The design channel has been drawn up using a consistent meander length or wavelength oscillation, while taking into account the existing channel location, channel areas and natural controls and restraints. This work has been undertaken in the Shag River/Waihemo between Waynes and the Pacific Ocean (Williams, 2017). An example is shown in Figure 18, and a full set of river corridor maps is provided in Appendix 3.

The river fairway and corridor mapping provides guidance for multi-purpose river management, and for the design and implementation of management measures, protection works and in-channel design. When physical works or activities are being considered within the fairway or on the riparian margin, these should be undertaken with reference to the mapped fairway and buffer zones. Guidance for managing the river within this corridor, and across the wider floodplain, is summarised in Figure 19.

ORC will work towards maintaining the Shag River/Waihemo to the mapped corridor lines in the study reach where reasonable and practicable. The fairway management will be achieved through river-management processes such as plantings, targeted vegetation spraying and when needed sediment movement (i.e. bank reinstatement and, in extreme cases, channel realignment and cross-blading). Keeping the fairways to the mapped lines will be undertaken as a pre-emptive process with the aim of limiting the degree of movement/deviation from these areas in flood events. This work will take into account Mana Whenua and community values (as discussed in Section 4). Maintenance work undertaken in the Shag River/Waihemo (as discussed above) will be provided for through the budget set in the ORC Annual Plan (Appendix 1). This work will be carried out in collaboration with affected parties.

In some locations, the mapped corridor crosses land that does not currently form part of the active channel of the Shag River/Waihemo, e.g. Figure 18. This is due to the fact that the mapped corridors show an 'envelope' within which the river would migrate under natural conditions. In many instances, they do not reflect the current position of the Shag River/Waihemo. In these situations, the ORC will not actively move the fairway into these mapped areas; however, if the channel switches its location into these areas (e.g. in response to a large flood event), ORC may decide not to undertake work to reverse the new alignment if the channel still lies within the mapped corridor.

Figure 18. **Shag River/Waihemo River mapped fairway deviating from the current channel alignment (aerial photography collected in 2014)**

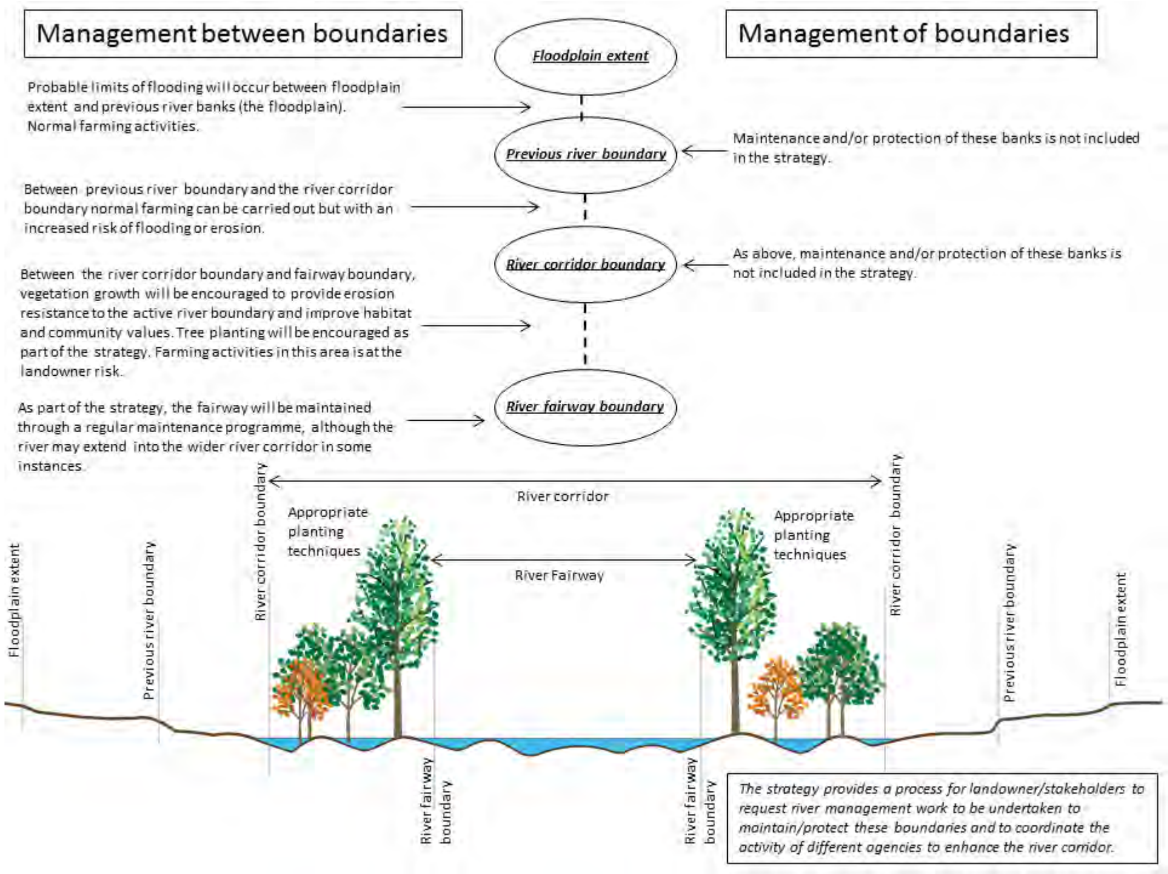

Figure 19. **Policy diagram for management of river boundaries and appropriate land-use on floodplain areas of the Shag River/Waihemo**

7.2. Riparian plantings

As identified in Section 3.7, careful management of riparian margins is key to achieving positive river management outcomes. In addition, feedback from consultation continues to show that iwi, the community and stakeholders would like to see additional planting and management of riparian plantings included in the strategy, as a means of improving the amenity and habitat values of the Waianakarua River, and to help to reduce the effects of erosion (Section 4.2). Mana Whenua have expressed their preference for natives in riparian planting. The principles identified in Section 6 reflect the importance of sustainable river management and enhancing the natural environment.

Research (Slui, 1991; Phillips & Daly, 2008) shows that to achieve bank protection, the Shag River/Waihemo riparian margins[13] should be planted in vegetation that assists with bank stabilisation. Planting these buffer areas would provide the banks of the rivers with greater stability and assist with limiting bank erosion, as well as providing vegetative cover to slow flood flows and limit the amount of sediment deposited out of the main channel, while also providing habitat for aquatic life. The wider the area of buffer zone planting, the more effective this will be.

Willow species (particularly moutere and kemuti willow) are more suitable for planting close to the river margin due to their rapid growth, ease of propagation and usefulness for vegetative groynes or bank-lining layering. Other vegetation can also be used, including poplars and alders on the relatively higher/drier land. Certain species of exotics are invasive and spread easily within these environments (i.e. crack willow and certain species of alders). Careful selection should be made of exotic species, to accommodate other community values along the river. Native vegetation can be used further back from the active river margin and can be useful, especially when part of other/wider riparian planting.

Development of the buffer areas can be undertaken as a staged approach, with planting of the active river margin occurring in areas where there is bank exposure, as well as at possible river breakout locations. Planting of the back area can be undertaken where direct river attack (i.e. bank erosion) is less likely to occur and the native species will have time to become established. Buffer development is about establishing a wide and dense vegetated margin that can absorb river attack and provide habitat for aquatic life.

Planting of the banks of the Shag River/Waihemo is generally seen as a beneficial process in most locations. The success of riparian plantings to accommodate the community values along the river depends on species selection; the exclusion of stock from river margins and the use of appropriate planting techniques. There are several methods to plant the banks of the two rivers, with the best method being dependent on the environment where the planting is to take place (see Appendix 2).

[13] i.e. the area that acts as a buffer between the active fairway and land used intensively for farming or other activities

Ngā Rūnanga encourage and support native riparian planting by landowners as an important habitat for mahinga kai.[14] The Ngāi Tahu Claims Settlement Act 1998 lists a number of species with which Kāi Tahu are recognised to have a cultural, spiritual, historic and traditional relationship. However some species considered to be taonga by Kāi Tahu were not included in this list, and Kāi Tahu do not see this list of species as exhaustive. For reference to Ngāi Tahu claims settlement act Taonga species see Appendix 6.

[14] For more information on this contact Aukaha (www.aukaha.com) or your local Rūnanga (Kāti Huirapa Rūnaka ki Puketeraki or Te Rūnanga o Moeraki)

8. Implementation

The objectives of the strategy are listed at the start of this document (in the overview section). The mechanisms that can be used to achieve or implement these objectives are shown in the following tables. These have been derived using the principles outlined in Section 6. The tables below highlight the actions that should be undertaken to maintain and enhance the values associated with the Shag River/Waihemo, as well as the key parties responsible for undertaking the listed actions.

In some cases, ORC has already undertaken work to help achieve objectives, and this work is described within this document (for example, mapping of natural-river corridors). It is noted that many of the key actions below are voluntary, and will rely on interactions between the key stakeholders, the community and iwi to be successful. It is also noted that many of the activities will be ongoing, and progress will depend on funding, not only through the ORC Annual Plan process, but also from other agencies and the wider community.

ORC has prepared the strategy, with input from the local community, to help protect the recreational, cultural, and ecological values of the Shag River/Waihemo riverbed, and to enable long-term sustainable use of the land that borders the river. The objectives and actions listed below are intended to help achieve this by guiding work programmes, decision-making activities for the community, stakeholders, iwi and ORC. It is therefore recommended that people who live, work, or play within the Shag River/Waihemo catchment consider and give effect to the principles, objectives and actions listed in this strategy.

Due to the dynamic nature of the Shag River/Waihemo, parts of this strategy are likely to change as the rivers themselves change; this strategy must therefore be treated as a 'live' document (Section 2.3). This means that some sections and maps in the strategy may change in response to changes in the Shag River/Waihemo (e.g. areas of gravel accumulation may shift).

Objective 1 Recognise and characterise natural-river processes

Activity	How this can be done	Intended outcome	Who will lead it	Timing	Comment
1.1. Collect information about flood and erosion processes					
	Map, describe and report on changes in channel morphology	Improved understanding of natural river processes	ORC	Ongoing	Previous reports describing changes in channel morphology are available
	Identify locations where erosion is occurring	Avoid high-value assets in erosion-prone areas	ORC	Ongoing	
	Make information publicly available, including through the Natural Hazards Database	Improved decision-making around placement of assets and land-use activities	ORC	Ongoing	Information is currently available through the Natural Hazards Database
1.2. Identify the location of river corridors, within which the river will naturally meander					
	Determine the natural meander form of the river, considering the existing channel location, and natural controls and restraints	Improved decision-making around placement of assets and land-use activities	ORC	Complete	Maps included in Appendix 3

Objective 2 Equip the community to live with the effects of changes in river morphology

Activity	How this can be done	Intended outcome	Who will lead it	Timing	Comment
2.1. Asset management and land-use practices (e.g. fences, vegetation clearance, and irrigation structure placement) are undertaken in such a way that reduces the risk associated with natural river processes					
	Land-use practices and other activities have greater regard to natural river processes	A reduction in risk over time	Landowners	Ongoing	ORC to provide guidance and information through field-days and other community programmes
	Consider implementation of land-use controls through the District Plan in areas with greater erosion risk	No net increase in risk over time	WDC	Long-term (5-10 years)	Incorporate into future revisions of WDC District Plan
	Identify mechanisms to modify/protect roading assets that consider natural river processes	Roading infrastructure is resilient	WDC	Ongoing	ORC to provide information as necessary
2.2. Consider all available options to manage the effects of bank erosion, including structural and non-structural options					
	Less intensive use of riparian margins	A reduction in risk over time	Landowners	Ongoing	
	Planting of native and exotic species on riparian margins	Increased stability of riparian margins and riverbanks, improve habitat and community values	Landowners	Ongoing	ORC to provide support, as determined through the ORC Annual Plan processs[15] Otago Fish & Game Council to provide support (through technical assistance in identifying critical areas in need of

[15] For further information on planting support available for landowners please see the ORC website www.orc.govt.nz in particular; www.orc.govt.nz/Publications-and-Reports/Farming-and-Land-Management/Riparian-management/ and http://www.orc.govt.nz/Information-and-Services/Environmental-Enhancement-Fund/ or contact ORC.

					planting or vegetation management to improve bank protection)[16].
	Produce guidelines for undertaking planting appropriate for river control and provision of habitat	Increased stability of riparian margins and riverbanks	ORC	Complete	Guidance included as Appendix 2
	Produce maps showing priority planting locations	Community requirements and natural river processes are considered before planting is undertaken	ORC	Ongoing	
	Proactive river management programme	Bank erosion and other river management issues addressed early	ORC	Ongoing	Maintenance work undertaken as provided for through the budget set in the ORC Annual Plan
	Provide information on the Regional Plan: Water permitted activity rules	The community is enabled to complete activities that manage the effects of bank erosion and other river management issues	ORC	Ongoing	Information on permitted activities to be provided to the community at any opportunity
2.3. Enable works that improve the conveyance of floodwater and 'train' the river within its natural corridor, without compromising features that are of high value to the community					
	Physical works by ORC to address existing river management issues	The Shag River/Waihemo is contained, as far as possible, within the natural river fairway/corridor, and convey small to-medium floods without overtopping	ORC	Ongoing	Locations and detail of work to be undertaken between October 2016 and 2019 included in Appendix 1

[16] For further information contact Otago Fish and Game Council at otago@fish-game.org.nz

	Physical works by landowners and other agencies to address river management issues	The Shag River/Waihemo is contained, as far as possible, within the natural river fairway/corridor, and convey small to-medium floods without overtopping	Landowners	Ongoing	ORC to provide guidance on suitable river-management methods (including resource consent requirements) through field days and other community programmes
	Provide information discussing the importance of community/stakeholder values	Works are undertaken in a manner that does not compromise features that are of high value to the community	ORC and the community	Complete	Values discussed in Section 4, these may be modified or adjusted as part of future reviews of this strategy
	Provide information discussing the importance of Mana Whenua values	Works are undertaken in a manner that does not compromise the values of Mana Whenua	ORC and Mana Whenua	Ongoing	Values discussed in Section 4 and Appendix 6, these may be modified or adjusted as part of future reviews of this strategy or future values reports.

Objective 3 Enable sustainable gravel extraction

Activity	How this can be done	Intended outcome	Who will lead it	Timing	Comment
3.1. Ensure sustainable quantities of gravel are extracted, for river management benefits					
	ORC will continue morphological studies of the Shag/Waihemo River and analyse whether gravel takes that are sustainable.	Gravel extraction is completed in a sustainable manner	ORC	Ongoing	
3.2. Identify areas where gravel extraction may affect community values					
	Provide information discussing the importance of community/stakeholder values	Extraction is undertaken in a manner that does not compromise features of the location that are of high value to the community	ORC and the community	Completed	Values discussed in Section 4. These may be modified or adjusted as part of future reviews of this strategy
	Provide information discussing the importance of Mana Whenua values	Extraction is undertaken in a manner that does not compromise values of Mana Whenua	ORC and Mana Whenua	Ongoing	Values discussed in Section 4 and Appendix 6, these may be modified or adjusted as part of future reviews of this strategy or future values reports.

Objective 4 Promote activities that enhance the natural character and enjoyment of the river

Activity	How this can be done	Intended outcome	Who will lead it	Timing	Comment
4.1. Identify the location and characteristics of features that are of high value to the community					
	Community values obtained through consultation and clearly identified within the strategy	Consideration of community values when making decisions	ORC	Completed	Values discussed in Section 4. These may be modified or adjusted as part of future reviews of this strategy
	Mana Whenua values obtained through consultation and clearly identified within the strategy	Consideration of mana Whenua values when making decisions	ORC	Completed	Values discussed in Section 4 and Appendix 6, these may be modified or adjusted as part of future reviews of this strategy or future values reports.
4.2. Establish riparian plantings that serve a purpose, and are appealing					
	Produce guidelines for undertaking planting appropriate for river control and provision of habitat	Increased stability of riparian margins and riverbanks. Improved aquatic and terrestrial habitat	ORC	Completed. See also 2.2 above	Guidance included as Appendix 2.
	Provide information about Mana Whenua positions on riparian planting	Improved aquatic and terrestrial habitat for native mahinga kai and taonga species.	Mana Whenua	Ongoing	Guidance included in Appendix 6.

4.3. Provide access for fishing activities and habitat for fish					
	Planting work that facilitates fishing activities and enhances fish habitat	The Shag River/Waihemo supports a regionally important sports fishery, and important populations of native fish (including threatened and endangered species)	Fish & Game, DOC	Ongoing	
	Consent conditions ensure that gravel extraction and physical works are undertaken in a way that does not damage habitat	The Shag River/Waihemo supports a regionally important sports fishery, and important populations of native fish (including threatened and endangered species)	ORC, extractors and landholders	Ongoing	See Objective 3 also
	Encourage the creation of additional public access points	River-access opportunities are increased	Fish & Game, ORC, WDC, landowners	Ongoing	
4.4. Adequate pest and weed control activities					
	Landowners (including LINZ) and other stakeholders work collaboratively to manage pest species	The Shag River /Waihemo fairway and riparian margin are relatively free of pest species	Landowners, stakeholders, ORC	Ongoing	
4.5. Discourage dumping, and arrange the regular collection of rubbish					
	Collection of rubbish through regular/routine work at key locations. Signs warning of penalties for rubbish dumping to be erected if issues persist.	Improved visual amenity and enjoyment of recreational areas	WDC	Ongoing	

4.6. Protect and enhance the natural character of the Shag River/Waihemo					
	Promote and encourage local restoration initiatives such as bank planting and wetland restoration	Riparian margins are planted/restored, look visually appealing, and provide aquatic and terrestrial habitat	Community& support from other agencies	Ongoing	

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Appendix 1 ORC river maintenance work within the Waitaki Special Rating District

Five locations (A, D, F, G, I) within the mapped river corridor have recently had works completed and four locations (B, C, E, H) have been identified as requiring observation or work to maintain the fairway within its natural position (as mapped in Appendix 3) and/or to ensure the adequate conveyance of floodwater[17]. Locations are shown in Figure 20 and 21 and a photo comparison showing before and after of recent works is shown in Figure 22. These priority locations have been determined using the latest information available (September 2017) about specific locations that are experiencing river management issues. ORC intends commencing work at the proposed locations during the 2017/2018 financial year. Ongoing maintenance may also be required at some of these locations into the future.

This list and the need to undertake work at particular locations may change into the future, in response to flood events and to other river management issues that the community may identify through the process outlined in Section 2.3.

The river management work (outlined below) that is scheduled to take place in the Shag/Waihemo River will need to consider the following:

- The principles outlined in Section 6.
- The location and width of the natural river corridor and active fairway as described in Section 7, and other natural river processes as described in the strategy.
- The objectives and associated activities listed in Section 7.3. In particular objective 2 (equip the community to live with the effects of changes in river morphology) and activity 2.3 (enable works that improve the conveyance of floodwater and 'train' the river within its natural corridor, without compromising features that are of high value to the community).
- The ecological, community and Māori values discussed in Section 4.

The increased program of work in the Shag/Waihemo River and the development of river morphology and riparian management strategies for the Waianakarua and Shag Rivers; increased costs for the Waitaki Special Rating District (SRD) in the 2016/17 year. Revenue from rates within the SRD is projected to increase slightly from $350,000 in 2016/17 to $440,000 in 2019/2020, in order to fund additional in-stream work required to meet community river management expectations.

The dynamic nature of these two rivers and the inability to predict the timing or consequences of future flood events in the Waitaki District means there is a risk that this additional funding for river management work may still be insufficient. It is noted that all ratepayers within the Waitaki District contribute funding towards the Waitaki SRD[18].

[17] Note that riparian management / planting work is not described here. As outlined in the overview section, it is intended that subsequent versions of the strategy will include further guidance and plans for undertaking planting on riparian margins, for river management purposes and for habitat enhancement.
[18] The river management rate is currently collected from 12,000 rating units across that part of the Waitaki District which lies within the Otago Region, at a rate of 0.00007728 cents per $1 of capital value

The anticipated budget for river management operations (physical works) in the Waitaki SRD until 2020/21 is shown in Table 5 below. This shows that $259,000 is budgeted for this work during the 2017/18 year, up $47,000 from the previous year. As noted above, this budget is not solely for the Shag/Waihemo River and includes other rivers in the Waitaki District, including the Waianakarua, Kauru and Kākanui rivers.

Table 5. ORC river management budget for the Waitaki District

Year	ORC river management (operations) budget
2016/17	$212,000
2017/18	$259,000
2018/19	$324,000
2019/20	$332,000
2020/21	$341,000

Planned and completed river maintenance work – Shag/Waihemo River

A. Work completed at this location involved spraying and controlling plants on the river bank and beaches, and has been completed from this location upstream to Jones road (Figure 20).

B. Work at this location will involve spraying and controlling plants on the river bank and beaches, and will be worked on from this location downstream (Figure 20).

C. This location will be under observation for possible works (Figure 20).

D. Work completed at this location involved moving gravel to maintain the active channel fairway (Figure 20).

E. This location will be monitored for possible gravel maintenance on the beach following significant build up (Figure 20).

F. Work completed at this location involved moving gravel to maintain the active channel fairway, plant clearing to enable clean flow and new planting to limit bank erosion (Figure 21).

G. Work completed at this location involved moving gravel to maintain the active channel fairway, and planting to limit bank erosion (Figure 21).

H. Work at this location will involve vegetation clearing (Figure 21).

I. Work completed at this location involved moving gravel to realign the active channel fairway, and planting to limit bank erosion and impacts on the SH1 and railway (Figure 21).

There are many locations along the river fairway where ORC will provide on a case by case basis trees for planting within the corridor to help prevent bank erosion and migration of the river from its fairway path.

Figure 20. Locations of completed and proposed operations work (Aerial imagery 2014).

Figure 21. Locations of completed and proposed operations work (Aerial imagery 2014).

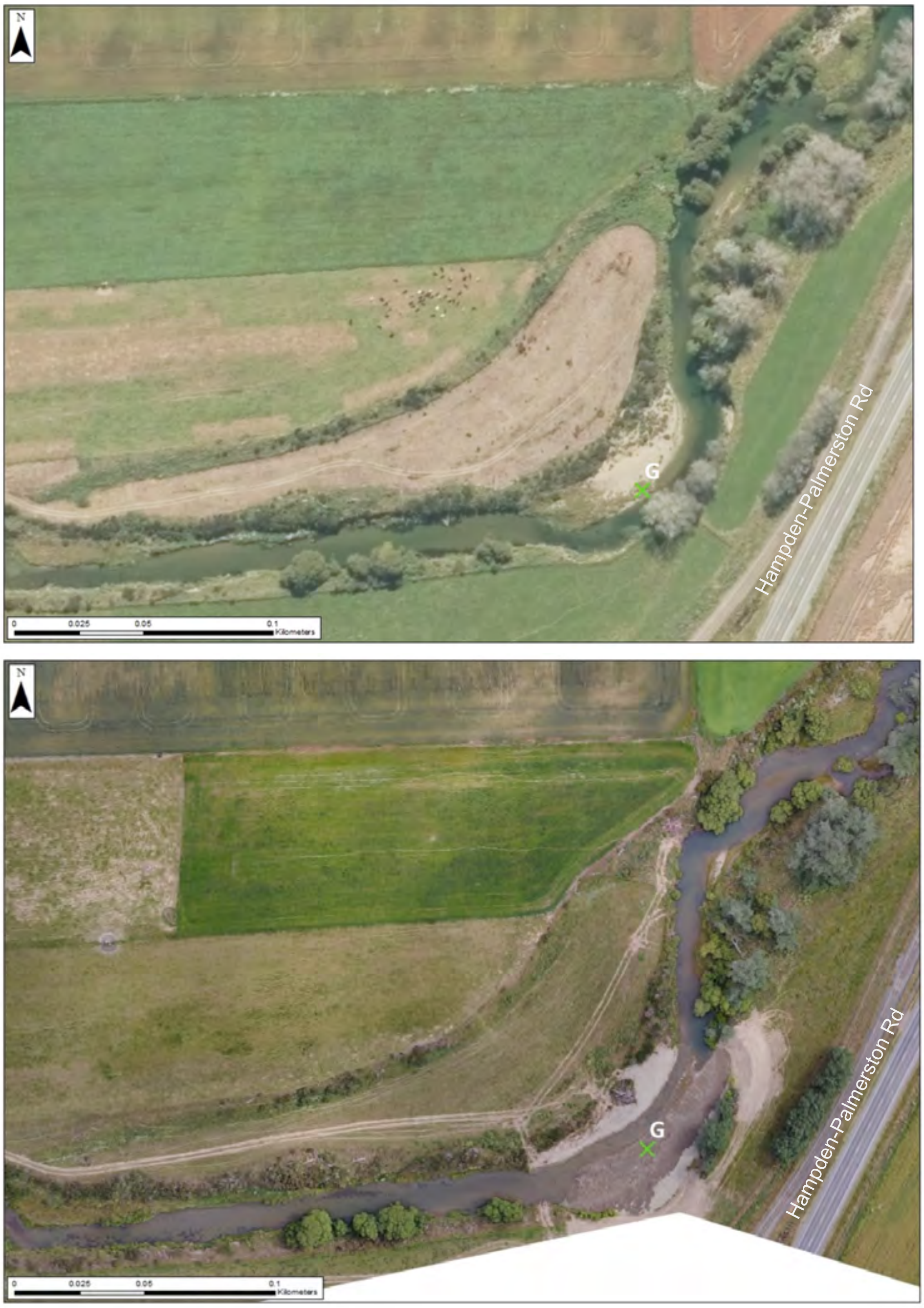

Figure 22. **Comparison pictures of operation location G. Upper image before works completed (Aerial imagery 2014), lower image after works completed (Aerial imagery 2016), the gravel beach has been removed, the channel realigned and bank protection measures out in place on the true right.**

Appendix 2 Planting guide

Benefits of riparian planting[19]

The benefits of well-planned and well-managed riparian planting areas on farms are considerable, and include:

- Increasing the quality and health of waterways
- Increasing the ability to filter nutrients before they reach waterways – Nitrogen, Phosphorus, and bacteria/viruses e.g. *E.Coli*
- Reducing sediment runoff and anchoring banks
- Reducing soil erosion of banks in waterways
- Providing shade, which reduces waterway temperatures and shelter for stock
- Minimising stock losses as animals are excluded from riparian strips by fences
- Increasing biodiversity – aquatic life, native plants, birds and insects
- Improving recreational opportunities (e.g. fishing)
- Enhancing and beautifying the river margins.

Both native and exotic species can be suitable for riparian planting. The species to be used will depend upon many factors, including environmental factors (exposure, soils, etc.) but also the width of the riparian strip, the height of plantings that is desired, and personal preference.

Ngā Rūnanga encourage and support native riparian planting by landowners as an important habitat for mahinga kai.[20] For reference to Ngāi Tahu claims settlement act taonga species see Appendix 6.

Using trees to stabilise stream banks[21]

Exotics

The most effective trees for stream bank erosion control are exotic willows and poplars. These are planted as stakes (less than 1 m high) or poles (1.5 – 3 m in height). Avoid invasive spreading species, such as crack willow, weeping willow, silver poplar and all non-sterile tree and shrub willows. Before planting fast-growing trees, consider their longer-term maintenance needs.

Winter is the best time to plant these species before stakes or poles sprout new growth. Plant about a third of the length below ground. On waterlogged ground, you can force them in by hand. On firm ground, you may be able to sharpen poles at one end and drive them in with a rammer or use a post auger. Stakes can be planted by putting them into a hole made

[19] Adapted from KCCP planting guide (2015)
[20] For more information on this contact Aukaha (www.aukaha.com) or your local Rūnanga (Kāti Huirapa Rūnaka ki Puketeraki or Te Rūnanga o Moeraki)
[21] Adapted from ORC (2005)

with a length of reinforcing rod or similar. The most important thing is to make sure stakes and poles are firmly planted.

Guide to planting willow poles

Storage

It is recommended that poles are planted as soon as possible following delivery. Poles can be stored for a few weeks in water, standing up in a water trough or pond/creek. The bottoms of the poles should be kept wet to keep them alive and absorbing water. Poles should be stored away from stock.

Planting

Poles should ideally be planted on the outside of river bends, or sections of river where erosion is occurring. Plant poles in rows with 2 – 3 m spacing between them. Poles need to be planted 300-500 mm deep. Try and plant down to ground water level. Either a crow bar, post-hole borer or tractor forks/digger with a spike can be used to make a hole in the ground that the pole can be dropped into, and then packed firm.

Looking after plantings

Fence planting off from stock to protect plants; plant protectors can also be purchased and can help give protection. It is recommended that poles are watered the day after planting and at least once a week during dry weather until they are established.

To stabilise banks:

- Pair-plant along straight reaches – one tree on one bank, one tree on the opposite bank, five to seven meters apart
- Plant at two to three metre spacing at critical points, such as the outside of the bends where erosion is the greatest
- Avoid planting on the inside of bends – soil builds up rather than erodes here, so trees will trap sediment and force current against the outer bank
- Avoid planting narrow channels where trees might impede floodwaters.

By the time trees are four or five years old, there will be a solid mass of roots along the bank. At 10 to 20 years, trees can be thinned to 10 to 12 metre spacing, but no wider. If you use sleeves on poles to protect the willows and poplars, sheep can be grazed around the trees from the time they are planted.

Natives[22]

There are many advantages of utilising native plants. These include:

- Enhancing natural character and landscape values
- Forming a habitat corridor and potentially ecological linkage in the catchment
- Restoration of rare riparian forest (and other habitats)
- Creating/enhancing habitat for native birds and invertebrates (including pollinators)
- Restoration or enhancement of threatened plant habitats
- Do not grow as high or require maintenance (e.g. pruning or thinning)
- Self-regenerating and maintaining.

Planting natives for bank stability will enhance the natural biodiversity of your riparian margin and provide habitat for invertebrates and birds. While exotic tree species are proven to stabilise banks, new research shows that native trees, such as ribbonwood, cabbage tree and pittosporum species, are suitable for bank stabilisation. These species are deep rooting, with a good root spread. Planting native species alongside exotics will help to maintain a mostly native planting on your banks.

Tables 6 through 9 list suitable native vegetation to plant in the Shag/Waihemo catchment, including trees, shrubs, tussock, and rare species. Guidance for the establishment of riparian buffer zones along reaches of the Shag/Waihemo River is provided in Appendix 3, Section 7.1 and 7.2. Additional technical assistance for identifying critical areas in need of plantings or vegetation management to improve bank protection can be provided by ORC staff or Fish and Game (Central South Island Council).

Table 6. Suitable native species for the Shag/Waihemo catchment (trees)

Common name	Scientific name	Mix of plants[23]
Black mapou/kohuhu	Pittosporum tenuifolium	major
Lemonwood	Pittosporum eugenoides	major
Lowland ribbonwood	Plagianthus regius	major
Narrow-leaved lacebark	Hoheria angustifolia	major
South island kowhai	Sophora microphylla	major
Cabbage tree	Cordyline australis	major
Broadleaf	Griselinia littoralis	moderate

[22] Information on native planting provided curtesy of DoC

[23] The major, moderate or minor is intended to direct the numbers/mix of plants used in a riparian/restoration planting. Therefore the bulk of the plants would compose the 'major' species, with some of the 'moderate' species and only a few of the 'minor' species. The species mix may be in the order of 10 of a 'major' species to 5 of a 'moderate' species to 1 of a 'minor' species.

Marbleleaf	Carpodetus serratus	moderate
Manuka	Leptospermum scoparium	moderate
Chatham Island akeake	Olearia traversii	moderate
hybrid olearia	Olearia x dartonii	moderate
Silver beech	Lophozonia (Nothofagus) menziesii	major
Red beech	Fuscospora (Nothofagus) fusca	moderate
Mountain beech	Fuscospora (Nothofagus) cliffortioides	moderate
Kahikatea	Dacrycarpus dacrydioides	minor
Mountain totara	Podocarpus hallii	minor
Matai	Prumnopitys taxifolia	minor

Table 7. **Suitable native species for the Shag/Waihemo catchment (shrubs)**

Common name	Scientific name	Mix of shrubs
Mingimingi	Coprosma propinqua	major
A coprosma	Coprosma dumosa/tayloriae	moderate
A coprosma	Coprosma rigida	moderate
Koromiko	Hebe salicifolia	major
Cottonwood	Ozothamnus vauvilliersii	moderate
Weeping mapu	Myrsine divaricata	minor

Table 8. **Suitable native species for the Shag/Waihemo catchment (tussock and tussock-like plants)**

Common name	Scientific name	Mix of tussock and tussock like plants
Ballerina sedge	Carex secta	major
Toetoe	Austrodieria (Cortadieria) richardii	major
Lowland flax	Phormium tenax	major
Red tussock	Chionochloa rubra ssp. cuprea	moderate

Table 9. Suitable native species for the Shag/Waihemo catchment (rare species)

Common name	Scientific name	Status
Pomahaka tree daisy	Olearia fimbriata	Nationally vulnerable
Hector’s tree daisy	Olearia hectorii	Nationally endangered
Linear-leaved tree daisy	Olearia lineata	At risk: declining
Fragrant tree daisy	Olearia fragrantissima	At risk: declining
Bloodwood	Coprosma wallii	At risk: declining
Teucridium	Teucridium parvifolium	At risk: declining

General planting tips

- Natives are preferable for the natural character of our landscapes; however, properly chosen exotics, which should not be a weed risk, can be more functional.
- Consider what environment you’re planting in; the values you and others have in the waterway environment and what species are needed to achieve these. Some species achieve bank stabilisation in larger waterways (i.e. willows), however block smaller streams and affect the connectivity of flow. Consider the use of natives instead for small streams/creeks and planting natives alongside exotics in larger waterways.
- Winter is the best time to plant exotics (including willows and poplars), before stakes or poles sprout new growth. Importantly, stakes and poles should be firmly planted, with a third of the length below ground.
- The wider the riparian strip that is created and planted, a wider range of benefits will be achieved.
- Riparian strips can be of variable width dependent upon site factors such as access for machinery, height above the river (and flood levels), topography, and soils. An example being that wet areas or depressions behind a river bank or levee should be included, as sediments and nutrients may leak into the river.
- Habitat strips/wildlife corridors need to be wider than 5 m (ideally at least 8 m) in order to incorporate the equivalent of three rows of plantings.

- Plantings can be either in rows or randomly scattered to give a more natural appearance. The scattering of plants and natural appearance is more important for restoration plantings and Habitat strips/wildlife corridors.

- Closer plant spacing will provide greater mutual shelter, and so achieve faster growth, however will require more plants and therefore greater cost. They may also require some thinning later. This balance needs to be considered.

- When planting natives for bank stabilisation, plant at 1.5 – 3 metres spacing.

- The clear felling of existing vegetation and the creation of bare patches should be avoided when planting. Significant bank erosion can result after the removal of vegetation which previously binded the soil. Such practices should be avoided until the root systems of new plantations have become fully established.

- Riparian margins should provide a wide variance of habitat and function. As a part of a wider matrix of habitats in the landscape, creates overhanging or drooping vegetation and shaded pools.

- Additional advice on your site may be available from ORC, DOC, local nurseries, websites and publications.

Tips for maintaining riparian margins

- Riparian margins should be maintained proactively, to ensure the best chance of planting success. Weed species are often fast growing and can quickly outcompete riparian plantings. Failure to carry out weed management can inhibit the growth and success of riparian plantings.

- Older tree species need to be maintained to prevent blockages and localised flooding associated with limbs and/or trunks that have fallen into the channel. This includes the removal of rotten limbs and large overhanging limbs which are unsupported.

Appendix 3 River corridor: maps

The river fairway and corridor mapping provides guidance for multi-purpose river management, and for the design and implementation of management measures, protection works and in-channel design. When physical works or activities are being considered within the fairway or on the riparian margin, these should be undertaken with reference to the mapped fairway and buffer zones. The method used to define the river corridor is explained in Section 7.1

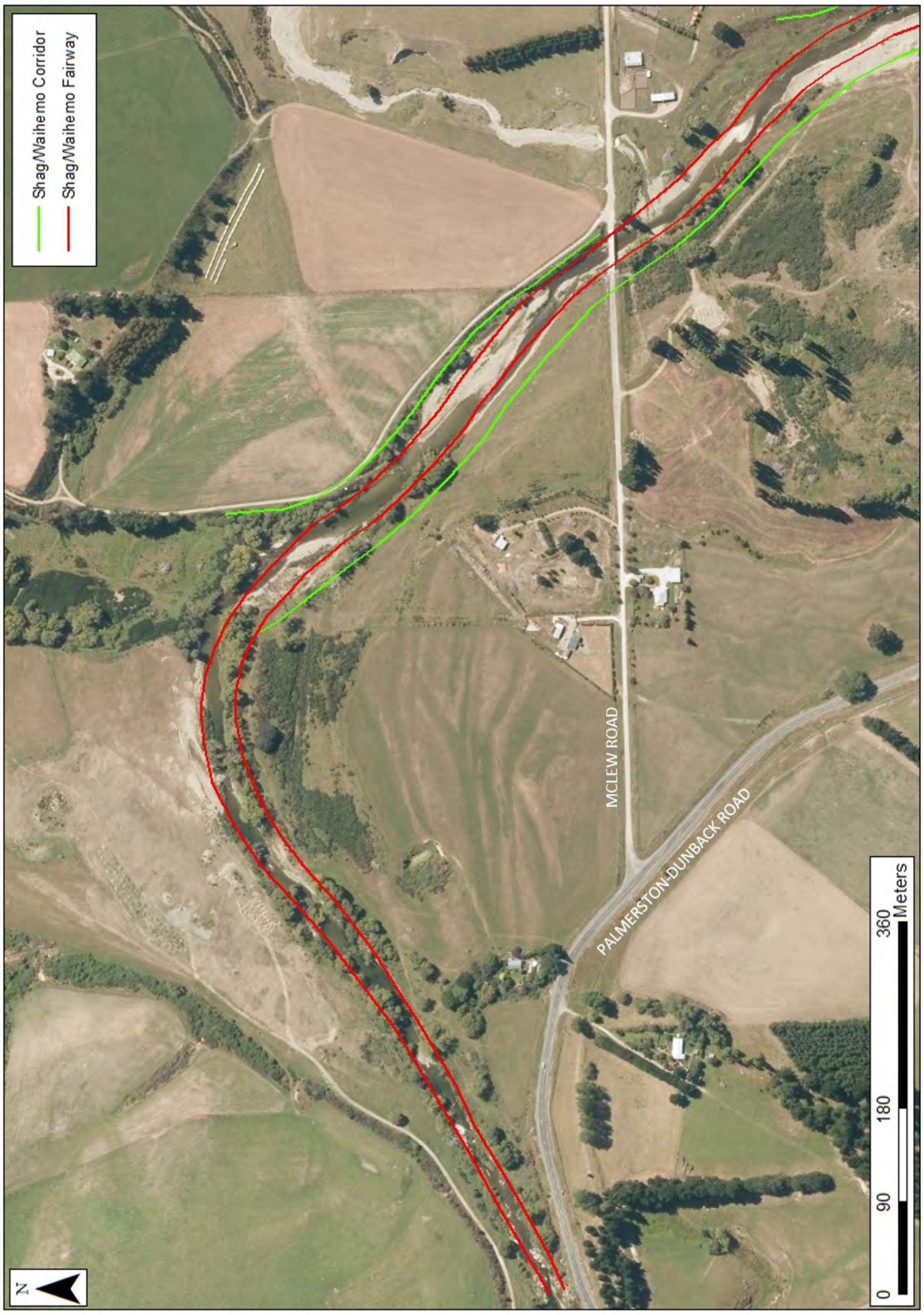

Figure 23. Shag/Waihemo River fairway and corridor Map 1 (aerial photography collected 2014).

Figure 24. Shag/Waihemo River fairway and corridor Map 2 (aerial photography collected 2014).

Figure 25. Shag/Waihemo River fairway and corridor Map 3 (aerial photography collected 2014).

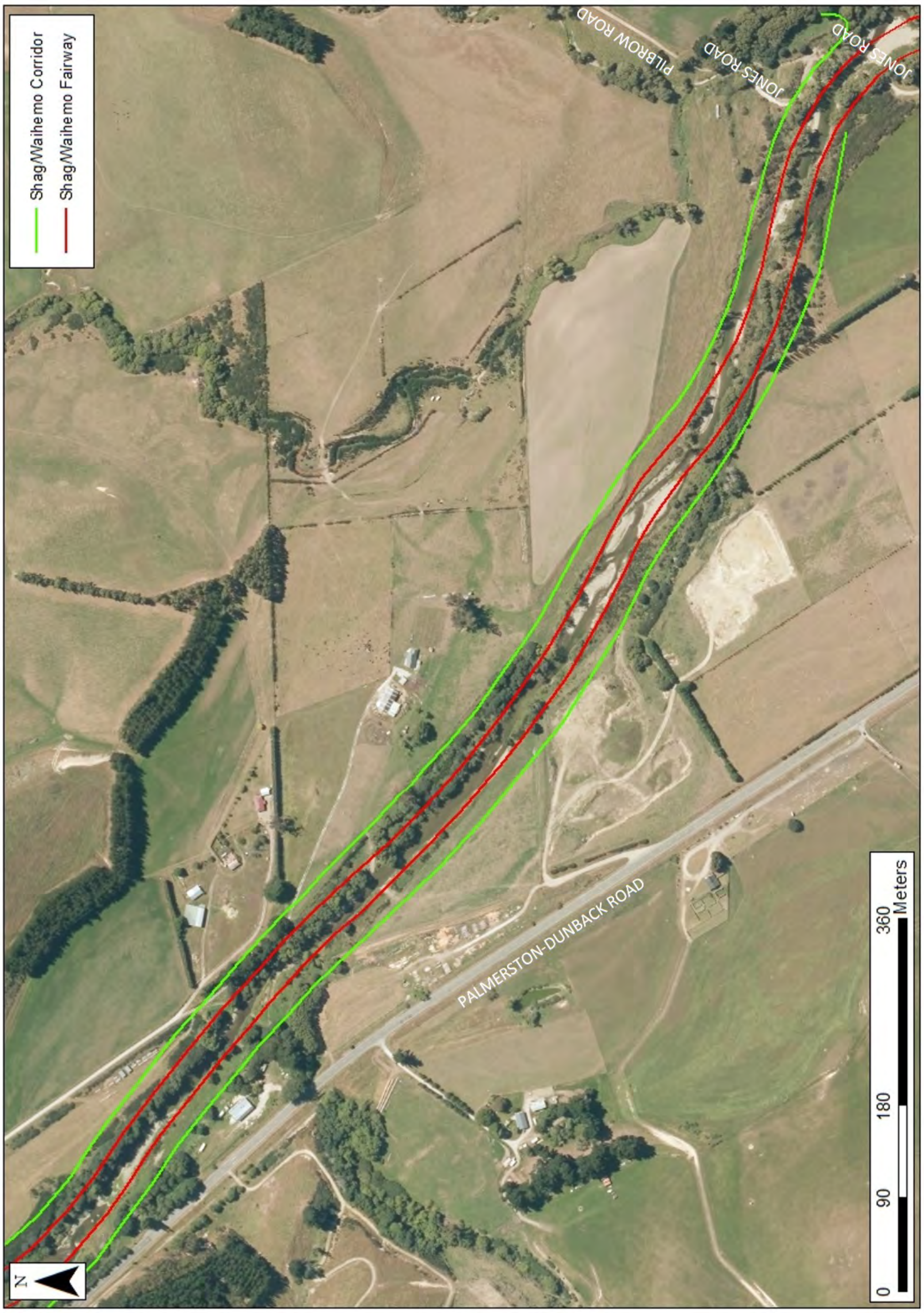

Figure 26. Shag/Waihemo River fairway and corridor Map 4 (aerial photography collected 2014).

Figure 27. Shag/Waihemo River fairway and corridor Map 5 (aerial photography collected 2014).

Figure 28. **Shag/Waihemo River fairway and corridor Map 6 (aerial photography collected 2014).**

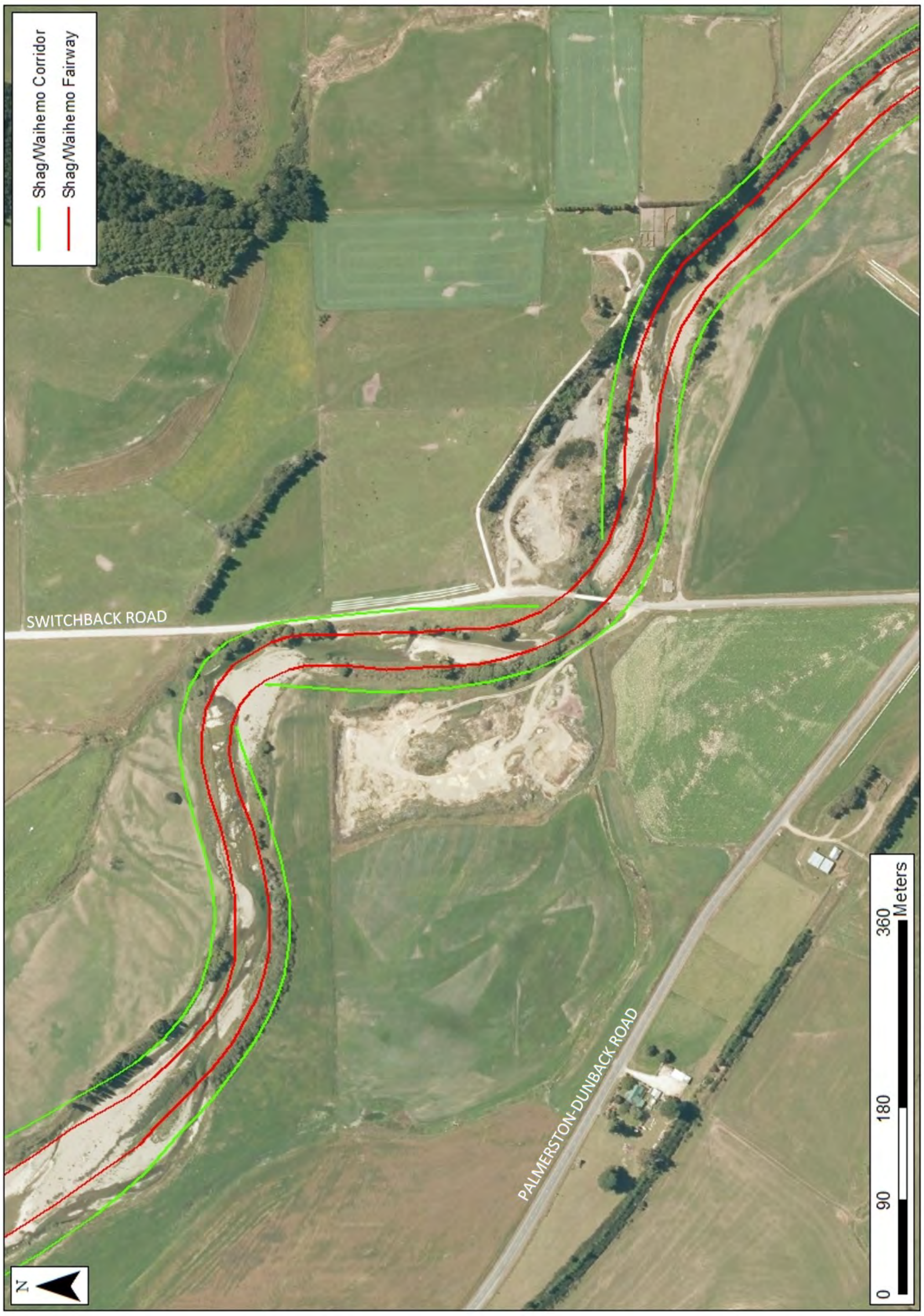

Figure 29. Shag/Waihemo River fairway and corridor Map 7 (aerial photography collected 2014).

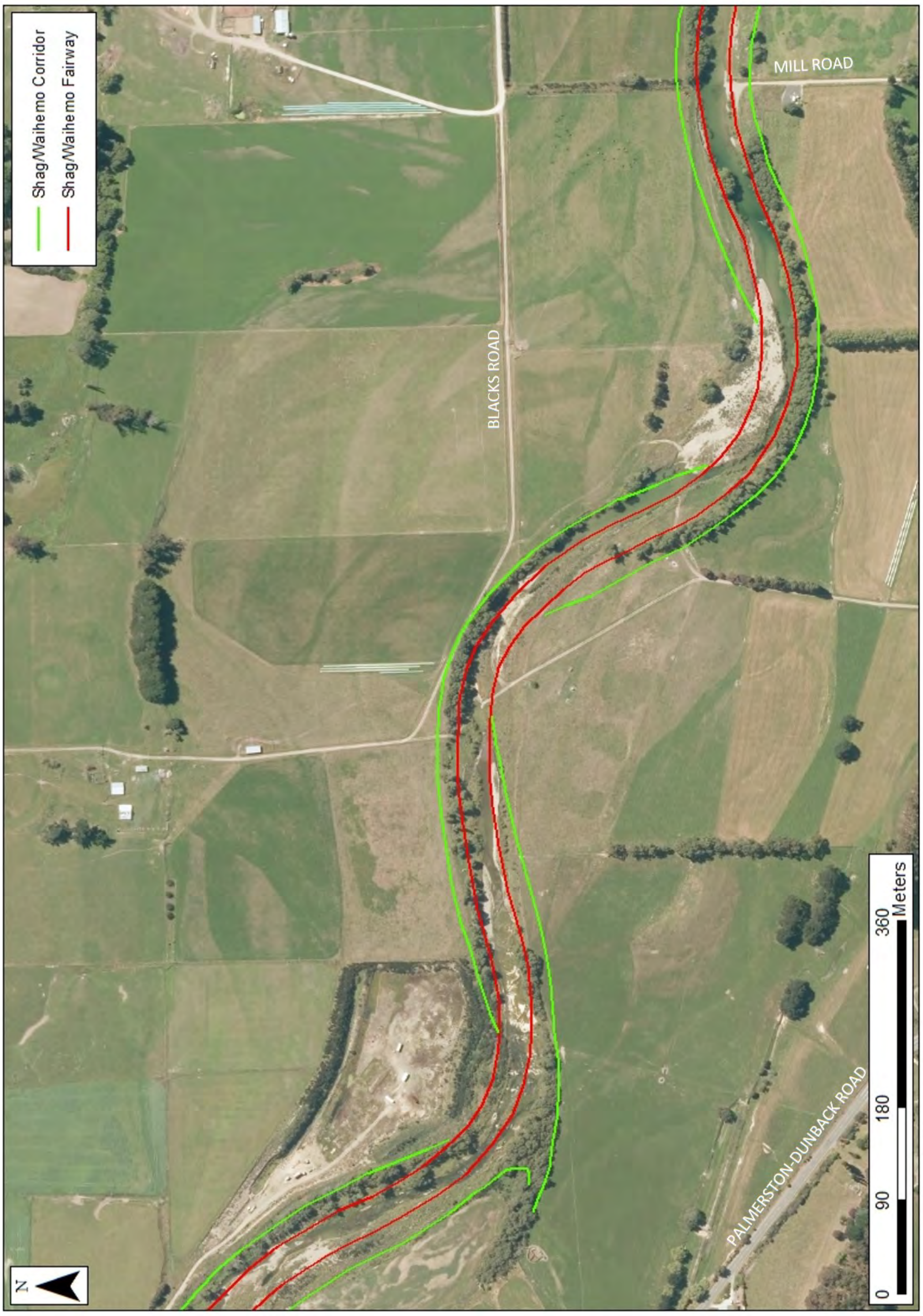

Figure 30. Shag/Waihemo River fairway and corridor Map 8 (aerial photography collected 2014).

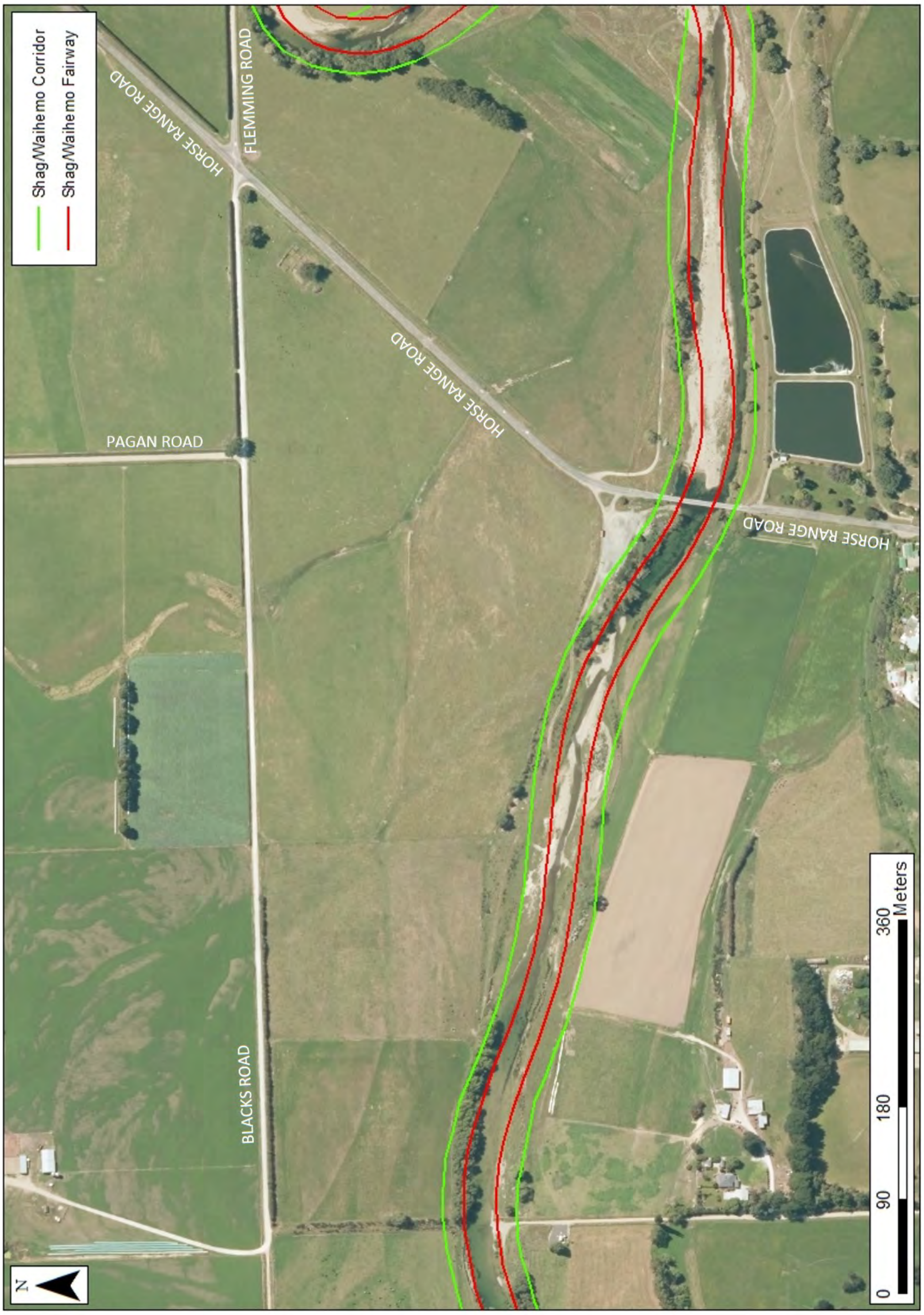

Figure 31. Shag/Waihemo River fairway and corridor Map 9 (aerial photography collected 2014).

Figure 32. Shag/Waihemo River fairway and corridor Map 10 (aerial photography collected 2014).

Figure 33. Shag/Waihemo River fairway and corridor Map 11 (aerial photography collected 2014).

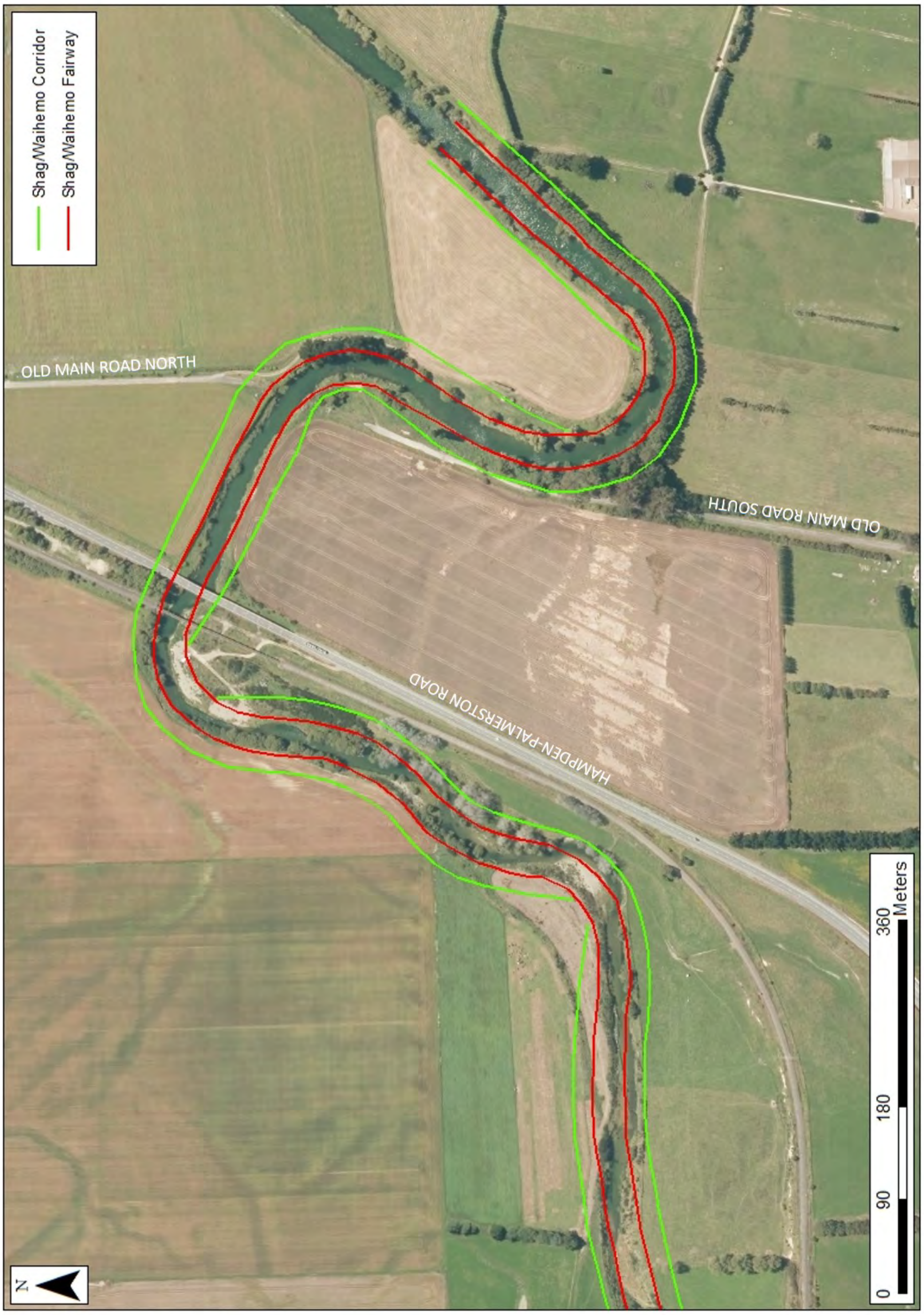

Figure 34. **Shag/Waihemo River fairway and corridor Map 12 (aerial photography collected 2014).**

Appendix 4 Mapped community values

The maps in this section show the location of important values associated with the riverbed and riparian margins, as identified by the community and other stakeholders. The community consultation process is outlined in Section 4, Appendix 5 provides a summary of public submissions.

Figure 35. Mapped community values in the Shag/Waihemo River Map 1 (aerial photography collected 2014).

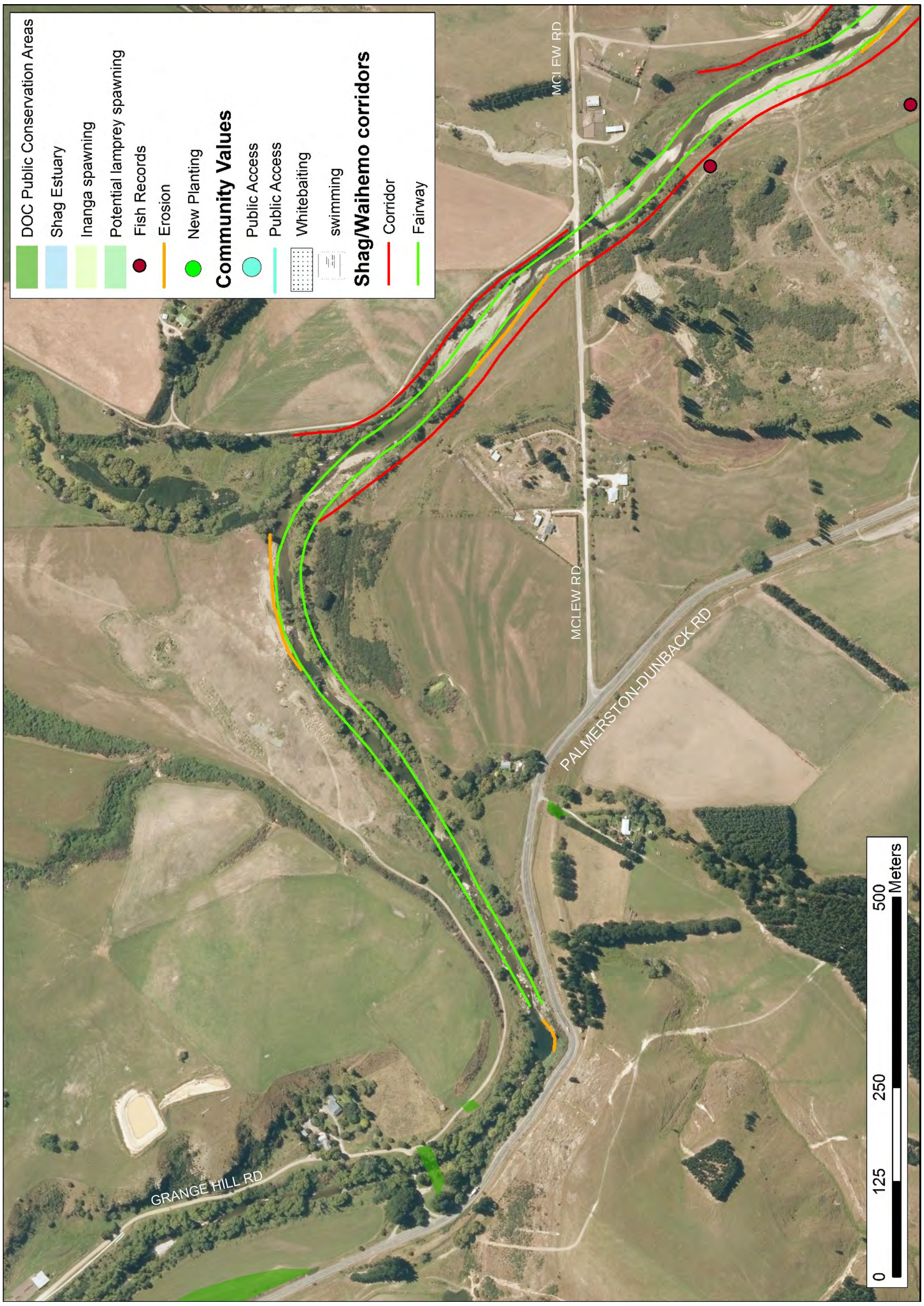

Figure 36. **Mapped community values in the Shag/Waihemo River Map 2 (aerial photography collected 2014).**

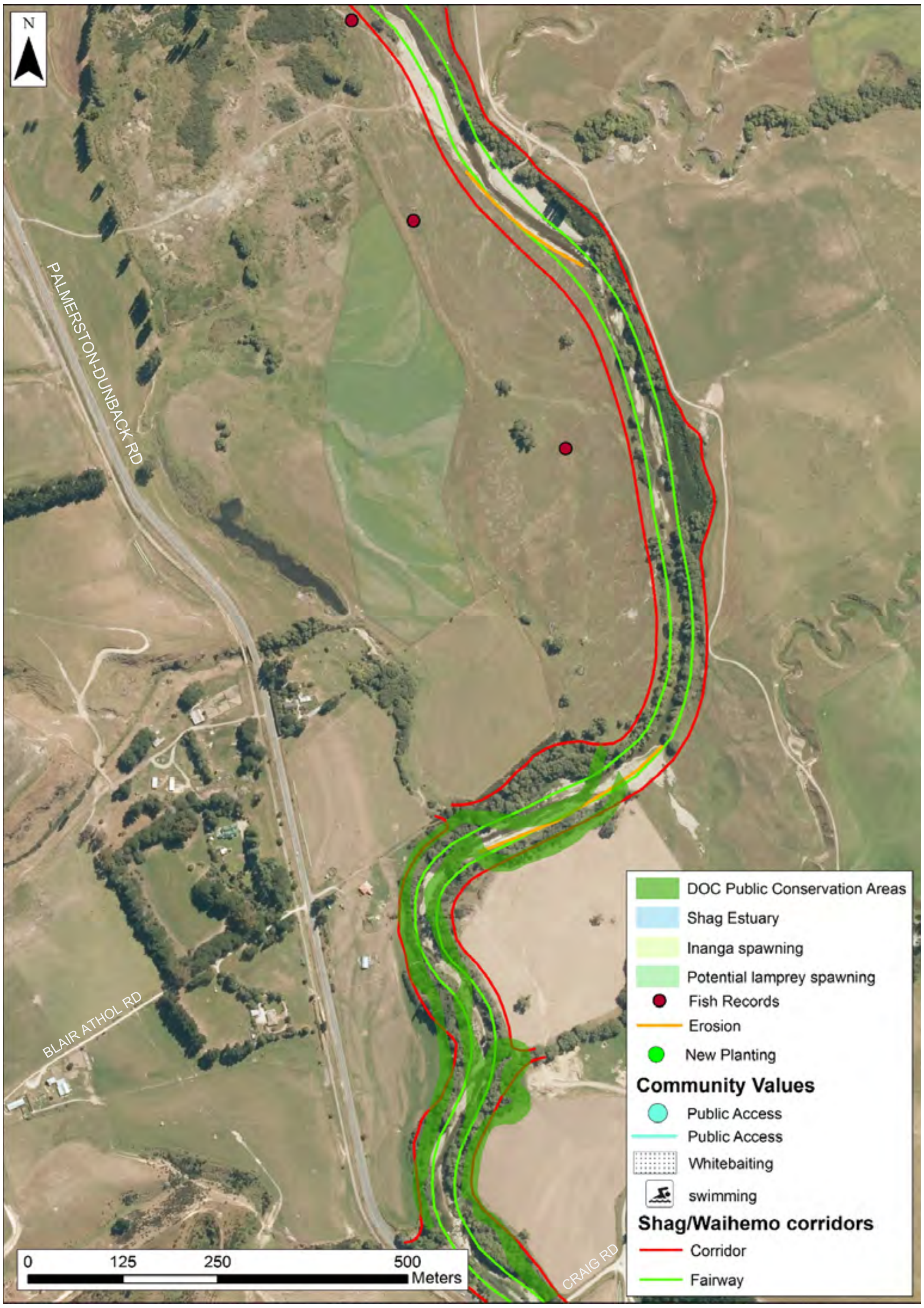

Figure 37. **Mapped community values in the Shag/Waihemo River Map 3 (aerial photography collected 2014).**

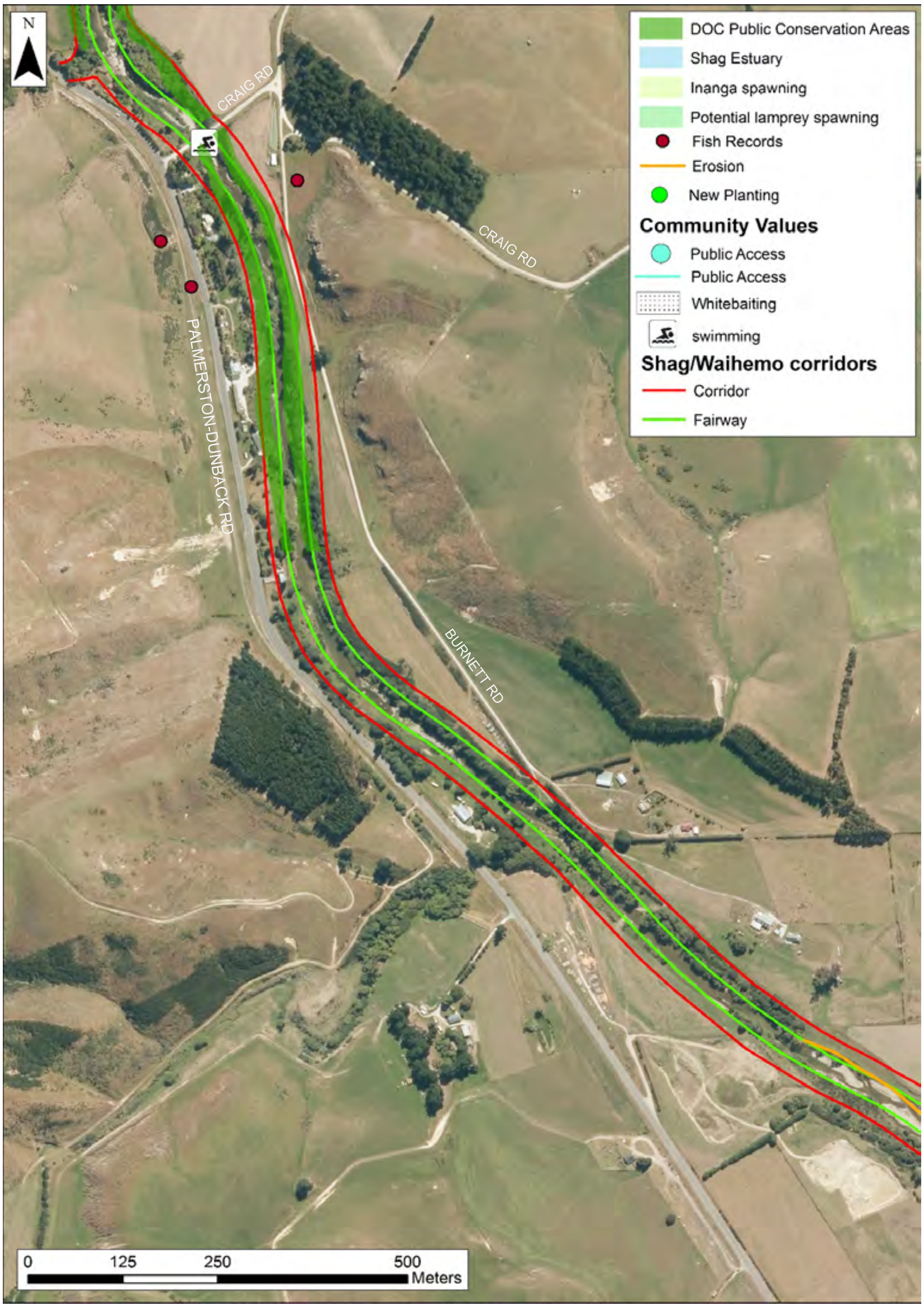

Figure 38. Mapped community values in the Shag/Waihemo River Map 4 (aerial photography collected 2014).

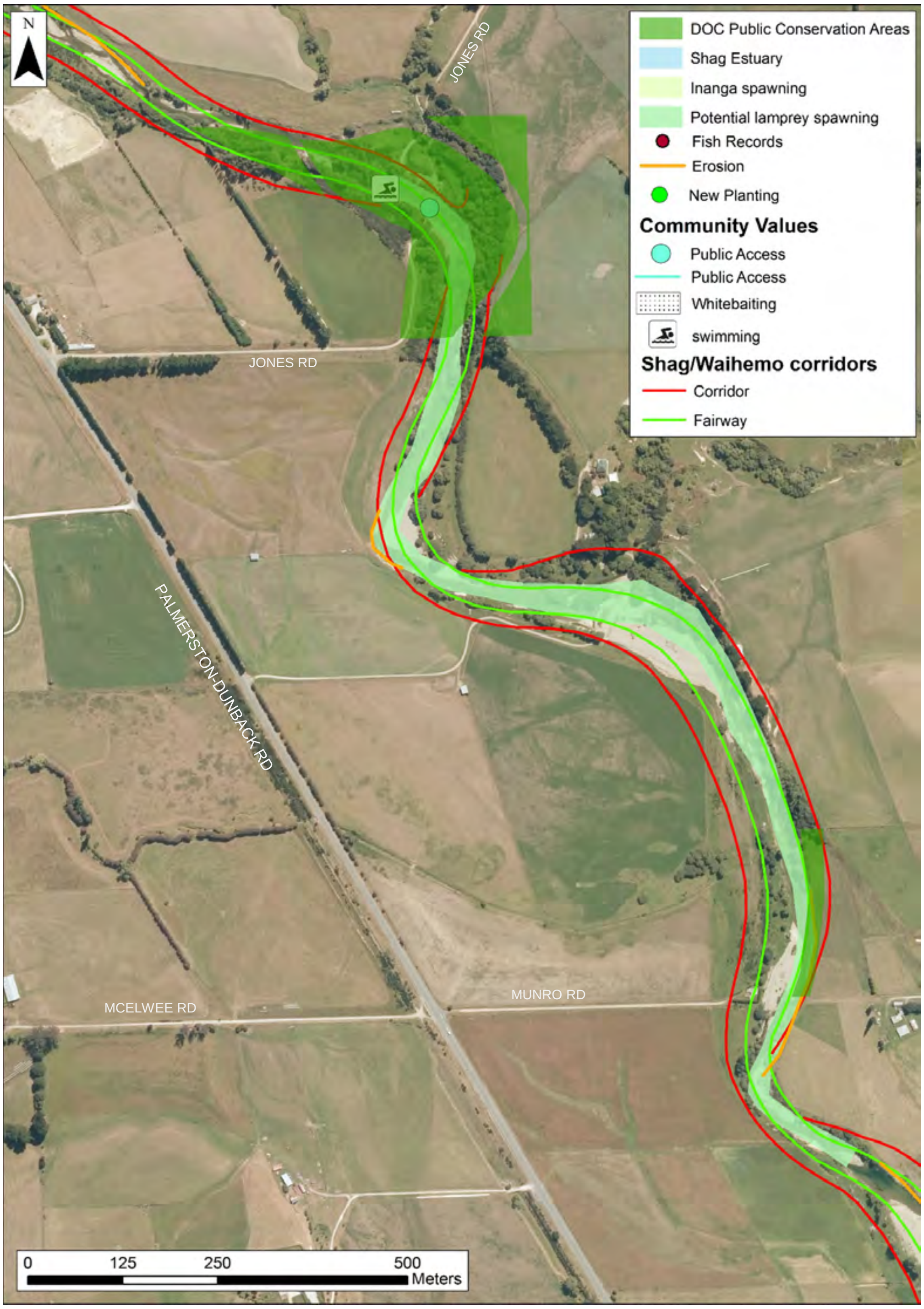

Figure 39. Mapped community values in the Shag/Waihemo River Map 5 (aerial photography collected 2014).

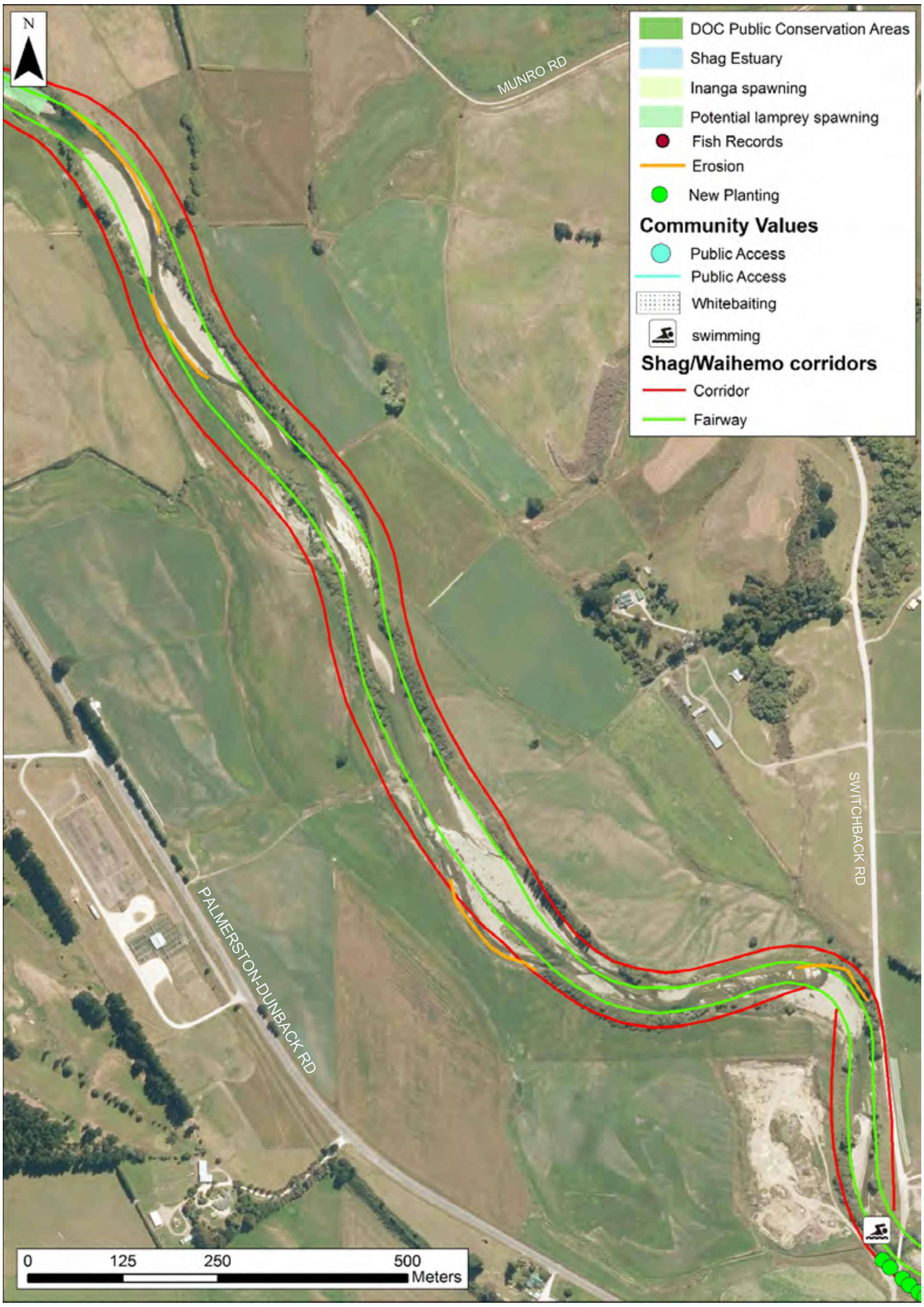

Figure 40. Mapped community values in the Shag/Waihemo River Map 6 (aerial photography collected 2014).

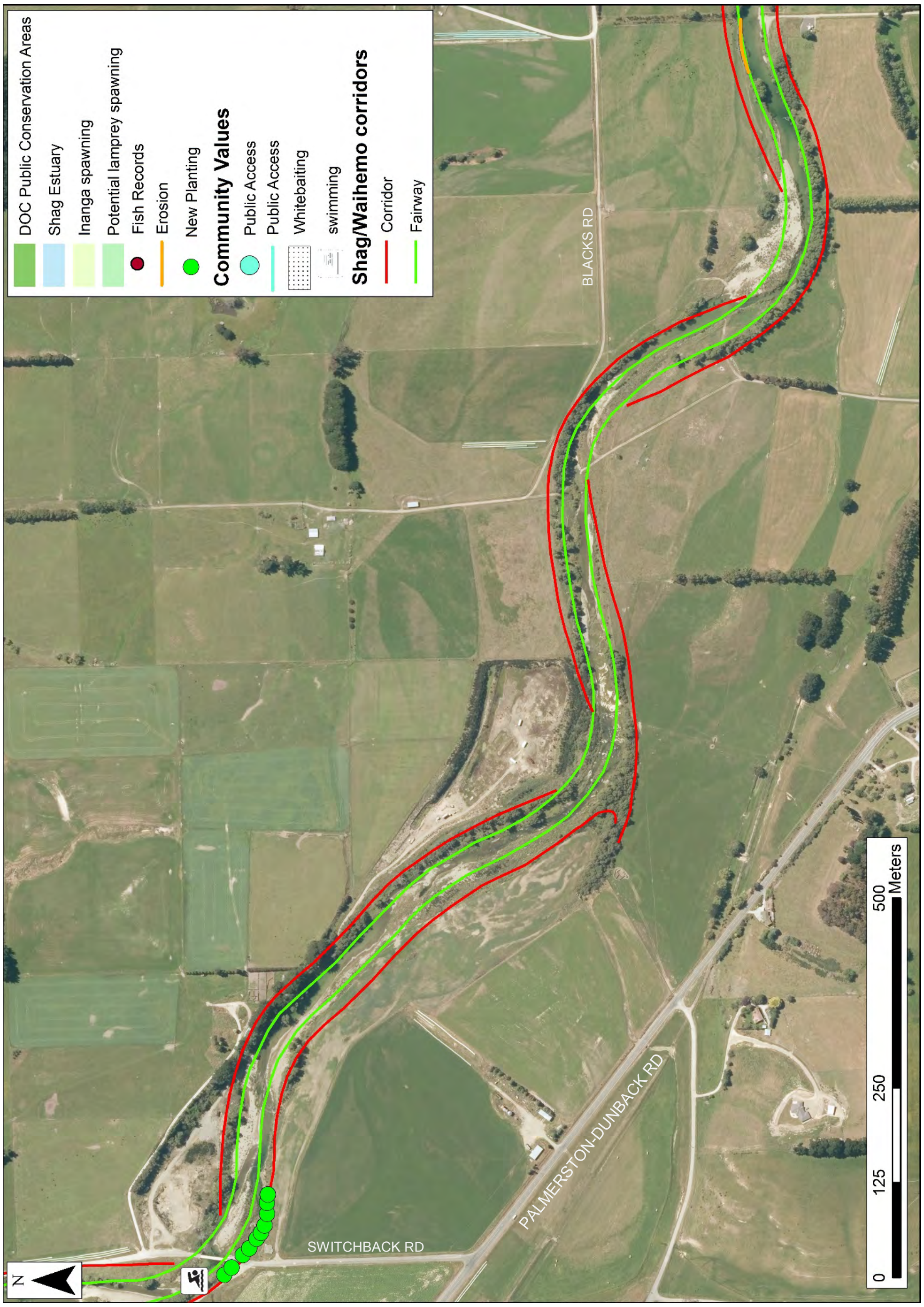

Figure 41. Mapped community values in the Shag/Waihemo River Map 7 (aerial photography collected 2014).

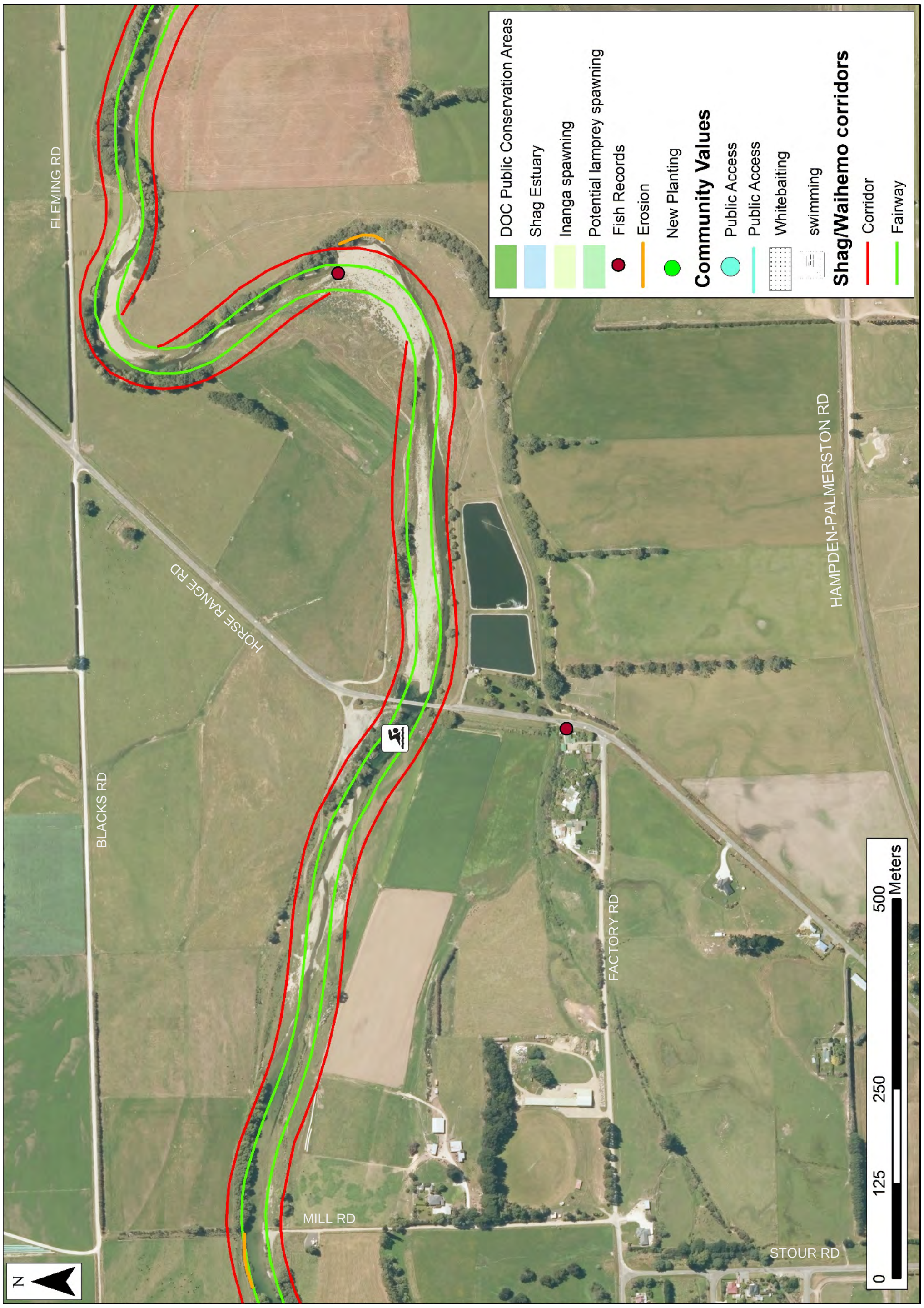

Figure 42. Mapped community values in the Shag/Waihemo River Map 8 (aerial photography collected 2014).

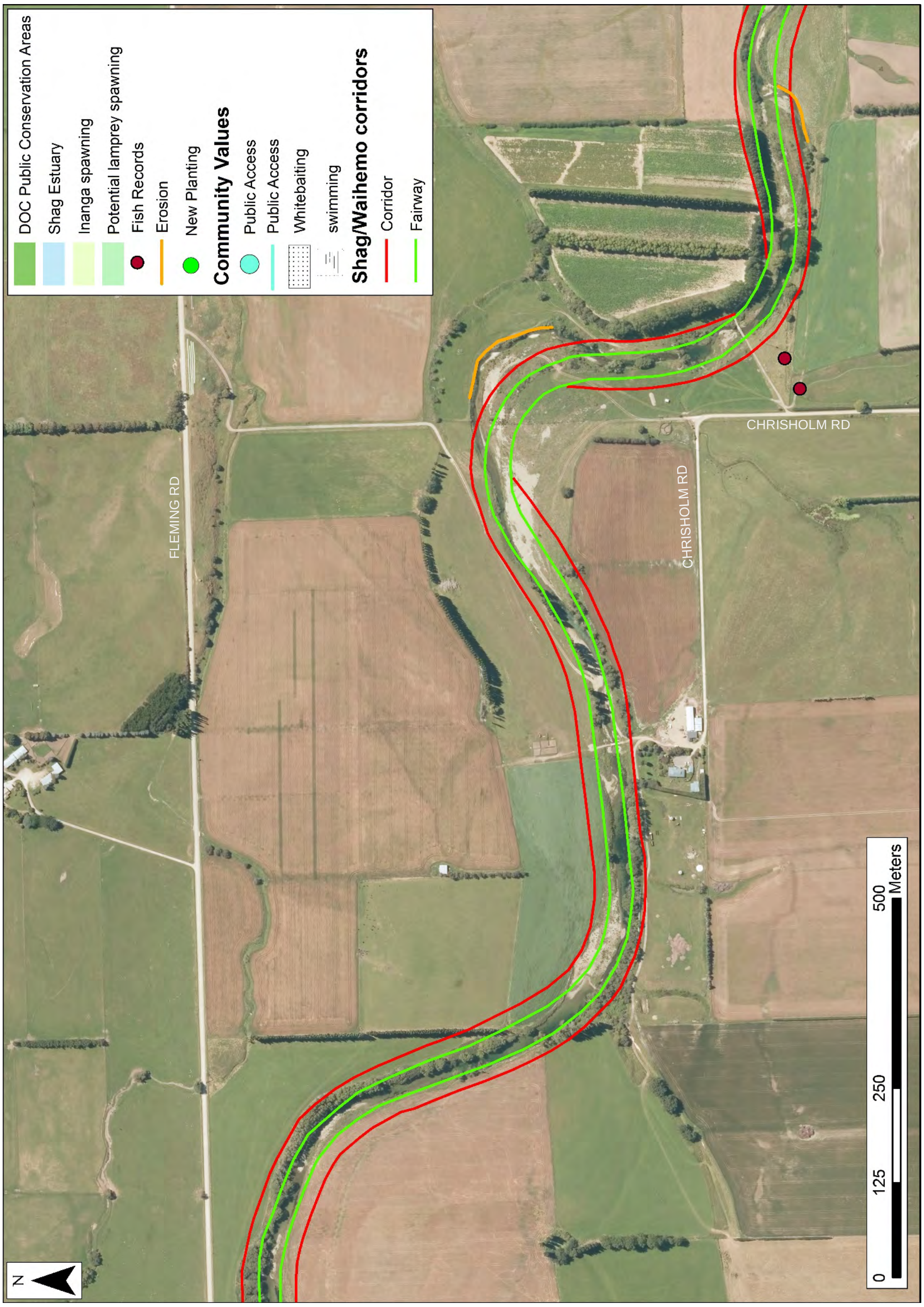

Figure 43. Mapped community values in the Shag/Waihemo River Map 9 (aerial photography collected 2014).

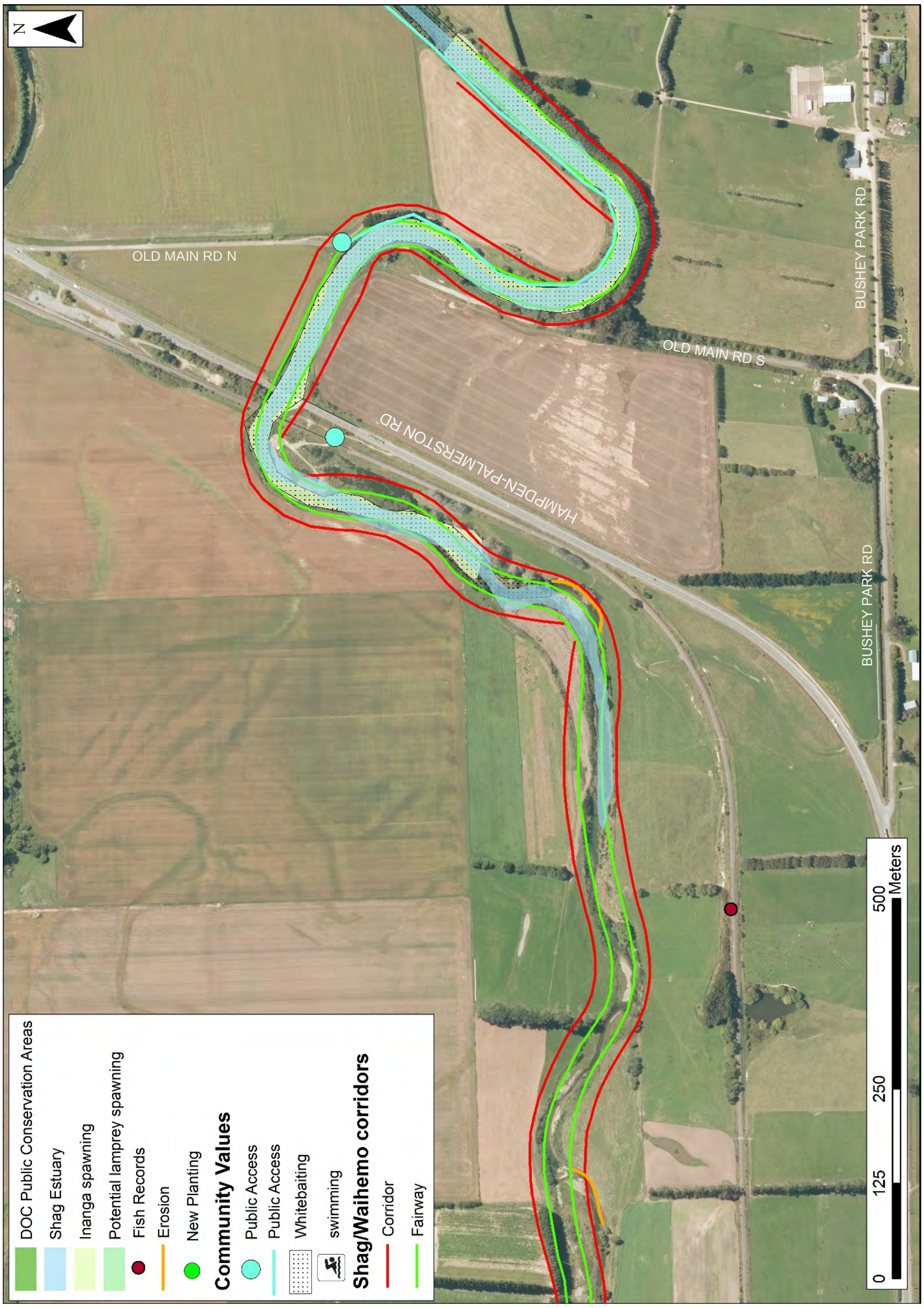

Figure 44. **Mapped community values in the Shag/Waihemo River Map 10 (aerial photography collected 2014).**

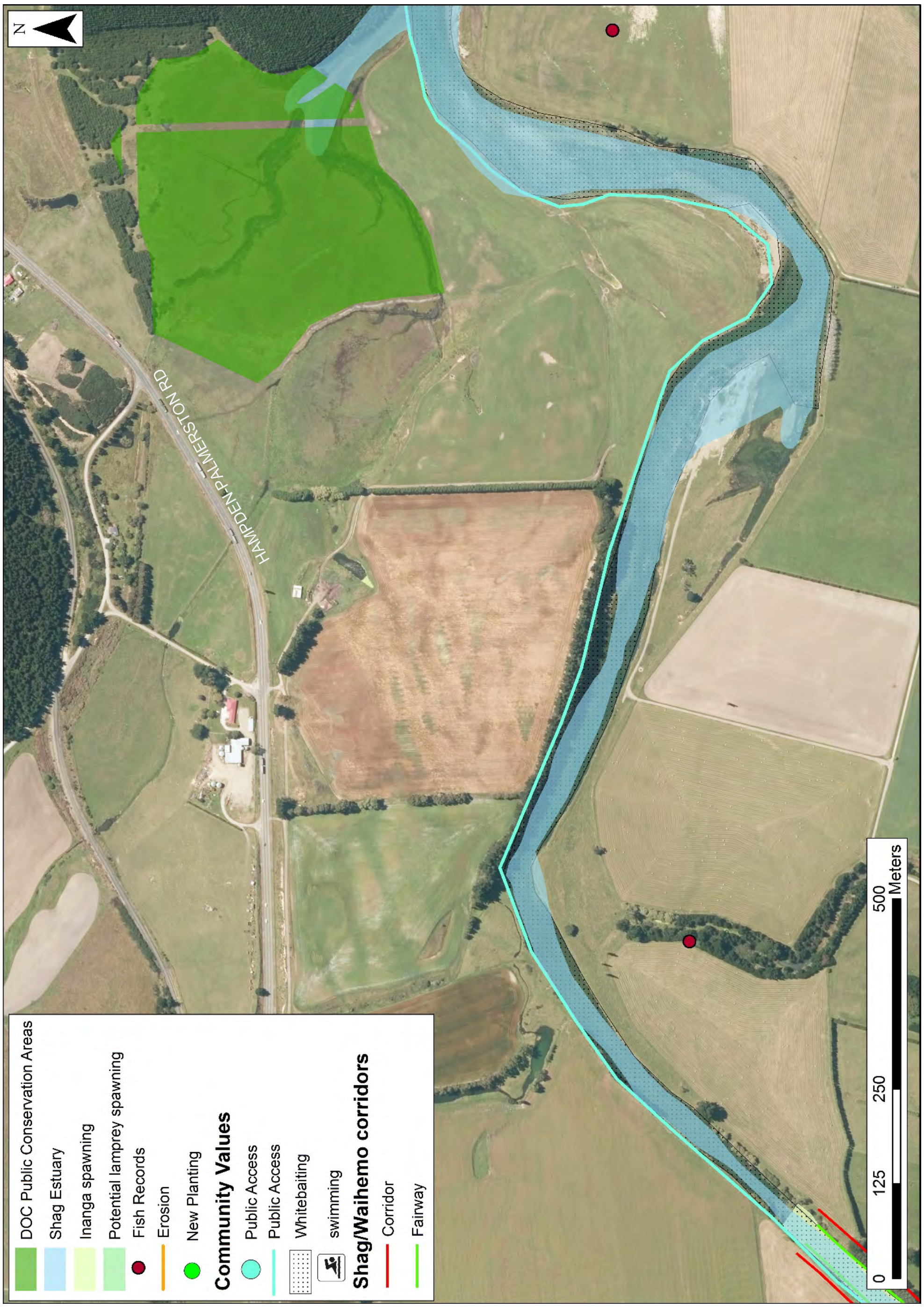

Figure 45. **Mapped community values in the Shag/Waihemo River Map 11 (aerial photography collected 2014).**

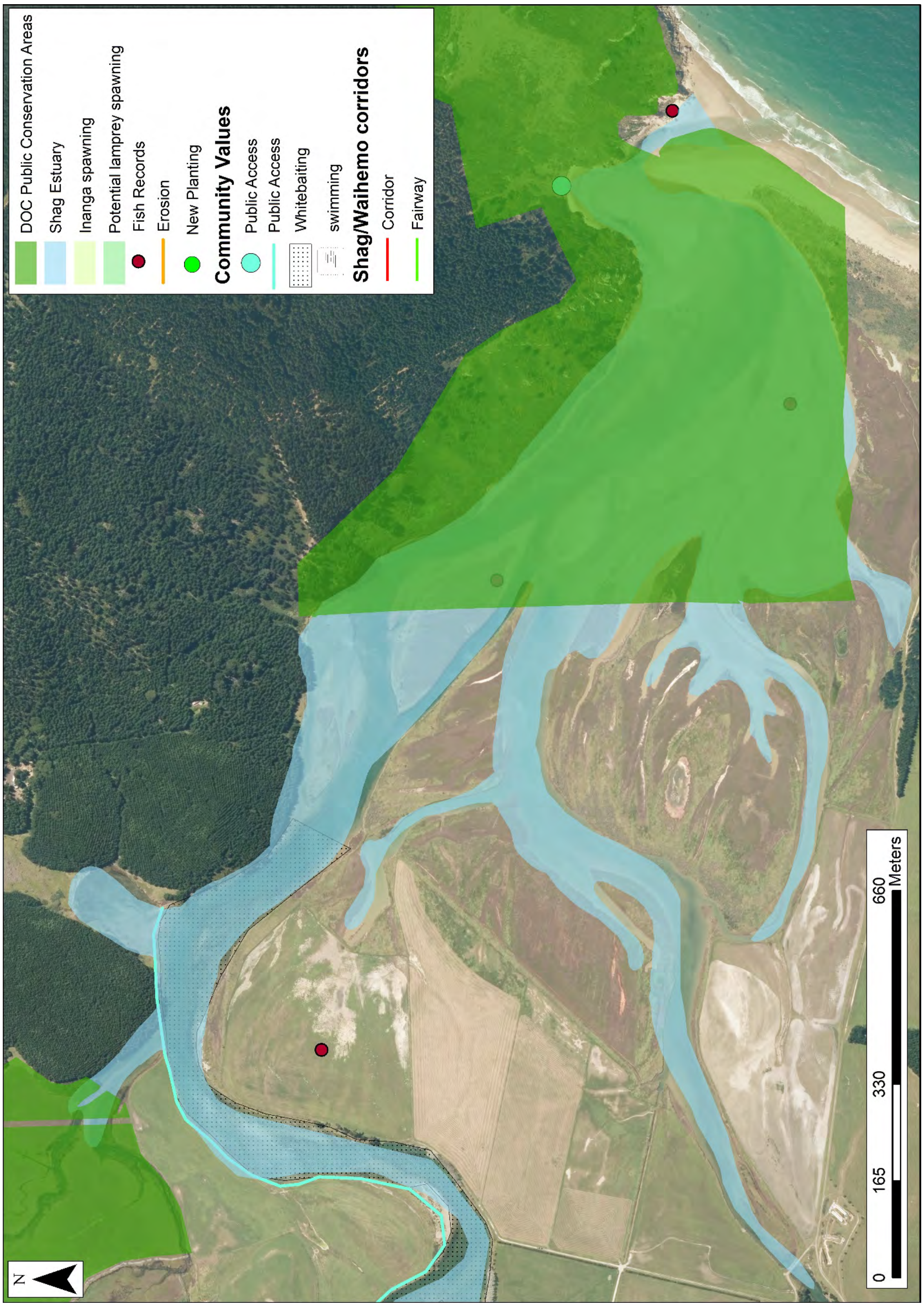

Figure 45. **Mapped community values in the Shag/Waihemo River Map 11 (aerial photography collected 2014).**

Appendix 5 Community consultations – public submissions

The community consultation undertaken in 2016 and 2017 included an opportunity for the public to submit on their concerns, as well as a chance to state what they valued about the river and what they would like the strategy to achieve. A small range of concerns were put forward: some people were concerned about riparian vegetation maintenance, gravel build up and bank erosion in multipole locations including near switchback road bridge and McLew Bridge. There was some concern raised over the gravel extraction and communication with affected parties on future works in the river. While others highlighted the importance of preserving the historic significance and structures along the river. There was also discussion around willow plantings; the loss of willows in areas and subsequent erosion and the maintenance of established willows along with weeds in the river bed.

Appendix 6 Consultation with Aukaha

Cultural Values Report, Aukaha 2017

Cultural Values Report

Shag River/Waihemo Morphology and Riparian Management Strategy

Contents

1. Introduction

Otago Regional Council (ORC) has asked Kāi Tahu ki Otago Ltd (KTKO) to provide feedback on its draft Shag River/Waihemo Morphology and Riparian Management Strategy (the Strategy) on behalf of Mana Whenua.

'Mana Whenua' literally means 'the people with mana over the land' and refers to the whānau (families), hapū (sub-tribe) or iwi (tribe) of a particular area who are recognised as holding the traditional rights and responsibilities within that area to manage and govern natural resources.

Ngāi Tahu is the iwi that is Mana Whenua of most of the South Island. KTKO writes this report on behalf of Te Rūnanga o Moeraki and Kāti Huirapa Rūnaka ki Puketeraki (Ngā Rūnanga), two Papatipu Rūnanga of Ngāi Tahu who represent the whānau and hapū that are Mana Whenua in the area the Strategy relates to.

The purpose of this report is to describe cultural values in the lower Waihemo catchment and provide recommendations on how to recognise these values in the Shag River/Waihemo Morphology and Riparian Management Strategy.

2. Mana Whenua Values and Perspectives on Freshwater

Ko te wai te ora ngā mea katoa. Water is the life giver of all things.

Ngāi Tahu see water as a taonga left by the ancestors to provide and sustain life. Water plays a significant role in Ngāi Tahu spiritual beliefs and cultural traditions, the condition of water is seen as a reflection of the health of Papatūānuku. The ability to gather and share food, which is a cornerstone of Ngāi Tahu society, tradition and mana is reliant on healthy ecosystems and especially water that is fit for human consumption and that is able to support mahinga kai species (KTKO, 2005; Tipa and Nelson, 2013).

Ngāi Tahu have a holistic view of environmental management that recognises the intrinsic relationship between the survival of natural resources and the way they are managed and used. Ngāi Tahu have a kaitiaki responsibility to ensure that resources are preserved for future generations – *mō tātou, ā mō kā uri, ā muri ake nei*.

2.1 Kaitiakitanga

Kaitiakitanga is the responsibility of Mana Whenua to ensure that the life-supporting capacity (mauri) of the natural resources of their takiwā is sustained. Te Rūnanga o Moeraki and Kāti Huirapa Rūnaka ki Puketeraki are the kaitiaki Rūnanga of the Waihemo, and are responsible for ensuring that natural resources in the catchment are available for Kāi Tahu to use now and in the future (KTKO, 2016).

1.1 Mahinga kai

Mahinga kai was and remains a cornerstone of Ngāi Tahu cultural identity. Mahinga kai is a term that literally means "food workings" and refers to the places where food is gathered or produced, the traditions and collection methods associated with gathering natural resources for cultural use and the resources themselves. For Ngāi Tahu Whānui today, participation in mahinga kai activities is an important expression of cultural identity. Continuation of traditional practices is an important means of passing values down to children and grandchildren, ensuring their survival through the generations. This is expressed in the Ngāi Tahu proverbial saying - "Mō tātou, ā mō kā uri i muri ake nei - for us and for the generations that come after us". Healthy waterbodies continue to be a direct source of mahinga kai. Ensuring the health and wellbeing of freshwater is a prerequisite for ensuring the continued health and wellbeing of mahinga kai resources and ultimately the people (Te Rūnanga o Ngāi Tahu, 2002; KTKO, 2005; KTKO, 2016).

1.2 Ki uta ki tai

Mana Whenua believe that a holistic approach should be taken to the management of the natural environment. This world view is articulated in the philosophy of 'Ki Uta Ki Tai', which is a holistic, culturally based 'mountains to the sea' natural resource management framework.

1.3 Mauri

All things, both living and non-living possess a mauri or life force. The primary management principle for Māori is the protection of the mauri of an ecosystem. If the mauri of the natural environment is degraded it no longer has the capacity to support cultural uses and values (KTKO, 2016).

2. Association with the lower Waihemo

The Waihemo River and estuary are recognised as culturally significant areas. They provide habitat for many wading birds species and nursery areas for juvenile fish such as pātiki (flounder) and īnanga (KTKO, 2005).

The Waihemo was part of a wider cultural landscape that extends from Matakaea (Shag Point) to Warrington. There are many wāhi tapu (sacred places) within this cultural landscape, including Onewhenua at Matakaea, which is a settlement site regarded as being of national archaeological importance. Approximately 500 years ago the Waitaha people (from whom many Ngāi Tahu Whānui descend) had settlements at Onewhenua where they hunted the moa over a wide range of territory, and targeted other abundant coastal resources. In the early 1800s Matakaea was also a seasonal fishing kāika of Te Matahaere and his people of the Kāti Kane hapū (KTKO, 2005).

1.1 Ngai Tahu Claims Settlement Act 1998

The Ngāi Tahu Claims Settlement Act included as cultural redress a number of mechanisms to recognise and give practical effect to Ngāi Tahu mana over taonga resources and cultural landscapes. These include Taonga Species, Statutory Acknowledgements and Tōpuni.

1.1.1 Taonga species

The Ngāi Tahu Claims Settlement Act 1998 lists a number of species with which Ngāi Tahu are recognised to have a cultural, spiritual, historic and traditional relationship. The list of Ngāi Tahu Taonga Species is attached as Appendix 1. Ngāi Tahu do not see this list of species as exhaustive (KTKO, 2016).

1.1.2 Tōpuni and Statutory Acknowledgements

The concept of tōpuni comes from the traditional Ngāi Tahu custom of rangatira (chiefs) extending their mana over areas or people by placing their cloak over them. Tōpuni provides a public symbol of Ngāi Tahu manawhenua and rangatiratanga over some of the most prominent landscape features in their takiwā. A Statutory Acknowledgement is an acknowledgement by the Crown of the particular cultural, spiritual, historical, and traditional association Ngāi Tahu has with specified areas (Ministry for the Environment, 1999). Matakaea (Shag Point) is recognised as both a tōpuni and a Statutory Acknowledgement area.

Matakaea

The name Matakaea recalls the tradition of the Arai Te Uru canoe, which capsized off Moeraki. From Moeraki, the crew managed to swim ashore, leaving the cargo to be taken ashore by the waves. The crew members fled inland and were transformed into the mountains which form the Southern Alps. The Arai Te Uru canoe is said to have carried kūmara from Hawaiiki to Aotearoa, along with the knowledge required to grow it successfully. Histories such as this reinforce tribal identity, continuity between generations, and document the events which shaped the environment of Te Wai Pounamu and Ngāi Tahu as an iwi (NTCSA, 1998; DOC, 2017).

The Matakaea area has been occupied for many centuries and is the site of numerous urupā (burial places) and wāhi tapu (sacred places). Urupā are the resting places of Ngāi Tahu tūpuna (ancestors) and are therefore often the focus for whānau traditions. Urupā and wāhi tapu are places holding the memories, traditions, victories and defeats of Ngāi Tahu tūpuna (NTCSA 1998; DOC, 2017).

The mauri of Matakaea represents the essence that binds the physical and spiritual elements of all things together, generating and upholding all life. Mauri is a critical element of the spiritual relationship of Ngāi Tahu Whānui with the area (NTCSA 1998).

1.1 Culturally significant sites

Ngāi Tahu has identified many culturally significant sites throughout the Waihemo catchment and within the area the Strategy applies to. The locations of these sites is known by Ngāi Tahu and is not shared publicly. Sites throughout the Waihemo are significant for their mahinga kai values, and several species including tuna (eels), kanakana (lamprey), raupō (bulrush), harakeke (flax), aruhe (fernroot) and īnanga were and continue to be gathered here.

Other values for the area include kāinga nohoanga (settlements), kāinga mahinga kai (temporary settlements where people stayed seasonally while gathering mahinga kai) and place names that record significant sites for Mana Whenua.

1.2 Māori Archaeological Sites

The New Zealand Archaeological Association has recorded several Māori archaeological sites in the lower Waihemo (see Figure 1 below). These include ovens, middens, rock shelters and sites where artefacts and other signs of occupation have been found.

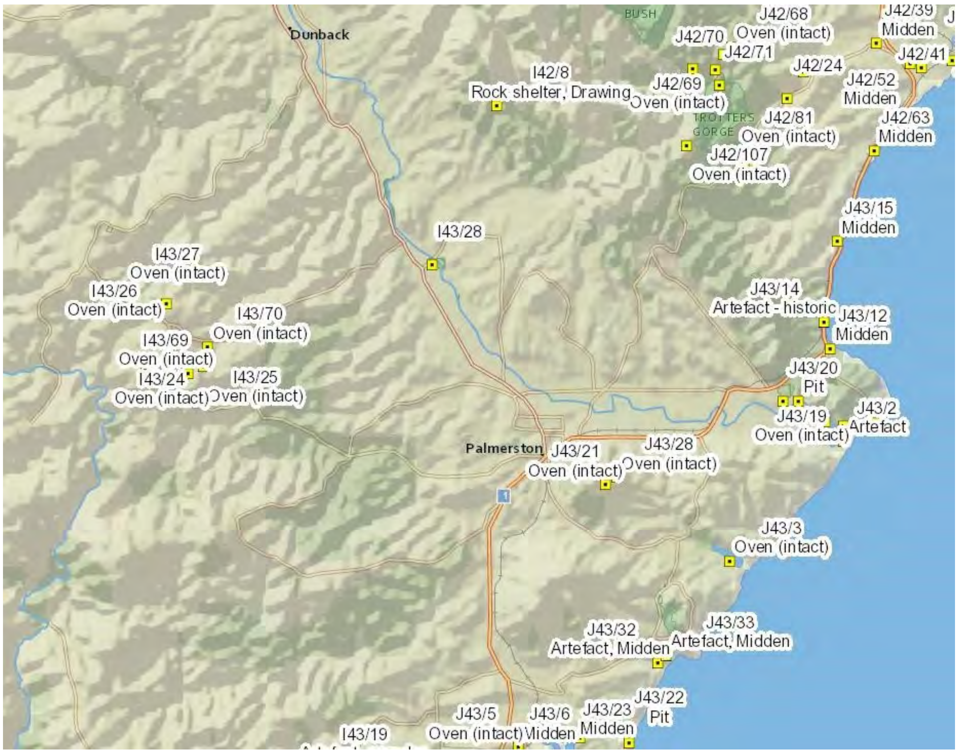

Figure 1: Māori Archaeological Sites within the Lower Waihemo Catchment

6

1. Ngā Rūnanga aspirations relevant to the Strategy

Ngā Rūnanga have many aspirations for the rivers across their shared takiwā. The following Rūnanga aspirations are especially relevant for the Waihemo catchment and to the Strategy:

- The waters of the Otago Catchment are healthy and support Ngāi Tahu customs
- To protect and restore the mauri of all water
- The rangatiratanga and kaitiakitanga of Ngāi Tahu is recognised and supported
- Ki uta ki tai management of catchments occurs
- Mahinga kai resources are healthy and abundant
- Enhancement of native fish populations and spawning areas
- That fish passage is provided for at all times
- To encourage the planting of native vegetation endemic to the area to help reduce erosion, provide habitat for native species including mahinga kai species and to enhance the cultural landscape.

2. Issues for Ngā Rūnanga relevant to the Strategy

Ngā Rūnanga have identified the following issues as relevant to the Waihemo catchment and the Strategy:

- Negative effects of gravel extractions including alteration of flow and gravel supply downstream, sedimentation, preventing fish passage and affecting freshwater species habitat
- Negative effects on spawning and nursery areas for native fish as a result of sedimentation and grazing (KTKO, 2005)
- Channelisation and channel modification activities are of particular concern to Ngāi Tahu (Te Rūnanga o Ngāi Tahu, 2002a)
- There is a lack of catchment-wide erosion and riparian management. Although this Strategy applies only to the lower part of the catchment, Ngā Runanga appreciate that it does intend to address issues in a holistic way in the area it does apply to.

1. Recommendations

Mana Whenua make the following recommendations:

- That a mihi be included at the beginning of the document. As there are two kaitiaki Rūnanga for the Waihemo, there could be a two mihi, one each from Kāti Huirapa Rūnaka ki Puketeraki and Te Rūnanga o Moeraki. This should be discussed with Ngā Rūnanga.
- An introductory section introducing Mana Whenua, explaining who Ngāi Tahu is and who the kaitiaki Rūnanga are
- That Mana Whenua are recognised as Treaty partners rather than stakeholders.
- Native riparian vegetation is an important habitat for mahinga kai. This should be included in references to the value and benefits of planting riparian margins.
- That the following positions held by Ngā Rūnanga are included in this Strategy:
  - Native riparian planting by landowners is encouraged/supported by Ngā Rūnanga o Where practicable, riparian vegetation should provide habitat for mahinga kai species such as īnanga spawning habitat
  - Activities in the bed and on the banks of the river should not be undertaken during spawning seasons or during periods when native fisheries are considered sensitive
  - That any fish disturbed/stranded during any works within any watercourse are rescued and returned/relocated safely to the watercourse
  - That fish passage is provided for at all times. Many native freshwater species need to migrate upstream and downstream at different lifecycle stages
  - That all practical measures are undertaken during works in the bed and on the banks of the river to minimise sedimentation in the waterway

Ngā Rūnanga and KTKO Ltd staff will continue to work with ORC to incorporate these recommendations into the Waihemo Morphology and Riparian Management Strategy.

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Ngāi Tahu Claims Settlement Act 1998, Schedule 41 Statutory acknowledgement for Matakaea (Shag Point)

Ministry for the Environment (1999) *Ngāi Tahu statutory acknowledgements: A guide for local authorities* Wellington, NZ: Ministry for the Environment.

Appendix 1: Ngāi Tahu Claims Settlement Act Taonga Species

Taonga fish species		
Ingoa Maori	**English name**	**Scientific name**
Kāeo	Sea tulip	*Pyura pachydermatum*
Koeke	Common shrimp	*Palaemon affinis*
Kōkopu/Hawai	Giant bully	*Gobiomorphus gobioides*
Kōwaro	Canterbury mudfish	*Neochanna burrowsius*
Paraki/Ngaiore	Common smelt	*Retropinna retropinna*
Piripiripōhatu	Torrentfish	*Cheimarrichthys fosteri*
Taiwharu	Giant kōkopu	*Galaxias argenteus*

Taonga shellfish species		
Ingoa Maori	**English name**	**Scientific name**
Pipi/Kākahi	Pipi	*Paphies australe*
Tuaki	Cockle	*Austrovenus stutchburgi*
Tuaki/Hākiari, Kuhakuha/Pūrimu	Surfclam	*Dosinia anus, Paphies donacina, Mactra discor, Mactra murchsoni, Spisula aequilateralis, Basina yatei,* or*Dosinia subrosa*
Tuatua	Tuatua	*Paphies subtriangulata, Paphies donacina*
Waikaka/Pūpū	Mudsnail	*Amphibola crenata, Turbo smaragdus, Zedilom* spp

Taonga marine mammal species		
Ingoa Maori	**English name**	**Scientific name**
Ihupuku	Southern elephant seal	*Mirounga leonina*
Kekeno	New Zealand fur seals	*Arctocephalus forsteri*
Paikea	Humpback whales	*Megaptera novaeangliae*
Parāoa	Sperm whale	*Physeter macrocephalus*
Rāpoka/Whakahao	New Zealand sea lion/Hooker's sea lion	*Phocarctos hookeri*
Tohorā	Southern right whale	*Balaena australis*

Taonga bird species		
Ingoa Maori	**English name**	**Scientific name**
Hoiho	Yellow-eyed penguin	*Megadyptes antipodes*
Kāhu	Australasian harrier	*Circus approximans*
Kākā	South Island kākā	*Nestor meridionalis meridionalis*
Kākāpō	Kākāpō	*Strigops habroptilus*
Kākāriki	New Zealand parakeet	*Cyanoramphus* spp
Kakaruai	South Island robin	*Petroica australis australis*
Kakī	Black stilt	*Himantopus novaezelandiae*
Kāmana	Crested grebe	*Podiceps cristatus*
Kārearea	New Zealand falcon	*Falco novaeseelandiae*
Karoro	Black-backed gull	*Larus dominicanus*
Kea	Kea	*Nestor notabilis*
Kōau	Black shag, Pied shag, Little shag	*Phalacrocorax carbo, Phalacrocorax varius varius, Phalacrocorax melanoleucos brevirostris*
Koekoeā	Long-tailed cuckoo	*Eudynamys taitensis*
Kōparapara *or* Korimako	Bellbird	*Anthornis melanura melanura*
Kororā	Blue penguin	*Eudyptula minor*
Kōtare	Kingfisher	*Halcyon sancta*
Kōtuku	White heron	*Egretta alba*
Kōwhiowhio	Blue duck	*Hymenolaimus malacorhynchos*
Kūaka	Bar-tailed godwit	*Limosa lapponica*
Kūkupa/Kererū	New Zealand wood pigeon	*Hemiphaga novaeseelandiae*
Kuruwhengu/Kuruwhengi	New Zealand shoveller	*Anas rhynchotis*
Mātā	Fernbird	*Bowdleria punctata punctata* and*Bowdleria punctata stewartiana* and*Bowdleria punctata wilsoni* and *Bowdleria punctata candata*
Matuku moana	Reef heron	*Egretta sacra*
Miromiro	South Island tomtit	*Petroica macrocephala macrocephala*
Miromiro	Snares Island tomtit	*Petroica macrocephala dannefaerdi*
Mohua	Yellowhead	*Mohoua ochrocephala*
Pākura/Pūkeko	Swamp hen/Pūkeko	*Porphyrio porphyrio*
Pārera	Grey duck	*Anas superciliosa*

Pateke	Brown teal	*Anas aucklandica*
Pīhoihoi	New Zealand pipit	*Anthus novaeseelandiae*
Pīpīwharauroa	Shining cuckoo	*Chrysococcyx lucidus*
Pīwakawaka	South Island fantail	*Rhipidura fuliginosa fuliginosa*
Poaka	Pied stilt	*Himantopus himantopus*
Pokotiwha	Snares crested penguin	*Eudyptes robustus*
Pūtakitaki	Paradise shelduck	*Tadorna variegata*
Riroriro	Grey warbler	*Gerygone igata*
Roroa	Great spotted kiwi	*Apteryx haastii*
Rowi	Ōkārito brown kiwi	*Apteryx mantelli*
Ruru koukou	Morepork	*Ninox novaeseelandiae*
Takahē	Takahē	*Porphyrio mantelli*
Tara	Terns	*Sterna* spp
Tawaki	Fiordland crested penguin	*Eudyptes pachyrhynchus*
Tete	Grey teal	*Anas gracilis*
Tīeke	South Island saddleback	*Philesturnus carunculatus carunculatus*
Tītī	Sooty shearwater/Muttonbird/Hutton's shearwater Common diving petrel South Georgian diving petrel Westland petrel Fairy prion Broad-billed prion White-faced storm petrel Cook's petrel Mottled petrel	*Puffinus griseus* and *Puffinus huttoni* and*Pelecanoides urinatrix* and *Pelecanoides georgicus* and *Procellaria westlandica* and*Pachyptila turtur* and *Pachyptila vittata*and *Pelagodroma marina* and *Pterodroma cookii* and *Pterodroma inexpectata*
Tītitipounamu	South Island rifleman	*Acanthisitta chloris chloris*
Tokoeka	South Island brown kiwi	*Apteryx australis*
Toroa	Albatrosses and Mollymawks	*Diomedea* spp
Toutouwai	Stewart Island robin	*Petroica australis rakiura*
Tūī	Tūī	*Prosthemadera novaeseelandiae*
Tutukiwi	Snares Island snipe	*Coenocorypha aucklandica huegeli*
Weka	Western weka	*Gallirallus australis australis*
Weka	Stewart Island weka	*Gallirallus australis scotti*
Weka	Buff weka	*Gallirallus australis hectori*

Taonga plant species		
Ingoa Maori	**English name**	**Scientific name**
Akatorotoro	White rata	*Metrosideros perforata*
Aruhe	Fernroot (bracken)	*Pteridium aquilinum* var *esculentum*
Harakeke	Flax	*Phormium tenax*
Horoeka	Lancewood	*Pseudopanax crassifolius*
Houhi	Mountain ribbonwood	*Hoheria lyalli* and *H. glabata*
Kahikatea	Kahikatea/White pine	*Dacrycarpus dacrydioides*
Kāmahi	Kāmahi	*Weinmannia racemosa*
Kānuka	Kānuka	*Kunzia ericoides*
Kāpuka	Broadleaf	*Griselinia littoralis*
Karaeopirita	Supplejack	*Ripogonum scandens*
Karaka	New Zealand laurel/Karaka	*Corynocarpus laevigata*
Karamū	Coprosma	*Coprosma robusta, coprosma lucida, coprosma foetidissima*
Kātote	Tree fern	*Cyathea smithii*
Kiekie	Kiekie	*Freycinetia baueriana* subsp *banksii*
Kōhia	NZ Passionfruit	*Passiflora tetranda*
Korokio	Korokio Wire-netting bush	*Corokia cotoneaster*
Koromiko/Kōkōmuka	Koromiko	*Hebe salicfolia*
Kōtukutuku	Tree fuchsia	*Fuchsia excorticata*
Kōwahi Kōhai	Kōwhai	*Sophora microphylla*
Mamaku	Tree fern	*Cyathea medullaris*
Mānia	Sedge	*Carex flagellifera*
Mānuka Kahikātoa	Tea-tree	*Leptospermum scoparium*
Māpou	Red matipo	*Myrsine australis*
Mataī	Mataī/Black pine	*Prumnopitys taxifolia*
Miro	Miro/Brown pine	*Podocarpus ferrugineus*
Ngaio	Ngaio	*Myoporum laetum*
Nīkau	New Zealand palm	*Rhopalostylis sapida*
Pānako	(Species of fern)	*Asplenium obtusatum*
Pānako	(Species of fern)	*Botrychium australe* and *B. biforme*
Pātōtara	Dwarf mingimingi	*Leucopogon fraseri*
Pīngao	Pīngao	*Desmoschoenus spiralis*
Pōkākā	Pōkākā	*Elaeocarpus hookerianus*
Ponga/Poka	Tree fern	*Cyathea dealbata*
Rātā	Southern rātā	*Metrosideros umbellata*

Raupō	Bulrush	*Typha angustifolia*
Rautāwhiri/Kōhūhū	Black matipo/Māpou	*Pittosporum tenuifolium*
Rimu	Rimu/Red pine	*Dacrydium cypressinum*
Rimurapa	Bull kelp	*Durvillaea antarctica*
Taramea	Speargrass, spaniard	*Aciphylla* spp
Tarata	Lemonwood	*Pittosporum eugenioides*
Tawai	Beech	*Nothofagus* spp
Tētēaweka	Muttonbird scrub	*Olearia angustifolia*
Tī rākau/Tī Kōuka	Cabbage tree	*Cordyline australis*
Tīkumu	Mountain daisy	*Celmisia spectabilis* and *C. semicordata*
Tītoki	New Zealand ash	*Alectryon excelsus*
Toatoa	Mountain Toatoa, Celery pine	*Phyllocladus alpinus*
Toetoe	Toetoe	*Cortaderia richardii*
Tōtara	Tōtara	*Podocarpus totara*
Tutu	Tutu	*Coriaria* spp
Wharariki	Mountain flax	*Phormium cookianum*
Whīnau	Hīnau	*Elaeocarpus dentatus*
Wī	Silver tussock	*Poa cita*
Wīwī	Rushes	*Juncus* all indigenous *Juncus* spp and *J. maritimus*

Appendix 2: Statutory acknowledgement for Matakaea (Shag Point)

Statutory area

The statutory area to which this statutory acknowledgement applies is the area known as Matakaea Recreation Reserve and Onewhenua Historic Reserve, as shown on Allocation Plan MS 9 (SO 24686).

Preamble

Under section 206, the Crown acknowledges Te Rūnanga o Ngāi Tahu's statement of Ngāi Tahu's cultural, spiritual, historic, and traditional association to Matakaea.

Ngāi Tahu association with Matakaea

The name Matakaea recalls the tradition of the Arai Te Uru canoe, which capsized off Moeraki. From Moeraki, the crew managed to swim ashore, leaving the cargo to be taken ashore by the waves. The crew members fled inland and were transformed into the mountains which form the Southern Alps.

The Arai Te Uru tradition is also important because it explains the origins of kūmara. The story originally began with Roko i Tua who came to Aotearoa and met the Kāhui Tipua. The Kāhui Tipua gave Roko i Tua mamaku (tree fern) to eat. However Roko i Tua preferred the kūmara that he had in his belt which he took out and soaked in a bowl of water. The Kāhui Tipua tasted the kūmara and asked where it was from. Roko i Tua replied saying that the kūmara came from "“across the sea”".

The Kāhui Tipua then made a canoe and, under the leadership of Tū Kākāriki, went to Hawaiiki and returned with the kūmara to Aotearoa. The Kāhui Tipua planted the kūmara but the crop failed. However, Roko i Tua had also sailed to Hawaiiki on the canoe called Arai Te Uru. Roko i Tua landed at Whangarā, Hawaiiki, and learnt the karakia (incantations) and tikanga (customs) connected with planting kūmara. Roko i Tua then gave his canoe to two crew members called Pakihiwitahi and Hape ki Tua Raki. The Arai Te Uru returned under the leadership of these two commanders and eventually foundered off the Moeraki Coast at Matakaea.

For Ngāi Tahu, traditions such as this represent the links between the cosmological world of the gods and present generations, these histories reinforce tribal identity and solidarity, and continuity between generations, and document the events which shaped the environment of Te Wai Pounamu and Ngāi Tahu as an iwi.

The Matakaea area has been occupied for many centuries and is the site of numerous urupā and wāhi tapu. Urupā are the resting places of Ngāi Tahu tūpuna (ancestors) and, as such, are the focus for whānau traditions. Urupā and wāhi tapu are places holding the memories, traditions, victories and defeats of Ngāi Tahu tūpuna, and are frequently protected by secret locations.

The mauri of Matakaea represents the essence that binds the physical and spiritual elements of all things together, generating and upholding all life. All elements of the natural environment possess a life force, and all forms of life are related. Mauri is a critical element of the spiritual relationship of Ngāi Tahu Whānui with the area.

<u>Purposes of statutory acknowledgement</u>

Pursuant to section 215, and without limiting the rest of this schedule, the only purposes of this statutory acknowledgement are—

(a) to require that consent authorities forward summaries of resource consent applications to Te Rūnanga o Ngāi Tahu as required by regulations made pursuant to section 207 (clause 12.2.3 of the deed of settlement); and

(b) to require that consent authorities, Heritage New Zealand Pouhere Taonga, or the Environment Court, as the case may be, have regard to this statutory acknowledgement in relation to Matakaea, as provided in sections 208 to 210 (clause 12.2.4 of the deed of settlement); and

(c) to empower the Minister responsible for management of Matakaea or the Commissioner of Crown Lands, as the case may be, to enter into a Deed of Recognition as provided in section 212 (clause 12.2.6 of the deed of settlement); and

(d) to enable Te Rūnanga o Ngāi Tahu and any member of Ngāi Tahu Whānui to cite this statutory acknowledgement as evidence of the association of Ngāi Tahu to Matakaea as provided in section 211 (clause 12.2.5 of the deed of settlement).

<u>Limitations on effect of statutory acknowledgement</u>

Except as expressly provided in sections 208 to 211, 213, and 215,—

(a) this statutory acknowledgement does not affect, and is not to be taken into account in, the exercise of any power, duty, or function by any person or entity under any statute, regulation, or bylaw; and

(b) without limiting paragraph (a), no person or entity, in considering any matter or making any decision or recommendation under any statute, regulation, or bylaw, may give any greater or lesser weight to Ngāi Tahu's association to Matakaea (as described in this statutory acknowledgement) than that person or entity would give under the relevant statute, regulation, or bylaw, if this statutory acknowledgement did not exist in respect of Matakaea.

Except as expressly provided in this Act, this statutory acknowledgement does not affect the lawful rights or interests of any person who is not a party to the deed of settlement.

Except as expressly provided in this Act, this statutory acknowledgement does not, of itself, have the effect of granting, creating, or providing evidence of any estate or interest in, or any rights of any kind whatsoever relating to, Matakaea.

Strategy Overview

Morphology and Riparian Management

Waianakarua River

Why have a Morphology and Riparian Management Strategy?

A morphology and riparian management strategy will ensure future generations can continue to enjoy Otago's beautiful landscape.

Otago Regional Council (ORC) engaged the community, including local iwi, to ensure their values and beliefs are represented in the strategy in a way that enhances the natural ecology of the area.

Ko te wai te ora ngā mea katoa
Water is the life giver of all things

More Information

The full Morphology and Riparian Management Strategy is available online. Access the strategy for the Waianakarua river here:

www.orc.govt.nz/WaianakaruaRiver-MRMS

Contact

0800 474 0827

info@orc.govt.nz

www.orc.govt.nz/contact-us

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Otago Regional Council

Objectives

Recognise and characterise natural river processes

- Collect information about flood and erosion processes
- Report on changes in channel morphology
- Provide information to the community
- Identify the location of river corridors within which the river will naturally meander

Promote activities that enhance natural character and enjoyment of the river

- Encourage the establishment of riparian plantings that are practical and appealing
- Provide access and habitat for sustainable fishing and white-baiting activities
- Support pest and weed control activities
- Discourage dumping, and arrange regular collection of rubbish
- Provide maps showing the location and characteristics of features that are of high value to the community

Equip the community to live with the effects of changes in river morphology

- Promote land-use practices and placement of assets that reduce the risk of changes in riverbed morphology
- Consider all options to manage the effects of bank erosion, including structural and non-structural options
- Enable works to improve the conveyance of floodwater and 'train' the river within its natural corridor, without compromising the features that are of high value to the community and iwi

Enable sustainable gravel extraction

- Identify areas where gravel accumulation can naturally occur
- Identify areas where permanent removal of gravel may have a detrimental effect on assets, riverbed morphology or community values
- Identify minimum bed levels/profiles, below which extraction must not occur

More Information

Access the strategy for the Waianakarua river here: www.orc.govt.nz/WaianakaruaRiver-MRMS

Ko te wai te ora ngā mea katoa
Water is the life giver of all things

Otago Regional Council

Actions

Native Plantings on Riparian Margins

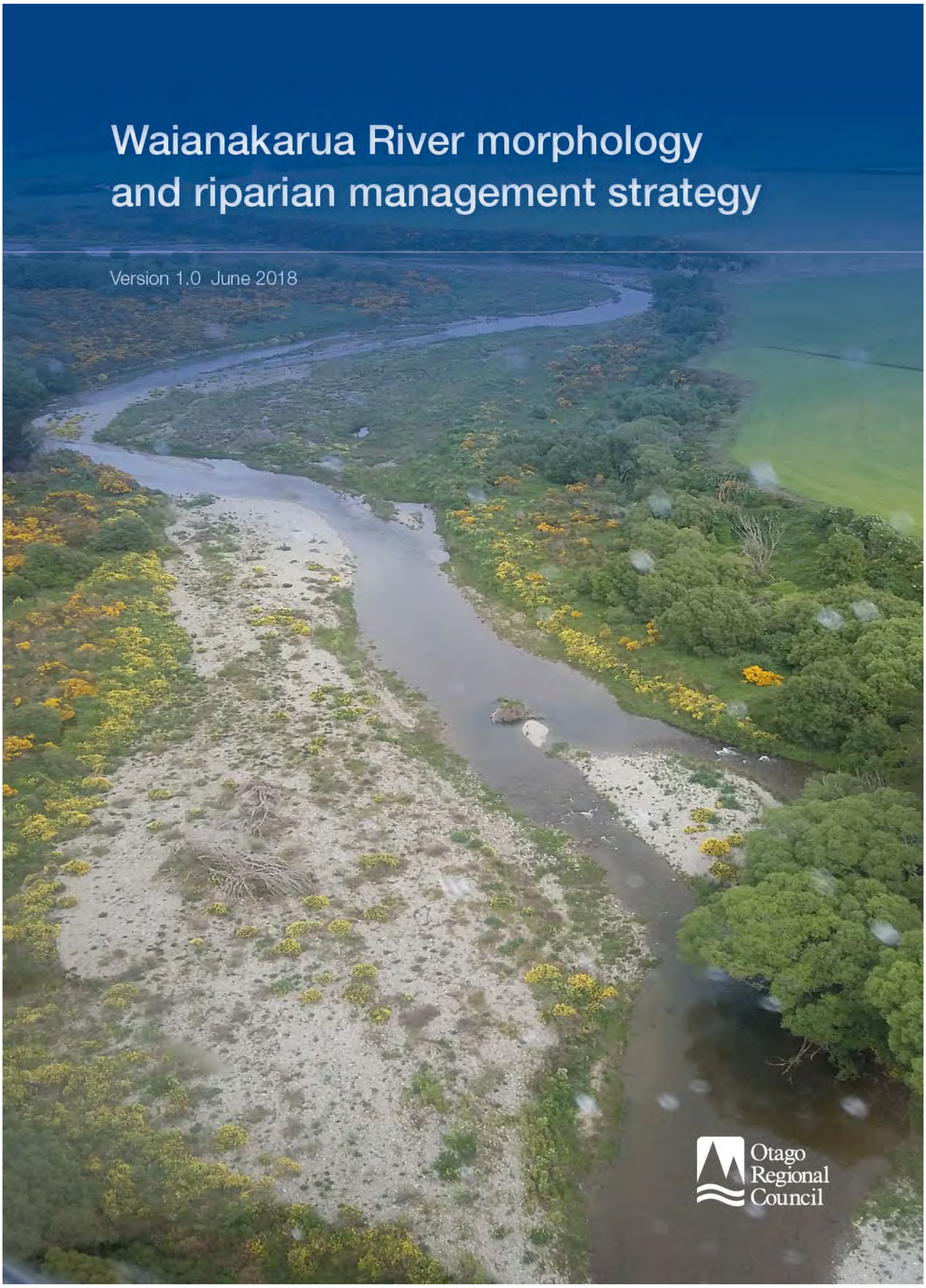
- Increase stability of riparian margins and riverbanks
- Improve habitat and community values
- Improve appearance of the river margins

Physical Works on Flood Conveyance

- Convey flood water within the natural fairway (or riverbed) without overtopping
- Re-alignment of the channel
- Maintenance of fairway
- Works do not compromise features that are of high value to the community and iwi

Gravel Extraction Management

- Continued morphological studies to ensure sustainable gravel-takes
- Moving sediment from an accumulating gravel beach onto an adjacent eroding bank
- Maintain channel shape to mitigate bank erosion and flooding
- Extraction will not compromise features that are of high value to the community and iwi



Waianakarua River morphology and riparian management strategy

Version 1.0 June 2018

Otago Regional Council

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Overview

The Waianakarua River morphology and riparian management strategy has been prepared by the Otago Regional Council (ORC), with input from the local community, to help protect the recreational, cultural and ecological values of the Waianakarua riverbed, and to enable long-term sustainable use of the land that borders the river. The strategy, as summarised in the two diagrams overleaf, is intended to help achieve this by guiding work programs, decision-making, and activities for the community, stakeholders, iwi and ORC. It is therefore recommended that people who live, work, or play within the Waianakarua River catchment consider, and give effect to, the principles, objectives, and actions listed in this strategy.

The strategy is not a statutory document; rather it is intended to present the aspirations of the community, iwi and the various stakeholder agencies. However, the statutory processes that do influence river management activities[1] are more likely to be used effectively and efficiently if there is a general consensus on what is valued about the river, and commonly understood objectives.

The strategy is intended to be a living document, which will evolve in response to new information, changes in the environment, the needs of the community and iwi, and the work of the ORC and other stakeholders. The strategy will be reviewed regularly, and this process will involve landowners with property alongside the river, other stakeholders, and ORC[2] working in partnership with iwi and will help to set priorities and work programmes for all of these groups. The strategy document will also record progress made towards achieving the stated objectives. It is intended that version 2 of the strategy will include further guidance and plans for undertaking planting on riparian margins, for river management purposes, and for habitat enhancement.

[1] Including the Local Government Act (in regards to funding considerations), and the Resource Management Act (in regards to environmental effects)
[2] In particular, staff with responsibilities for river and waterway management and natural hazards

Mana Whenua

Mana Whenua literally means ‘the people with mana over the land’ and refers to the whānau (families), hapū (sub-tribe) or iwi (tribe) of a particular area who are recognised as holding the traditional rights and responsibilities within that area to manage and govern natural resources.

Ngāi Tahu[3] is the iwi that is Mana Whenua in Otago. Te Rūnanga o Ngāi Tahu (the iwi authority) is made up of 18 Papatipu Rūnaka. Located predominantly in traditional coastal settlements, Papatipu Rūnaka are a focus for whānau and hapū who have Mana Whenua status within their area. Te Rūnanga o Moeraki and Kāti Huirapa Rūnaka ki Puketeraki are the two Papatipu Rūnaka of Ngāi Tahu who are Mana Whenua of the Waihemo catchment.

Kāi Tahu – Treaty Partner

Te Tiriti o Waitangi (the Treaty of Waitangi) is the founding document for New Zealand, the basis on which the partnership between Māori and the Crown was established. The Kāi Tahu rakatira Karetai and Korako signed the Treaty at Pukekura (Taiaroa Head) on 13 June 1840. Kāi Tahu considered that the Treaty bound the whole tribe of Kāi Tahu irrevocably to an agreement which imposed responsibilities on both signatories, the Crown and Kāi Tahu. The Otago Regional Council has an established relationship with Kāi Tahu based on the treaty partnership. Partnership between the ORC and Kāi Tahu embodies the principles of the Treaty of Waitangi in decision making and local environmental management.

[3] In the south of the South Island, the local Māori dialect uses a ‘k’ interchangeably with ‘ng’. The preference is to use a ‘k’ so southern Māori are known as Kāi Tahu, rather than Ngāi Tahu. In this document, the “ng” is used for the iwi in general, and the “k” for southern Māori in particular.

Waianakarua River morphology and riparian management strategy - overview

Purpose

- To provide guidance to landowners, stakeholders, iwi and the community for good decision-making and appropriate activities within the riverbed and on the riparian margins of the Wainakarua.

Vision

- The long-term sustainable use and enjoyment of the Waianakarua and its riparian margins.

Functions

Appropriate guidance and active engagement to empower good decision-making. Ensure activities are undertaken in a sustainable and appropriate manner.

Understand natural river processes and morphological characteristics, and the potential effects of those on the river and its margins.

The wise use of resources to:

- Manage the risk to property and assets
- Enable sustainable gravel extraction
- Protect and enhance community values
- Improve community resilience.

A shared vision of the river's values and features to be utilised, preserved and enhanced.

Waianakarua morphology and riparian management strategy - overview

Objectives & associated activities (these are further refined in Section 8 - implementation)

1. To recognize and characterize natural river processes.	**2.** To equip the community to live with the effects of changes in river morphology.	**3.** To enable sustainable gravel extraction.	**4.** To promote activities that enhance natural character and enjoyment of the river.
Collect information about flood and erosion processes. Report on changes in channel morphology. Provide information to the community Identify the location of river corridors, within which the river will naturally meander.	Promote land-use practices and the placement of assets that reduce the risk associated with changes in riverbed morphology. Consider all available options to manage the effects of bank erosion, including structural and non-structural options. Enable works that will, where necessary, improve the conveyance of floodwater and 'train' the river within its natural corridor, without compromising the features that are of high value to the community and iwi.	Identify areas where gravel accumulation can naturally occur. Identify areas where permanent removal of gravel may have a detrimental effect on assets, riverbed morphology or community values. Identify minimum bed levels/profiles, below which extraction will not occur.	Provide maps showing the location and characteristics of features that are of high value to the community. Encourage the establishment of riparian plantings that are practical and appealing. Provide access and habitat for fishing and white-baiting activities. Support pest and weed control activities. Discourage dumping, and arrange the regular collection of rubbish.

Contents

1. Introduction

Changes in the morphology (physical form) of riverbeds occur as a result of natural processes that are often uncontrollable, and also from human intervention. The Waianakarua riverbed is an integral part of the wider Waianakarua River catchment (Figure 1). The Waianakarua riverbed is part of a dynamic river system, and has experienced changes in morphology in recent decades. These changes will have occurred in response to naturally occurring flood events, as well as gravel extraction activities and historic river management decisions. Changes to riverbed morphology have included degradation[4] and sedimentation within the main channel (Figure 2) and significant bank erosion in places (Figure 3). In some cases these changes have negatively affected the values placed upon the river by the community, iwi and stakeholders (landowners, Fish & Game New Zealand, Department of Conservation (DoC), Waitaki District Council (WDC), and residents).

Land alongside the river channel is often referred to as the ‘riparian margin’. More intensive use of the land that borders the river has occurred in recent decades, with valuable farmland replacing what was previously rough vegetation. As a result, changes in the position and form of the riverbed can cause issues for landowners and other river users. The Waianakarua River is valued as a recreational, commercial, and cultural resource e.g. swimming, walking, fishing, and farming.

The Otago Regional Council (ORC) has proposed the Waianakarua River morphology and riparian management strategy (‘the strategy’) to help provide guidance (for all users of the river) for good decision-making and appropriate activities on the riverbed and riparian margins of the Waianakarua River. The strategy has a vision of long-term sustainable use and enjoyment of the Waianakarua riverbed and its riparian margins. It is also important when undertaking activities within the riverbed and on the riparian margins of the Waianakarua River that people recognise, and allow for, the traditional, spiritual, and cultural values of local iwi.

The strategy’s key objectives are to:

- Recognise and characterise the natural river and catchment processes that occur in the Waianakarua River
- Equip the community to understand, and live with, the effects of changes in river morphology
- Enable sustainable gravel extraction
- Promote activities that enhance the natural character and enjoyment of the river.

The strategy is also intended to guide the nature and extent of land-use, so that the negative effects of morphological changes in the riverbed do not increase and, where possible, are progressively reduced. It provides a framework for decision-making, so that activities undertaken by people occur in such a way that the results are:

[4] The term ‘degradation’ in this case refers to the wearing down of the channel by the erosive action of water.

- A visually appealing river system
- A habitat that supports existing wildlife, fish, and preferred plant species
- Limited effects on assets as a result of flood events
- Resilient infrastructure (roads, bridges, water supply)
- Continued use of the river for recreational activities.

Many of the actions listed in this strategy are voluntary and will rely on interactions between the key stakeholders, iwi and the community to be successful. It is therefore recommended that people who live, work, or play in the Waianakarua River catchment consider, and give effect to, the principles, objectives, and actions listed in the strategy.

1.1. Report outline

Section 2 describes the scope of the strategy; while Section 3 summarises the natural environment within which it sits and Section 4 summarises the community values associated with the river[5]. Section 5 describes the legislative context within which the strategy has been defined and will operate. Section 6 outlines the strategy's guiding principles and core components. Section 7 outlines the work that ORC has undertaken to help define an appropriate and sustainable river form for the riverbed and riparian margins and summarises the methods that the various parties (ORC, stakeholders, iwi and the community) have designed to meet the strategy's key objectives.

A series of appendices are included at the end of this document:

- Appendix 1 describes the physical river management work to be undertaken by ORC in the next three years, which will also assist in achieving the strategy's objectives.
- Appendix 2 describes the areas where gravel has been identified as naturally accumulating and the river management profiles which have been calculated for those areas.
- Appendix 3 contains a guide on planting on river banks
- Appendix 4 contains the mapped river corridors (the active fairway, and buffer zones).
- Appendix 5 contains the mapped community values for the Waianakarua River
- Appendix 6 provides a summary of the public feedback received in late-2016 and early-2017 regarding what they value from the Waianakarua River.
- Appendix 7 contains information from the consultation with landowners, treaty partners and stakeholder groups in 2016 - early 2017.
- Appendix 8 contains the Cultural Values Report provided by Aukaha.

[5] As determined by landowners, stakeholders, iwi and members of the public during community consultation in October 2016 and April 2017.

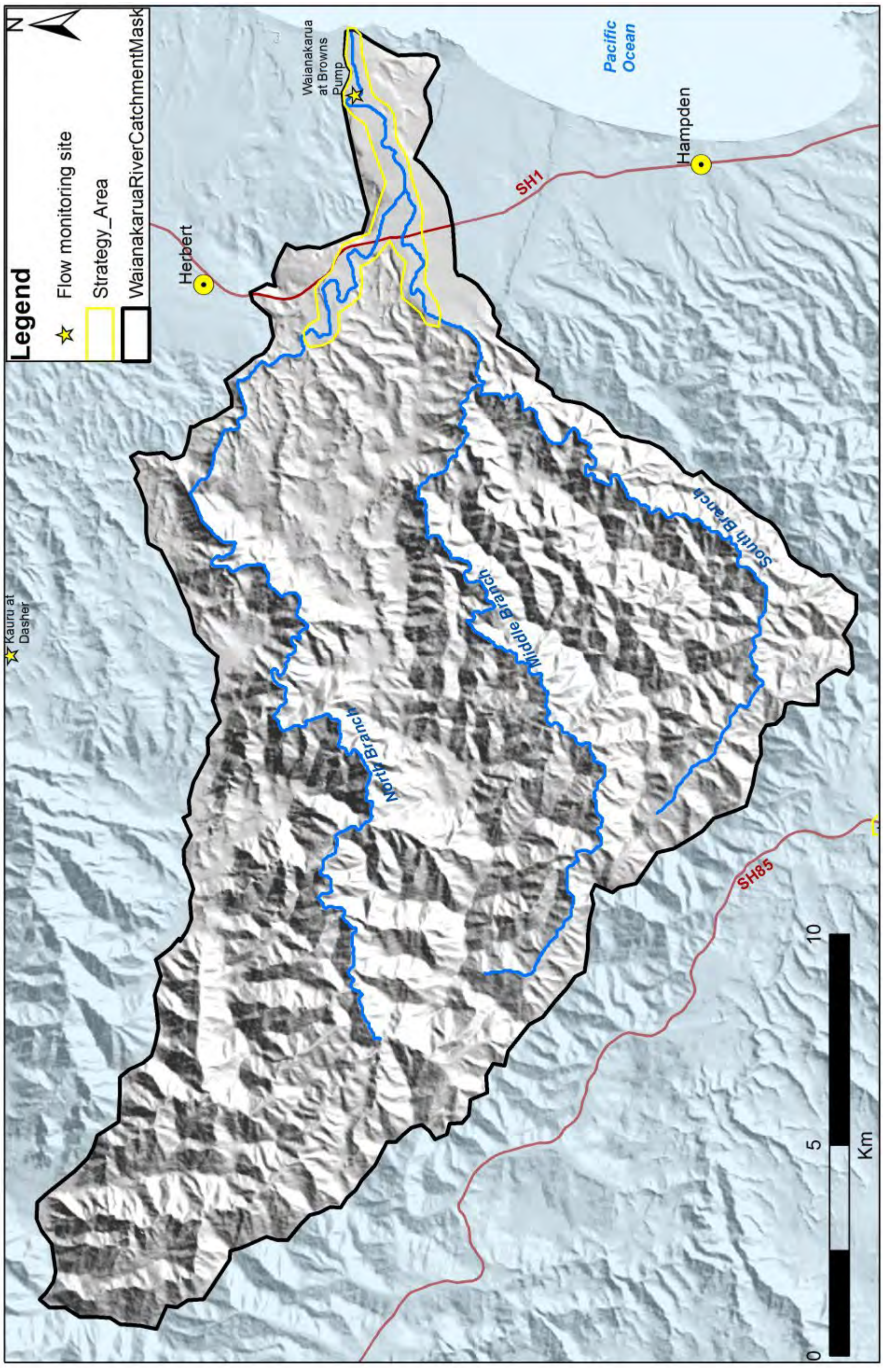

Figure 1. **Waianakarua River catchment boundary, showing the main tributaries and reaches of the river to which this strategy applies.**

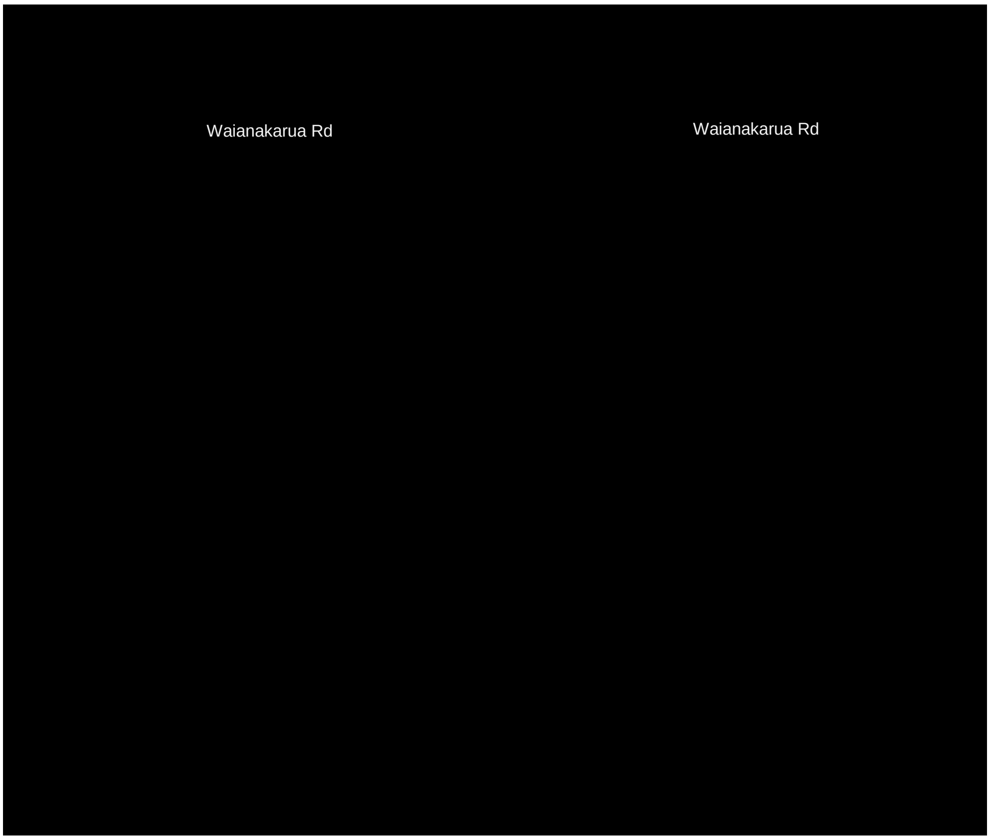

Figure 2. **Comparison of aerial photographs illustrating lateral shifts in the channel position and gravel build up at the confluence of the North and South branches of the Waianakarua River. Aerial photography collected in 2006 (left) and 2014 (right).**

Figure 3. **Examples of changes in channel morphology. Top: Bank erosion on the true-left bank of the Waianakarua River (Summer 2014/15). Bottom: Bank erosion at a bend of the Waianakarua River adjacent to Waianakarua Road. The establishment of invasive weed species on the inner bend of the channel, reduces the lateral confines of the channel.**

2. Scope

2.1. Study reach

The geographical scope of the strategy is the reach of the Waianakarua River North Branch from Graves Dam and the Waianakarua River South Branch from McKerrow Road to the confluence with the Pacific Ocean (Figure 4). The upper reaches and tributary streams were not investigated in this report as most concerns previously raised by the community were located in the study reach as well as the steeper upper catchment topography limiting management opportunities. The focus was therefore on this location. Other areas in the Waianakarua River catchment may also experience problems and issues associated with river processes; however these are not examined here.

2.2. Risk

The strategy has a focus on the risks and effects associated with changes in riverbed morphology (including channel degradation and bank erosion, sedimentation, and flooding) in the study reach of the Waianakarua River. However, it is acknowledged that heavy rainfall events may lead to a range of other risks, including widespread flooding and surface runoff.

There are several other environmental issues and hazards in the Waianakarua River catchment. These include natural hazards such as seismic activity, as well as water quality and quantity issues. While numerous other issues do exist, this strategy is primarily concerned with the negative effects of changes in river form on the values associated with the Waianakarua River. Guidance and regulations relating to other issues can be obtained from the ORC.[6]

[6] For example, the Otago Natural Hazards Database, the Water Info website and the Regional Plan: Water for Otago; all available from www.orc.govt.nz

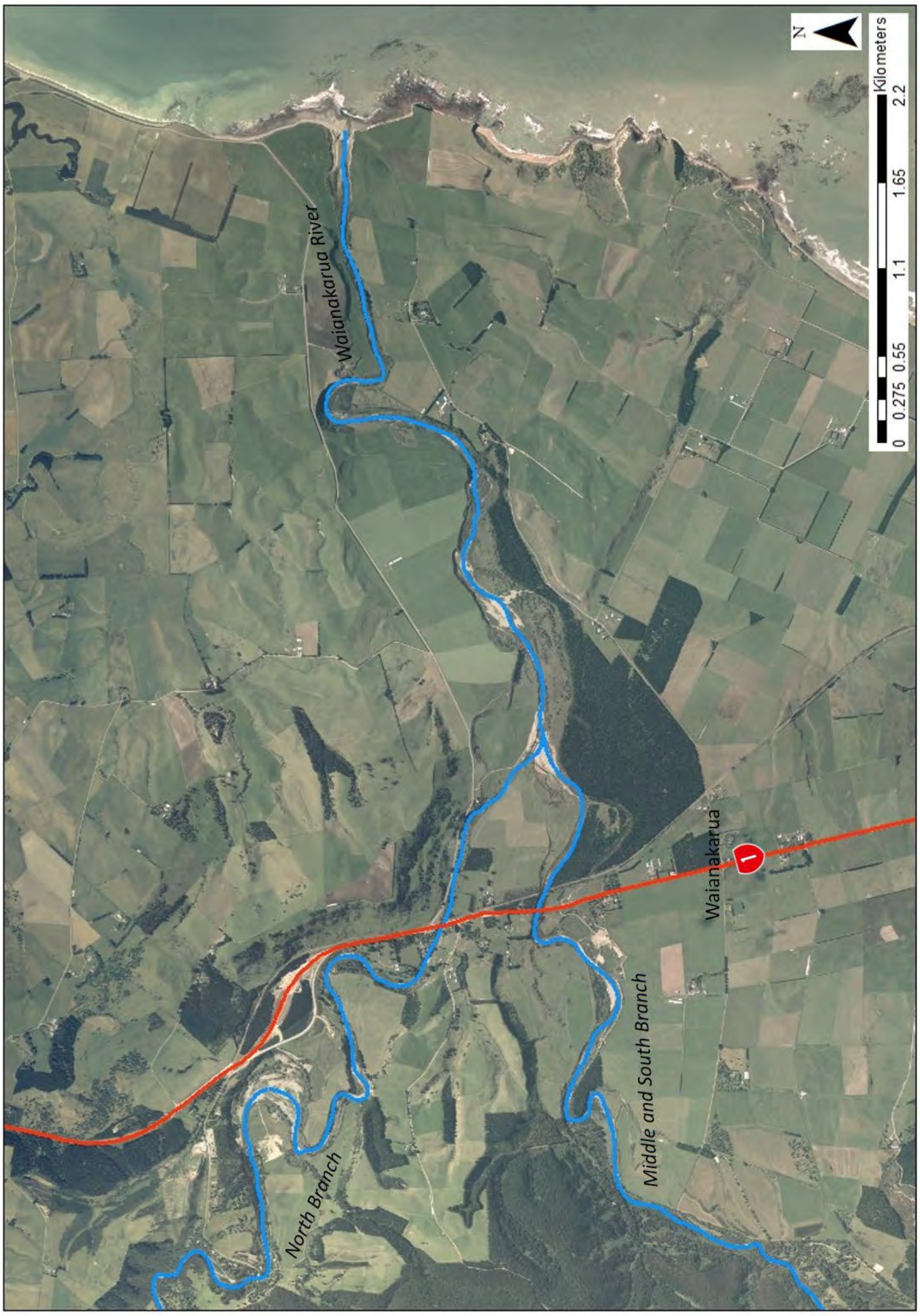

Figure 4. **Map showing the branches of the Waianakarua River and the reaches of the Waianakarua River to which this strategy applies.**

2.3. Strategy development

The strategy is intended to be a living document, which will evolve in response to new information and changes in river morphology,[7] the needs of the community, and the work of the ORC and other stakeholders. It will be reviewed regularly as part of council's annual and long term planning process, or in response to large flood events. The review process will involve landowners with property alongside the river, other stakeholders, and ORC staff with responsibilities for river and waterway management and natural hazards. The review is proposed to monitor the effectiveness of the strategy, the workability of its stated objectives, and to note progress towards achieving those objectives. It will also help ORC to set priorities when considering funding and undertaking river-maintenance work in the rivers concerned.

Before the review process, ORC will arrange and facilitate a workshop with the local community and invited stakeholder groups. This will consist of two parts:

- An opportunity for participants to present to the group any issues they face as to changes in channel morphology or riparian management; work they have undertaken or would like to see undertaken; or to discuss, question or suggest changes to the strategy itself.

- A facilitated process to coordinate activity and work towards achieving the principals and objectives outlined in the strategy.

[7] Including additional understanding gathered during future flood events

3. Environmental setting

The natural and social settings of the Waianakarua River catchment are described in this section, with particular focus on the special characteristics that give rise to the risks associated with changes in riverbed morphology.

3.1. Geological and soil setting

The geology of the upper catchment (Figure 5) consists mainly of semi-schist (Forsyth 2001). The lower catchment is mainly sandstone and mudstones with alluvium overlying the bedrock. Below SH1 the geology consists of river gravel/alluvium and volcanics (Deborah volcanics), however most of the surface water in this geology drains into the Bow Alley Creek catchment (Forsyth 2001).

There are a number of visible geological features, especially within the lower reaches of the catchment. They include the large boulders above Awanui Bluff; the cliffs near the mouth of the joint rivers; the cliffs up from Graves Dam; the Katiki Boulders; and the waterfalls in the forested tributaries (ORC, 2008).

The Waianakarua catchment is comprised of a variety of soil types. A variety of upland and high-country soils are found in the upper catchment, while shallow silt loams are predominantly found in the lower catchment. The presence of silt loams in the adjacent rolling country makes these areas more susceptible to erosion events (ORC, 2008).

Figure 5. **Geological map showing the main rock types for the reach of the Waianakarua River, for which this strategy applies; and the surrounding catchment.**

3.2. Geographical setting

The Waianakarua River (Waianakarua meaning 'between two rivers') has a catchment area of 262 km^2 and consists of three tributaries: the South Branch, Middle Branch, and the North Branch (Figure 5). The South and Middle branches arise in the Horse Range and join near the base of the ranges on the western side of State Highway 1. The North Branch arises in the eastern Kakanui Mountains and joins the South Branch approximately 5 km's from the coast, downstream of State Highway 1. Vegetation in the upper catchment (Figure 6) is mostly tussock and scrub which is extensively grazed (ORC, 2013). The vegetation in the Middle and South branches is mainly mixed native bush as well as some plantation forestry; the North Branch consists of a greater proportion of plantation forestry as well as large areas of native bush and scrub (ORC, 2013). The lower catchment is covered in agricultural grazing land (ORC, 2013).

The three branches of the Waianakarua River consist of confined, meandering channels cut into schist bedrock with a mixed gravel and bedrock bed (ORC, 2008). The lower catchment is mostly wandering with a section of braiding that is incised into an elevated gravel floodplain (ORC, 2008).

Patches of native podocarp and kowhai forest remnants exist within the catchment along with extensive areas of exotic forestry, pasture grasses and tussock grassland (ORC, 2008). The vegetation structure has changed significantly over time with changing land uses.

Figure 6. **Upper Waianakarua catchment (photograph taken December 2016).**

3.3. Meteorological setting

Flood events within the Otago east coast catchments such as the Waianakarua are generally caused by persistent rain bearing easterlies, with continual rainfall over days saturating the soil, leading to rapid runoff (ORC, 2015). Generally, these types of events occur in late summer to late autumn, although they can occur at any time (ORC, 2015). The nearest long-term automatic rain gauges are located in the Kauru River catchment at the Dasher. Annual average and maximum daily rainfall totals for these sites are listed in Table 1.

Table 1. Annual average and maximum observed daily rainfall total for rain gauges within and near the Waianakarua River catchment.

Hydrological monitoring site (rain) (date record commences)	Annual average rainfall (mm)	Maximum daily rainfall (mm)	Date of peak 24 hr rainfall
Kauru at the Dasher (1953-2016) (missing record 1995)	808	199	12 Jan 2002
Herbert Forest (1967-1989)	661	184	9 Mar 1968

Rainfall information dating back to the mid 1930's indicates that the median annual rainfall in the catchment is highly variable ranging from 400 mm in the lower catchment to 1500 mm in the upper catchment. Generally, most rainfall occurs in the periods June to August, and December to January, and the catchment can be subject to long dry periods in summer and autumn. There appears to be a direct correlation between an increase in rainfall and distance from the coast.

3.4. Hydrological setting

The Waianakarua has a variable river flow, with seasonal low flows and periodic flushes. The North branch is higher yielding with a more consistent flow, while the South Branch has been shown to be the driest. The South Branch may occasionally run 'dry' or underneath the gravel surface naturally, however this is not a feature of the whole river system.

Information on river flow in the Waianakarua River is available from one monitoring site (see Table 2). The Browns Pump recorder has been operating since 2005. Permanent flow recorders were not installed in the Waianakarua River catchment until 2005; as a result flow records are short and should be treated with some caution (ORC, 2006). The five largest flows on record for the Browns Pump recorder are shown in Figure 7. The Waianakarua River can rise rapidly during flood events, with a rate of rise greater than 1.80 metres per hour observed. Average velocities observed at this site (based of gauged flows) range from 0.1 to 2.1 metres per second, with velocities likely to be higher in the steeper, more confined sections of the Waianakarua River.

Table 2. Summary of hydrological information for sites within the Waianakarua River catchments

Hydrological monitoring site (river flow) (date record commences)	Maximum observed flow (m^3/sec) (date occurred)	Annual flood (2.3 year return period) (m^3/sec)	Median flow (m^3/sec)
Waianakarua River at Browns Pump (2005-2016)	635 (17 Jun 2013)	276	0.95

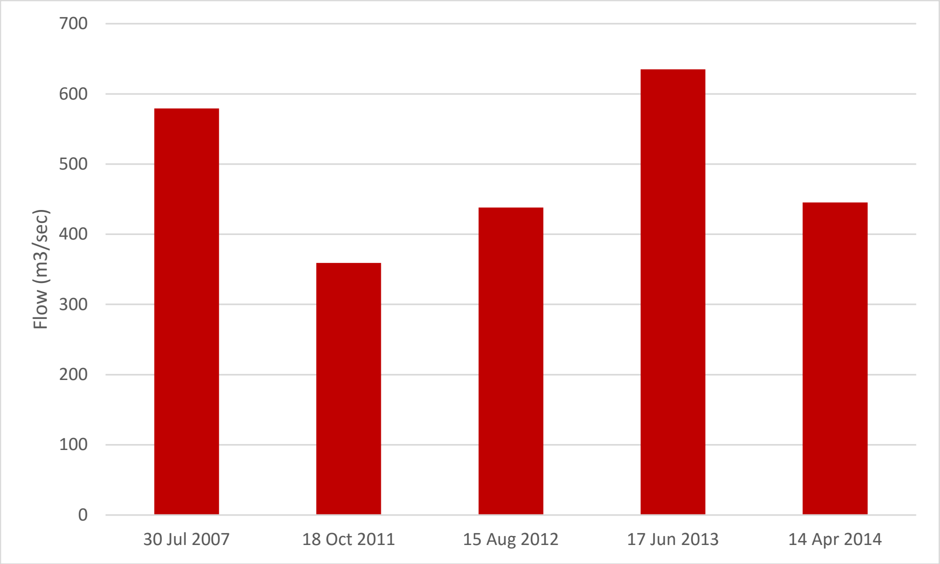

Figure 7. Five highest flows in the Waianakarua River at the Browns Pump flow recorder, since records began in 2005.

3.5. Flooding

Changes in the morphology of the Waianakarua River channel are in part, driven by the hydrological characteristics of the river, including the magnitude and frequency of flood flows. The Waianakarua River has experienced large flood events in the past, with the Jun 2013 flood being the largest on record. Land loss in the Waianakarua catchment is mainly due to erosion and slumping associated with high flow events; whilst no buildings are known to flood (ORC, 1991, 2002). Figures 8 and 9 show the Waianakarua River in flood, where water has escaped the main channel because of the high flow event. Adjustments in the position of the channel can also result from high events. In December 1993, the main channel of the Waianakarua River developed a new course down the left side bank at Sharpes Bend. State Highway 1 was subsequently threatened by undermining and then again in 1994, when further erosion resulted on the true left bank

The mapped flood hazard for the Waianakarua River is shown in Figure 10. The flood hazard mapping is primarily based on observed flood extents and is not completed using modelling or topographic information (ORC, 2002).

Figure 8. **Flooding of farmland on the true left bank of the Waianakarua River, downstream of the confluence of the North and South branches (photograph taken in the morning of 19 April 2014 by Jill and Grey Campbell).**

Figure 9. **Flooding of farm land on the true left bank of the North Branch of the Waianakarua River, upstream of the confluence of the North and South branches (photograph taken in the morning of 19 April 2014 by Jill and Grey Campbell).**

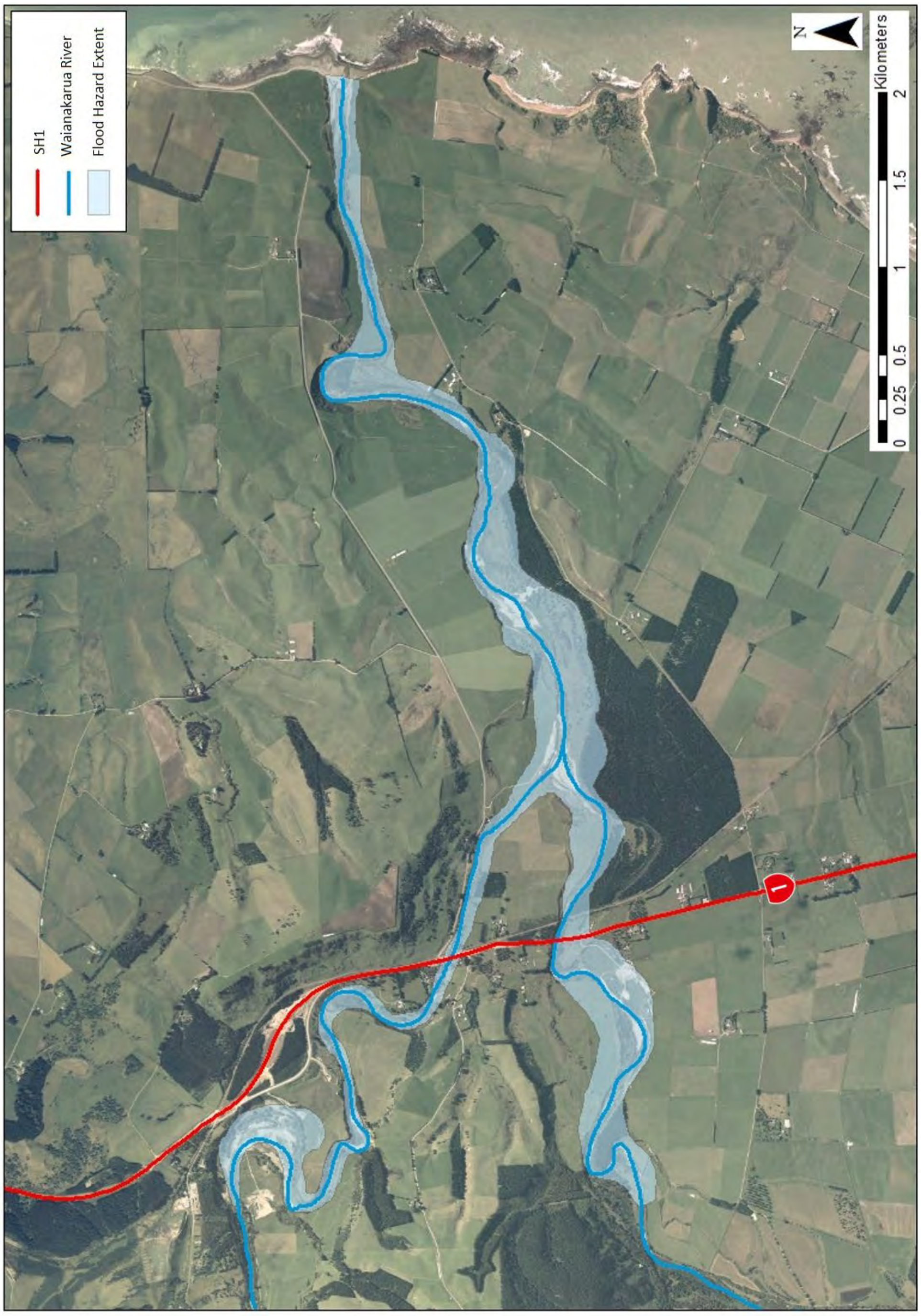

Figure 10. **Waianakarua River flood hazard extent (ORC, 2002).**

3.6. Riverbed morphology

The active channel of the Waianakarua River is a dynamic system where flood events and sediment transport regularly cause changes in riverbed morphology. Changes in the longitudinal profile of the riverbed occur due to aggradation and degradation along the channel, and as a result of lateral bank erosion. Significant changes often occur as a result of extreme flood events, but small scale, incremental changes can also occur over longer timeframes. Human activities, such as gravel extraction and physical works, can also result in significant morphological changes, particularly near these works, but they can also occur across the wider river system.

ORC undertakes work to describe these changes in morphology using visual inspections, aerial and ground photography, and cross-section analysis. Reports summarising these investigations were published in 2008 and 2013 (ORC 2008, 2013).

Observations of the Waianakarua River in 2016 and 2017 by ORC staff helped to reinforce the findings of previous investigations, in particular:

- There are several locations along the river where bank erosion is ongoing. Many of these sites are not captured by ORC's cross section network.
- The river is experiencing both aggradation and degradation and is affected by natural and human processes.
- Gravel moves downstream gradually and is shifted in large quantities during flood events.
- There are areas of significant riparian plantings and other areas where there is limited vegetation cover. The riverbed changes between stable reaches where there is riparian planting and limited bank erosion and areas where there is limited bank vegetation and ongoing bank erosion.
- The encroachment of weeds on the inside of river bends; locks up gravel and narrows the confines of the channel. This can promote bank erosion on the neighbouring bank of the channel (Figure 12).

A comparison between aerial photography collected in 2004 and 2016, highlight the dynamic nature of the Waianakarua River (Figures 11 and12). Cross section surveys of the channel also show how the channel moved laterally, accumulated sediment on the riverbed and deepened in some locations (Figures 13 and14). In some places the active river channel has changed positions and eroded into adjacent farmland. The upper reaches of the strategy area are relatively stable, with lateral changes in the channel position only occurring at gravel extraction and river management locations. Significant quantities of gravel have accumulated at the confluence of the north and south branches downstream (Figure 11). Active channels adjacent to the confluence have shifted up to 40 m in response to the build-up of sediment and altered flow pathways (Figures 11 and12). Between the confluence and 1900 m downstream, the position of the active channel within the fairway has shifted between 30 and 50 m in cases (Figures 11 and13). Further changes have also been seen before the last meander bend (adjacent to the Waianakarua River) where the position of the channel before it enters the bend has changed.

Figure 11. **Comparison of the Waianakarua River fairway between 2007 and 2016 downstream of the confluence between the North and South branches (aerial photograph collected in 2016).**

Figure 12. **Comparison of the Waianakarua River fairway between 2007 and 2016, for the North Branch, directly upstream of the confluence with the South Branch (aerial photograph collected in 2016).**

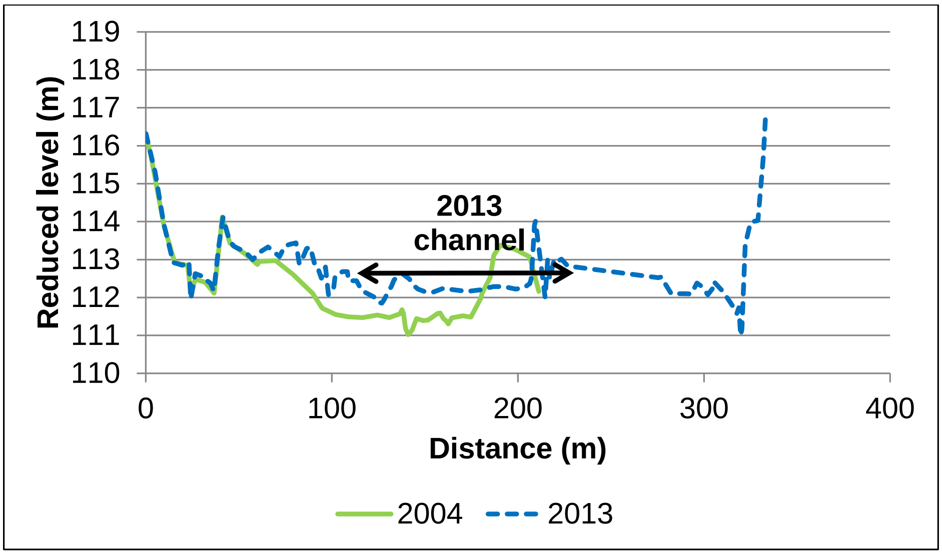

Figure 13. Cross section of the Wainakarua River at WA3 (located downstream of the confluence between the North and South branches), looking downstream. Between 2004 and 2013, the main channel aggraded up to 1 m on the true left and eroded the true right bank by approximately 20 m.

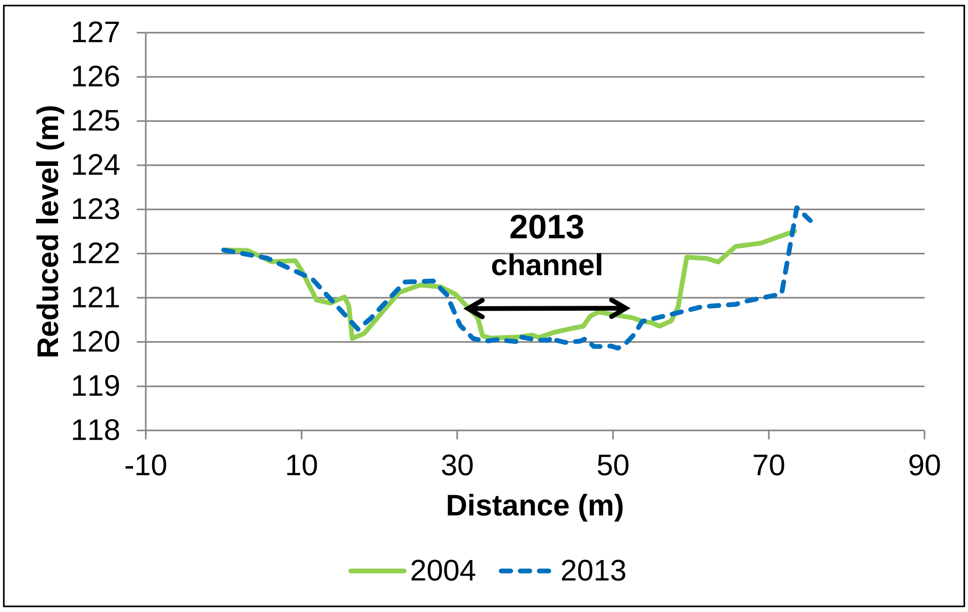

Figure 14. Cross section of the Wainakarua River at WA5S (located upstream of the SH1 bridge on the South Branch), looking downstream. Between 2004 and 2013, the main channel degraded by 0.7m on the true right. Bank erosion occurred on both banks adjacent to the main channel, where the right bank eroded by approximated 14m .

3.7. Riparian margins

The riparian margin is the area beside waterways that forms the interface between water and land. As noted in the introduction, more intensive use of the land that borders the Waianakarua River has occurred in recent decades. In some parts of the catchment, farmland has encroached onto what was previously a more natural area of rough vegetation. This has resulted in a narrowing (or in some cases, complete removal) of the riparian margin that separates the active river fairway from land that is used for farming, or which accommodates community infrastructure. Previous ORC reports have identified that channel widening by bank collapse and erosion are processes that continue to occur in the Waianakarua River (ORC, 2013). The loss of primary agricultural land and physical property adjacent to eroding stream banks is very costly and the need for their protection against erosion has long been recognised.

Historically, the permanent removal of gravel from the river system has been used as a tool in an attempt to address bank erosion issues. The strategy identifies that gravel extraction, and other river management tools (such as the movement of gravel within the channel and spraying), should still be considered for river management purposes, where that is appropriate. However, a number of authors have identified that the most effective means of controlling river bank erosion is to establish a vegetative cover of strongly rooting plants (Slui 1991, Marden *et al.* 2005, ORC 2005, Phillips & Daly 2008). In general terms, vegetation roots increase bank stability by protecting soils against entrainment from flood flows, and root mass and density provide soil shear strength, thereby protecting against gravity collapse of undercut banks.

Other indirect benefits of riparian plantings include trapping nutrients and fine sediment, shade, shelter and filtering qualities for the aquatic eco-system, as well as aesthetic and recreational value. If well managed, riparian margins can help to improve water quality, provide food and habitat for freshwater life, and improve diversity (ORC, 2005).

4. Values

The Waianakarua River is one of the few rivers left in North Otago with a high water quality, which supports a diverse biodiversity; including vulnerable native fish and remnants of native vegetation. It is important for the viability of commercial farming and gravel extraction operations, and has many recreational users. Every aspect of the river is important, and all aspects of the river must fit together. The river and its catchment must be managed in a coherent and integrated way, with regard to all values.

Information on the values that the community, iwi and stakeholders have for the Waianakarua River was collected through community meetings and collecting feedback (Appendices 6 and 7). The Waianakarua River fulfils a number of important roles within the community at a local, district, and regional scale. These roles include (but are not limited to):

- A source of water for irrigation, stock, and people (e.g. town water supplies).
- A source of gravel for roading and construction purposes.
- For recreational purposes, including swimming, fishing, whitebaiting (ORC, 2006), picnicking and camping. The Waianakarua is a popular recreational destination for people who live outside of the local community (e.g. people from Oamaru, Dunedin).
- A habitat for native and introduced species.
- For customary use by local iwi ranging from the use of water for ceremonial purposes, to maintaining the quality and quantity of water to sustain mahika kai populations and habitat.
- Mana Whenua values including kaitiakitanga, mahinga kai, ki uta ki tai and mauri

Limited information was collected on the spatial location of the values discussed and presented by the community and stakeholders. The lack of geographical information on the values discussed in this strategy therefore means all values should be considered whenever activities are planned for the beds and banks of the Waianakarua River at any location.

The below sections discuss the ecological, community, Māori cultural and historical values that are held for the Waianakarua River.

4.1. Ecological values

Wetlands

The Waianakarua River Estuary Swamp is believed to have significant wetland values and has been classified as a regionally significant wetland in Schedule 9 of the Water for Otago Regional Plan. Bank vegetation and long grasses provide spawning habitats for īnanga (whitebait) spawning during floods or high tide events.

Fish

The Waianakarua River provides an important habitat for a range of native and exotic freshwater species. It provides one of the best Otago Rivers for fish diversity and abundance, and associated recreational opportunities. Recognition of this habitat has previously seen the transfer of a number of endangered Lowland longjaw galaxias into the mid reaches of the Waianakarua. There classification as nationally critical, is the highest threat category. There are over 14 species of fish being present in the catchment (NIWA freshwater fish database, ORC 2013). Seven species are classified as ‘at risk’ and ‘declining’ in the New Zealand Freshwater Fish Threat Classification (ORC, 2013) and include longfin eel, Torrentfish , bluegill bully, redfin bully and two migratory galaxiids (īnanga and koaro). Other species include three species of bully (common, upland and giant), two non-migratory galaxiids (Canterbury galaxias and the Lowland longjaw galaxias), smelt, shortfin eel, black flounder, and brown trout (ORC, 2006). Lamprey are threatened and are ranked as nationally vulnerable; the third highest threat classification given to threatened species.

Brown trout are the only species of introduced sports fish found in the Waianakarua River catchment (ORC 2006). The Waianakarua River is not considered a significant sports fishery, but has seen an increase in angler effort over the 15 years (Table 3). Information from Fish and Game Central South Island recognises that the Waianakarua River is a limited sports fishery due to the lack of cover and low flow (Pringle 2003). The Waianakarua River trout fishery is believed to be heavily dependent on the sea run component (Pringle 2003).

Spawning and incubation periods are an important consideration when undertaking river works. Spawning success is dependent on adequate river flows and appropriate substrate. Interstitial spaces should be present between coarser gravels, where the sedimentation of finer particles is limited. For brown trout, this spawning period extends from the start of May, until the end of September (Central South Island Fish and Game Council, pers.comm., 27 June). Redd environments and the incubation process are sensitive to physical disturbance and silt deposition during these periods.

Table 3. **Angler effort in the Waianakarua catchment (angler days $^{+}/_{-}$ standard error) based on the national angler survey (Unwin, 2016)**

River	Angler usage (angler days $^{+}/_{-}$ SE)			
	1994/1995	2001/2002	2007/2008	2014/15
Waianakarua		140 $^{+}/_{-}$ 140		280 $^{+}/_{-}$ 230

Birds

The Waianakarua catchment provides sanctuary for a range of native fauna including the jewelled gecko (Kakanui Mountain), piwakawaka (fantail), korimako (bellbird), kereru (pigeon) and tui (ORC, 2008). Black-backed gulls also nest above the gorge. Avifauna which utilise habitats along the lower Waianakarua River and its mouth, are suspected to be relatively close to that of the Kakanui River (located several kilometres north) (ORC, 2015). Birds include the white-fronted tern, banded dotterel and the South Island oystercatcher.

Modification of the river bed and margins of the Waianakarua River, threaten the habitats of these species. Human activities in and around the river bed may also disturb nesting birds.

Mana Whenua Values

Ngā Rūnanga hold strong positions regarding riparian management and protection of the fish species in the Waihemo, especially in regard to mahinga kai. This includes the use of taonga species for riparian planting, planting that provide habitat for mahinga kai species, protection of native spawning fish, protection of disturbed fish, allowing passage for migration and minimising sedimentation in the river. For more information on these positions see appendix 8.

4.2. Community

To help identify aspects of the wider river environment that is important to the local community, ORC consulted with a range of stakeholders in 2016 and again in 2017. These included landowners, Central South Island Fish and Game Council, the Waitaki Branch of Forest and Bird, Department of Conservation (DoC), and WDC. ORC also consulted with Te Rūnanga o Moeraki through Auhaka in 2017 and into 2018.

The Waianakarua River has a long connection with Maori culture, as well as European settlement. In addition to the natural character of the river and its margins, amenity values are supported by the important natural values of the river. Community values include:

- Clear, high quality water adds to the aesthetic appeal of the river
- The Waianakarua provides an environment for fishing, white baiting, game bird hunting, utilising water holes for swimming, recreation and family gathering
- Utilising swimming holes
- Source of clean drinking water and stock water
- Irrigation is important for some farming operations
- Being able to manage the river through the use of gravel extraction and tree planting
    - Extracting gravel for use (i.e. an aggregate supply) and for river management purposes. Gravel has previously been extracted to improve the conveyance of flood flows and to reduce outer bank erosion.

Values that the community and other stakeholder groups identified with the Waianakarua River environment have been summarised around community river form and function ‘values’ as summarised in the box below. A full list of feedback and these values that have been identified through the consultation process are included in Appendices 6 and 7.

Community river form and function 'values'

- That the function of the river continues to support social, cultural, spiritual, ecological, recreational, and farming activities – as well as continuing to provide for the taking of gravel as a resource.
- That the form of the river includes riparian plantings (including both native vegetation and willows), weed control and fencing.

4.3. Mana Whenua Values

To understand the cultural importance of the wider river environment to the local Iwi, ORC have worked in partnership with Te Rūnanga o Moeraki through Aukaha (formerly KTKO).

Values identified have been summarised in the box below. More information on Mana whenua values and perspectives on freshwater, association with the Waianakarua, Ngā Rūnanga aspirations relevant to the strategy, issues for Ngā Rūnanaga relevant to the strategy and recommendations that have been identified through the consultation process are included in Appendix 8.

Mana Whenua Values

Ko te wai te ora ngā mea katoa. Water is the life giver of all things

- Kaitiakitanga is the responsibility of Mana Whenua to ensure that the life-supporting capacity (mauri) of the natural resources of their takiwā is sustained.
- Mahinga Kai literally means "food workings" and refers to the places where food is gathered or produced, the traditions and collection methods associated with gathering natural resources for cultural use and the resources themselves.
- 'Ki uta ki tai' a holistic culturally based 'mountains to the sea' natural resource management framework.
- Mauri or life force of all things living and non-living must be protected.

4.4. Historical

Several historical landmarks utilised the Waianakarua River in the lower catchment. The Waianakarua Bridge (Figure 15) (formerly known as the Otepopo Bridge) was established over the North Branch in 1874, to provide a reliable transport connection between the settlements of Dunedin and Oamaru. One of the oldest bridges remaining on New Zealand's state highway network; the twin-arched stone bridge was designed by John Turnball Thomson and built using limestone (Heritage New Zealand Pouhere Taonga). The

Waianakakarua Bridge holds a New Zealand Historical Places Trust classification, as a monument of national importance. Thomson also designed the bridge over the South Branch, which was completed in 1861.

The water wheels of two historic flour mills utilised the flow of the North Branch of the Waianakarua River. The remains of the former Fernyhaugh Flour Mill (constructed in 1870), are located immediately upstream of the Breakneck Road bridge, which includes a curved stone dam (Heritage New Zealand Pouhere Taonga). Damming occurred twice at Grave's Dam in the 1870's, but currently does not impede river flows. The Phoenix Mill (Figure 16) was also built adjacent to the Waianakarua Bridge in 1879, using quarried stone blocks.

Figure 15. **The historic Waianakarua Bridge, built over the North Branch of the Waianakarua River in 1874 (Image courtesy of Nicola Jackson, Heritage New Zealand Pouhere Taonga).**

Figure 16. **Historic flour mill located adjacent to the North Branch of the Waianakarua River (Image courtesy of The Mill House).**

4.5. Gravel extraction

The removal of gravel from the bed of the Waianakarua River has occurred for many decades, with extracted material generally used for farm laneways, roading and construction. Gravel extraction typically occurs from locations where sediment accumulates e.g. where there is a decrease in the gradient of the river, leading to a reduction in the velocity of flood flows, or in an attempt to mitigate issues such as bank erosion. In either case, extraction from the bed of the river will tend to increase the conveyance of water during flood events by widening the channel and reducing the mean bed level (MDL)[8] at that location. It can also lead to a decrease in the sinuosity of the river channel, as bends are straightened in an attempt to reduce the effects of bank erosion.

The Waianakarua River has previously been identified as having limited gravel supply rates (ORC 2004). Gravel extraction and past flood events have contributed to localised erosion and aggradation (ORC 2008) as well as degradation of the channel bed (ORC 2004). Gravel extraction is carried out on the North Branch, the South Branch and the main stem of the Waianakarua River. Localised gravel extraction from areas of high accumulation, is used to assist the conveyance of flood flows and by keeping the river in its assessed fairway, reduce bank erosion. River morphology reports and the monitoring of gravel extraction by the ORC, is used to ensure sustainable gravel extraction in the long term, which balances river management requirements and instream values (see ORC 2008 and 2013).

Gravel extraction within the study reach has been occurring over several decades. Between 2004 and March 2017 about 93,035 m^3 of gravel has been extracted. 26,463 m^3 was extracted between 2014 and March 2017. Currently a total of 28,000 m^3 per year of gravel is consented to be removed from the Waianakarua River from extraction locations at Sharpes Bend, upstream of Herbert-Hampden road on the south branch, the confluence of the North and South branches and 900 metres downstream of the confluence.

Gravel that is removed from the Waianakarua River system in excess of the natural replenishment rate can lead to instability and reduced integrity of structures downstream. This includes undermining of river protection works and other assets (e.g. water intakes, bridges, and roads) as well as increased bank erosion and bed degradation. It is important to recognise that gravel beds are still of value to a wide range of species and perform critical ecological functions.

Ongoing channel degradation can allow increased water velocities (particularly during flood events) to scour the river bed, deepening the channel, which can result in continued bed degradation. As the channel deepens, flood flows become confined within the channel and continue to scour the bed. This ongoing degradation decouples the channel from the floodplain and alters the floodplain catchment interactions (Fuller *et al.* 2014). Deeper channels contain larger floods and concentrate flows, leading to more incised channels, potentially generating higher sediment transport rates (due to bank erosion and further removal of material from the riverbed). This process gives the appearance of more prominent gravel bars within the active channel due to the deeper channel. As the channel deepens and gravel bars become more prominent, pressure is often exerted by adjacent landowners

[8] MBL represents a 'horizontal straight line across the channel, positioned so there is as much bed above the line as below it' (Griffiths, 1979).

to remove the obvious (but in fact non-existent) excess gravel accumulation, which in turn exacerbates the degradation trend (Fuller *et al*. 2014).

The permanent removal of gravel can also result in the undermining of river protection works and other assets (e.g. water intakes, bridges and roads), as well as degrading ecological values. Gravel extraction can have a negative effect on the local ecology, with the severity of effects dependent on the extraction methods used and the environment from which the gravel is being extracted. Gravel extraction activities can lead to a reduction in habitat heterogeneity/diversity, an increase in fine sediment, as well as bed compaction that can have a negative impact on the native and exotic animals residing in and on the banks of the Waianakarua River. Over-extraction of gravel can remove potential spawning sites and limit spawning success within the catchment, due to the removal of aggregate and reduction in the size of gravels. This in turn can limit the success of the fishery and recreational opportunities.

The potential beneficial and adverse effects of significant gravel extraction are summarised in Table 4.

Table 4. Potential beneficial and adverse effects of gravel extraction (Canterbury Regional Council, 2015).

Potential beneficial effects	***Potential adverse effects***
Channel capacity increased, flood levels lowered	Disturbance of fish and bird habitat
Concentration of flow against riverbanks, resultant lateral erosion, and localised bed scour is minimised	Accidental discharge of fuels and lubricants from machinery
Stable channel alignment and optimum bed level is maintained	Disturbance of the natural meander patter and channel stability
Open gravel beaches can provide a good habitat for indigenous birds	Overall degradation of the riverbed
A renewable gravel resource for local construction may be utilised	Increased bank erosion
* Mauri (life force) of the riverbed affected	Sediment is discharged, increasing turbidity and smothering habitat
	Temporary reduction in recreational access
	Mauri (life force) of the riverbed affected

	Disturbance of fish spawning sites
	Dust generation
	Reduced river bed heterogeneity

*Consultation with Auhaka in 2017 indicated 'Mauri (life force) of the riverbed affected' also needed to be added to the Potential beneficial effects side of the table

Sediment replenishment rates from the upper catchment of the Waianakarua River are insufficient to maintain the profile of the surveyed reaches (ORC 2004). The Waianakarua River is currently experiencing ongoing bank erosion as well as areas of both channel widening and narrowing with the largest observed change occurring in the South Branch (ORC, 2013).

5. Future changes

The latest guidance from the National Institute of Water and Atmospheric Research (NIWA) and the Ministry for the Environment (MfE), predicts an increase in daily extreme precipitation and stronger westerly winds (westerlies) for southern New Zealand (MfE, 2016). Warmer atmospheres are able to hold more moisture, which can result in shorter and more intense rainfall events. More precipitation is likely to fall in eastern Otago during winter and spring, due to predictions forecasting an increase in easterly winds.

Understanding changes to the climate in southern New Zealand, is important for forecasting potential changes to the flow regime of the Waianakarua River. More frequent high flow events are likely due to increases in the intensity and total amount of precipitation. Larger floods are more likely, where the Waianakarua may rise rapidly; have a higher peak flow and result in longer duration high flow events. This will place additional pressure on the existing channel, as the channel makes adjustments to incorporate changing flow characteristics.

The upper catchment of the Waianakarua is largely vegetated with tussock grasslands, native bush and exotic plantation forestry (Herbert Forest). The presence of vegetation provides a buffer to rainfall events, which slows the movement of water to the river drainage network. Floods are dissipated, as overland flows take longer to enter the channel; which reduces the magnitude of high flow events and potential flooding. As native vegetation is largely present on conservation land, hydrological changes will most likely result from the harvesting of trees within Herbert Forest. Ongoing harvesting currently occurs in Herbert Forest, due to the mixed age of plantations (Port Blakely, pers.comm., 27 July). In comparison to harvesting rates over the previous decade; harvesting activity is expected to increase into the next decade due to an upcoming “wave” of volume. The impacts of increased harvesting will be minimalized if appropriate harvesting techniques are implemented and reforestation occurs.

6. Legislative context

The manner and degree to which the issues in the Waianakarua River can be managed by the community, iwi, stakeholders and local councils is influenced by the obligation, powers and restrictions set out in various statues. No legislation confers the exclusive power or the right to manage the Waianakarua River to ORC or WDC. Whether through works or services, individuals are empowered to initiate their own measures provided they operate within the law. They are also allowed to develop and promote proposals for bank protection works, to apply for and hold the necessary resource consents, and to privately fund works and services should they wish to.

The law provides for a range of methods that both councils and the community can use to manage the Waianakarua River. These methods do not only relate to physical works, but also to planning, information, emergency preparedness and response. They can only be implemented after taking environmental effects into account (under the Resource Management Act 1991 (RMA)) and funding consideration (under the Local Government Act 2002 (LGA)). The latter includes consideration of the distribution of benefits between the community as a whole, any identifiable part of the community, and individuals.

The Otago Regional Policy Statement (RPS) provides a high-level policy framework for the sustainable integrated management of Otago's resources, as well as giving effect to the requirements of the RMA. This includes the management of the values of water bodies, natural resource systems and the form and function of Otago's rivers, whilst still enabling communities to provide for their needs.

This strategy is concerned with the form and function of the Waianakarua River. Any activities in or on the bed and banks of the Waianakarua River, need to be focused on maintaining or enhancing that form and function. The strategy is not a statutory document; rather it is intended to present the aspirations of the community, iwi and the various stakeholder agencies. However, the statutory processes that do influence river management activities[9] are more likely to be used effectively and efficiently if there is a general consensus on what is valued about the river, and commonly understood objectives. The strategy sets out the values identified by the community, and the outcomes they seek from managing river form and function, and will be used to inform resource consent decision-making.

[9] Including the LGA and the RMA

7. Principles

The strategy provides a framework to guide activities and decision-making, based on an agreed set of principles. It is intended to help protect the recreational, cultural and ecological values of the Waianakarua River, and to enable long-term sustainable use of the riverbed and its riparian margins.

ORC has developed the framework, in partnership with iwi and in consultation with the local community and other stakeholders. The principles and associated strategic elements are outlined below, and these are intended to protect or enhance the important values and features of the river identified by the community and other stakeholders.

Principle 1: Ensure sustainable river management

Ensure that:

- There is recognition of the kaitiaki responsibilities of Mana Whenua through clear and consistent communication between Manawhenua and the ORC.
- There is clear and consistent communication between the ORC and other parties.
- There is recognition that certain river and catchment processes, such as flooding, bank and channel erosion and sedimentation, will occur naturally, and an understanding of the potential effects of those processes.
- Any practices undertaken limit exposure to negative natural-river and catchment processes.
- There is an awareness and acknowledgement of the benefits and the risks (including the risk associated with ‘super-design’ events) that exist for activities such as farming that occur in areas prone to natural-river and catchment processes.
- Any negative effects of natural-river processes do not increase beyond their current levels, and are actively reduced where there is opportunity to do so.
- Activities are managed in a way that result in:

- Limited effects on assets during flood events
- Essential community infrastructure that is resilient (roads, bridges, water supply)
- Acceptable level of effects to farming caused by river processes
- Sustainable use of river resources
- There is recognition of the kaitiaki responsibilities of the local iwi.

Principle 2: Plan ahead

Ensure that:

- There is clear and consistent communication between the ORC and other parties
- There is an adaptive approach to river management that will allow for the dynamic nature of the Waianakarua River
- Resources are used wisely to ensure that the location and form of community assets and essential infrastructure will result in a more resilient community
- The impacts of climate change and natural climate variability are considered so that future generations do not have to cope with the results of poor decisions made today
- The risk associated with natural-river processes are reduced over time by taking a broad-scale, adaptive approach over the longer term.
- Decision making considers ecological life cycles and temporal variation in river flows.

Principle 3: Maintain and enhance the natural environment

Ensure that:

- Cultural use by Mana Whenua is enabled, maintained and enhanced by clear and consistent communication between Mana Whenua and the ORC.
- There is clear and consistent communication between the ORC and other parties.
- Activities are managed in a way that results in:
  - A habitat that supports existing wildlife, fish, and suitable plant species[10]
  - A more visually appealing river system
  - The ability of the local community and visitors to access and enjoy the river is maintained and/or enhanced
  - Traditional and cultural use is enabled, maintained and enhanced.
  - The consideration of ecological cycles and flow variation.

[10] While native species would be the preferred option and used wherever possible, in some cases a mix of native and exotics may be required to balance river management and biodiversity objectives. See also Appendix 2.

8. River form and habitat enhancement

8.1. River corridor design and management

ORC has undertaken work to identify the location and width of the active fairway (or riverbed), as well as appropriate buffer zones, which together form a corridor within which the river would naturally lie (Williams, 2017). The widths of fairway and buffer zones were completed by assessing the appropriate meander form in relation to the nature and width of the river channel. The design channel has been drawn up using a consistent meander length or wavelength oscillation, while taking into account the existing channel location, channel areas and natural controls and restraints. This work has been undertaken in the Waianakarua River North Branch from Graves Dam and the Waianakarua River South Branch from McKerrow Road to the confluence with the Pacific Ocean (Williams, 2017). An example is shown in Figure 17, and a full set of river corridor maps is provided in Appendix 4.

The river fairway and corridor mapping provides guidance for multi-purpose river management, and for the design and implementation of management measures, protection works and in-channel design. When physical works or activities are being considered within the fairway or on the riparian margin, these should be undertaken with reference to the mapped fairway and buffer zones. Guidance for managing the river within this corridor, and across the wider floodplain, is summarised in Figure 18.

ORC will work towards maintaining the Waianakarua River to the mapped corridor lines in the study reach where reasonable and practicable. The fairway management will be achieved through river-management practices such as plantings, targeted vegetation spraying and when needed sediment movement (i.e. bank reinstatement and, in extreme cases, channel realignment and cross-blading). Hard options (i.e. gabion cages and rock armouring) will only be used for land stabilisation as a final option; in combination of more 'natural' defences (i.e. piled gravel and plantings) to improve the aesthetics of these management options.

Figure 19 is an example where gravel has been shifted to promote the channel to flow away from the true left bank; it has been eroding between 2004 and 2016. Keeping the fairways to the mapped lines will be undertaken as a pre-emptive process with the aim of limiting the degree of movement/deviation from these areas in flood events. This work will take into account the community values (as discussed in Section 4). Maintenance work undertaken in the Waianakarua River (as discussed above) will be provided for through the budget set in the ORC Annual Plan (Appendix 1). This work will be carried out in collaboration with affected parties.

In some locations, the mapped corridor crosses land that does not currently form part of the active channel of the Waianakarua River, e.g. Figure 17. This is due to the fact that the mapped corridors show an 'envelope' within which the river would migrate under natural conditions. In many instances, they do not reflect the current position of the Waianakarua River. In these situations the ORC will not actively move the fairway into these mapped areas; however, if the channel switches its location into these areas (e.g. in response to a large flood event), ORC may decide not to undertake work to reverse the new alignment if the channel still lies within the mapped corridor.

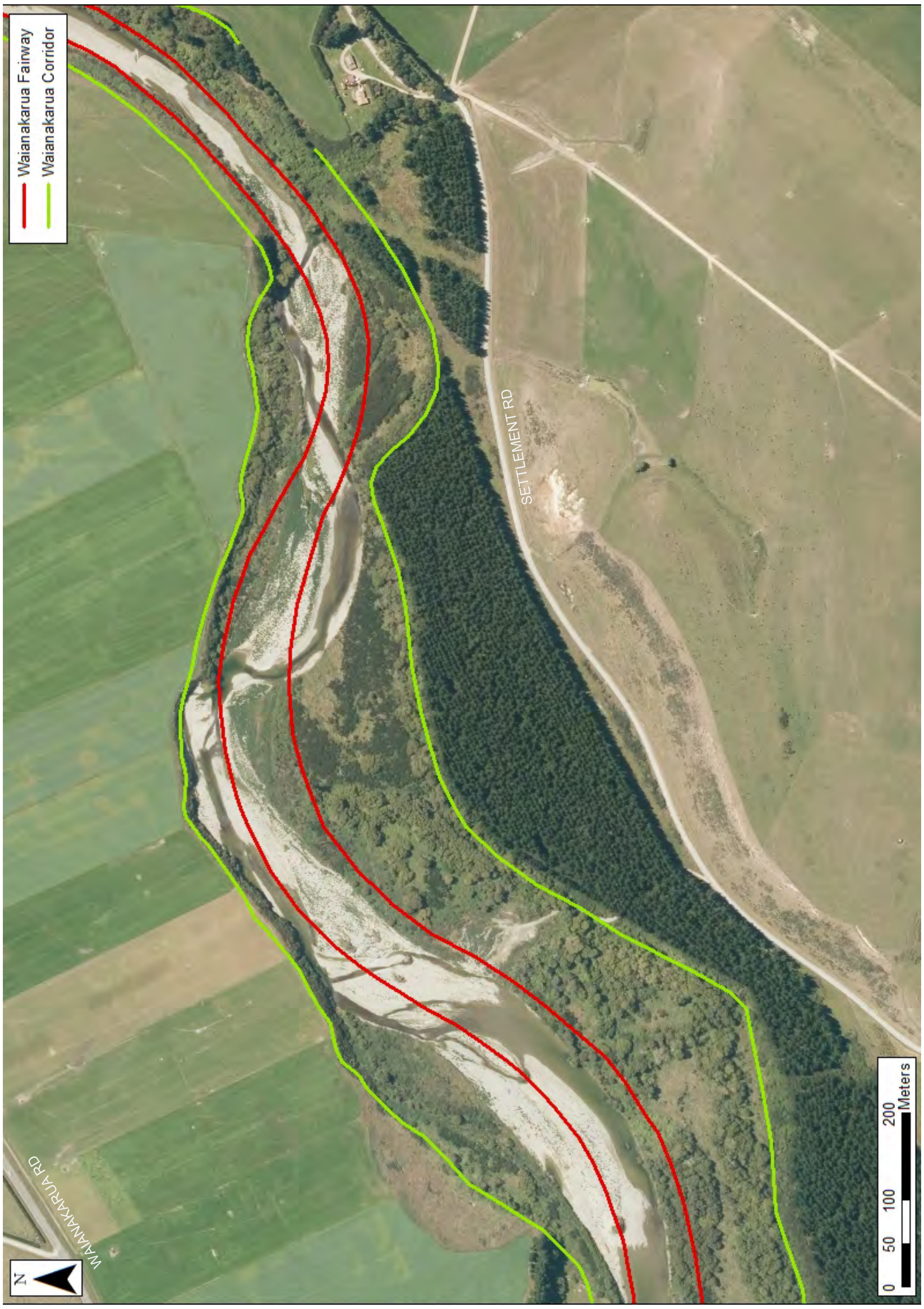

Figure 17. Waianakarua River mapped fairway deviating from the current channel alignment (aerial photography collected in 2016).

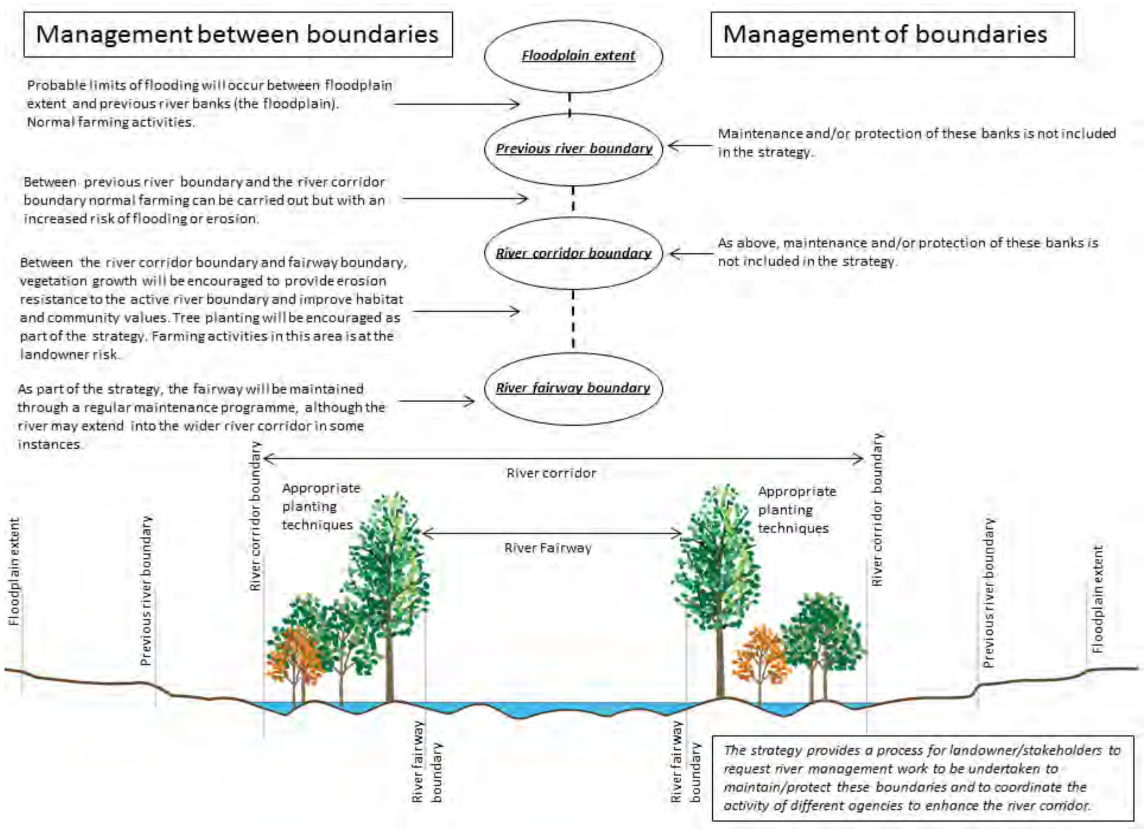

Figure 18. **Policy diagram for management of river boundaries and appropriate land-use on floodplain areas of the Waianakarua River.**

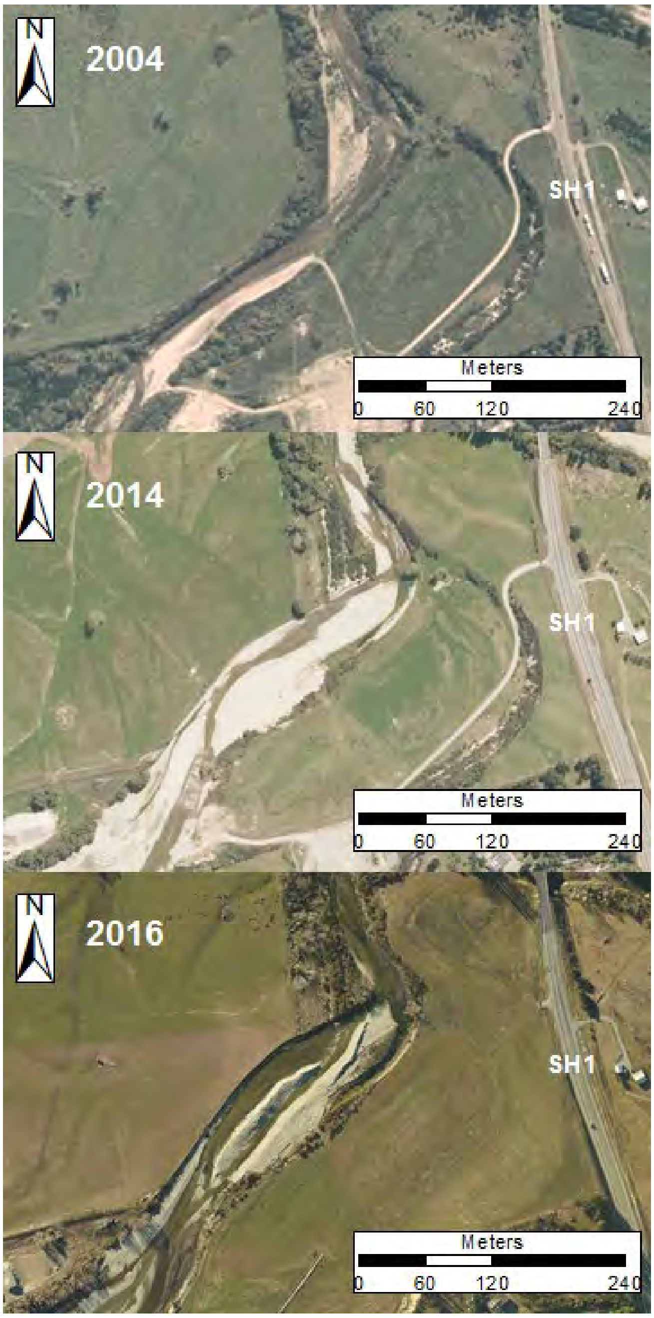

Figure 19. **Aerial photos showing the South Branch of the Waianakarua River between 2004 and 2016, upstream of the SH1 bridge. Erosion of the true left bank within this reach has resulted from lateral changes in the position of the channel. River management work by the ORC in late 2016 has shifted gravel along the banks of the channel, to direct flow away from the true left bank.**

8.2. Riparian plantings

As identified in Section 3.7 careful management of riparian margins is key to achieving positive river management outcomes. In addition, feedback from consultation continues to show that iwi, the community and stakeholders would like to see additional planting and management of riparian plantings included in the strategy, as a means of improving the amenity and habitat values of the Waianakarua River, and to help to reduce the effects of erosion (Section 4.2). The principles identified in Section 6 reflect the importance of sustainable river management and enhancing the natural environment.

Research (Slui, 1991; Phillips & Daly, 2008) shows that to achieve bank protection, the Waianakarua River riparian margins[11] should be planted in vegetation that assists with bank stabilisation. Planting these buffer areas would provide the banks of the rivers with greater stability and assist with limiting bank erosion, as well as providing vegetative cover to slow flood flows and limit the amount of sediment deposited out of the main channel, while also providing habitat for aquatic life. The wider the area of buffer zone planting, the more effective this will be.

Willow species (particularly moutere and kemuti willow) are more suitable for planting close to the river margin due to their rapid growth, ease of propagation and usefulness for vegetative groynes or bank-lining layering. Other vegetation can also be used, including poplars and alders on the relatively higher/drier land. Certain species of exotics are invasive and spread easily within these environments (i.e. crack willow and certain species of alders). Careful selection should be made of exotic species, to accommodate other community values along the river. Native vegetation can be used further back from the active river margin and can be useful, especially when part of other/wider riparian planting.

Development of the buffer areas can be undertaken as a staged approach, with planting of the active river margin occurring in areas where there is bank exposure, as well as at possible river breakout locations. Planting of the back area can be undertaken where direct river attack (i.e. bank erosion) is less likely to occur and the native species will have time to become established. Buffer development is about establishing a wide and dense vegetated margin that can absorb river attack and provide habitat for aquatic life.

Planting of the banks of the Waianakarua River is generally seen as a beneficial process in most locations. The success of riparian plantings to accommodate the community values along the river depends on species selection; the exclusion of stock from river margins and the use of appropriate planting techniques. There are several methods to plant the banks of the two rivers, with the best method being dependent on the environment where the planting is to take place (see Appendix 3).

[11] i.e. the area that acts as a buffer between the active fairway and land used intensively for farming or other activities

Ngā Rūnanga encourage and support native riparian planting, specifically of Taonga and mahinga kai species, by landowners as an important habitat for mahinga kai. The Ngāi Tahu Claims Settlement Act 1998 lists a number of species with which Kāi Tahu are recognised to have a cultural, spiritual, historic and traditional relationship. However, some species considered to be taonga by Kāi Tahu were not included in this list, and Kāi Tahu do not see this list of species as exhaustive. For reference to Ngāi Tahu claims settlement act Taonga species see Appendix 8.

9. Implementation

The objectives of the strategy are listed at the start of this document (in the overview section). The mechanisms that can be used to achieve or implement these objectives are shown in the following tables. These have been derived using the principles outlined in Section 6. The tables below highlight the actions that should be undertaken to maintain and enhance the values associated with the Waianakarua River, as well as the key parties responsible for undertaking the listed actions.

In some cases, ORC has already undertaken work to help achieve objectives, and this work is described within this document (for example, mapping of natural-river corridors). It is noted that many of the key actions below are voluntary and will rely on interactions between the key stakeholders and the community and iwi to be successful. It is also noted that many of the activities will be ongoing, and progress will depend on funding, not only through the ORC Annual Plan process, but also from other agencies and the wider community.

ORC has prepared the strategy, with input from the local community, to help protect the recreational, cultural, and ecological values of the Waianakarua River riverbed, and to enable long-term sustainable use of the land that borders the river. The objectives and actions listed below are intended to help achieve this by guiding work programmes, decision-making activities for the community, stakeholders, iwi and ORC. It is therefore recommended that people who live, work, or play within the Waianakarua River catchment consider and give effect to the principles, objectives and actions listed in this strategy.

Due to the dynamic nature of the Waianakarua River, parts of this strategy are likely to change as the rivers themselves change; this strategy must therefore be treated as a ‘live’ document (Section 2.3). This means that some sections and maps in the strategy may change in response to changes in the Waianakarua River (e.g. areas of gravel accumulation may shift).

Objective 1 Recognise and characterise natural-river processes

Activity	How this can be done	Intended outcome	Who will lead it	Timing	Comment
1.1. Collect information about flood and erosion processes					
	Map, describe and report on changes in channel morphology	Improved understanding of natural river processes	ORC	Ongoing	Previous reports describing changes in channel morphology are available
	Identify locations where erosion is occurring	Avoid high-value assets in erosion-prone areas	ORC	Ongoing	
	Make information publicly available, including through the Natural Hazards Database	Improved decision-making around placement of assets and land-use activities	ORC	Ongoing	Information is currently available through the Natural Hazards Database
1.2. Identify the location of river corridors, within which the river will naturally meander					
	Determine the natural meander form of the river, considering the existing channel location, and natural controls and restraints	Improved decision-making around placement of assets and land-use activities	ORC	Complete	Maps included in Appendix 4

Objective 2 Equip the community to live with the effects of changes in river morphology

Activity	How this can be done	Intended outcome	Who will lead it	Timing	Comment
2.1. Asset management and land-use practices (e.g. fences, vegetation clearance, and irrigation structure placement) are undertaken in such a way that reduces the risk associated with natural river processes					
	Land-use practices and other activities have greater regard to natural river processes	A reduction in risk over time	Landowners	Ongoing	ORC to provide guidance and information through field-days and other community programmes
	Consider implementation of land-use controls through the District Plan in areas with greater erosion risk	No net increase in risk over time	WDC	Long-term (5-10 years)	Incorporate into future revisions of WDC District Plan
	Identify mechanisms to modify/protect roading assets that consider natural river processes	Roading infrastructure is resilient	WDC	Ongoing	ORC to provide information as necessary
2.2. Consider all available options to manage the effects of bank erosion, including structural and non-structural options					
	Less intensive use of riparian margins	A reduction in risk over time	Landowners	Ongoing	
	Planting of native and exotic species on riparian margins	Increased stability of riparian margins and riverbanks, improve habitat and community values	Landowners	Ongoing	ORC to provide support, as determined through the ORC Annual Plan process[12] Central South Island Fish & Game

[12] For further information on planting support available for landowners please see the ORC website www.orc.govt.nz in particular; www.orc.govt.nz/Publications-and-Reports/Farming-and-Land-Management/Riparian-management/ and http://www.orc.govt.nz/Information-and-Services/Environmental-Enhancement-Fund/ or contact ORC.

					Council to provide support (through technical assistance in identifying critical areas in need of planting or vegetation management to improve bank protection)[13].
	Produce guidelines for undertaking planting appropriate for river control and provision of habitat	Increased stability of riparian margins and riverbanks	ORC	Complete	Guidance included as Appendix 3
	Produce maps showing priority planting locations	Community requirements and natural river processes are considered before planting is undertaken	ORC	Ongoing	
	Proactive river management programme	Bank erosion and other river management issues addressed early	ORC	Ongoing	Maintenance work undertaken as provided for through the budget set in the ORC Annual Plan
	Provide information on the Regional Plan: Water permitted activity rules	The community is enabled to complete activities that manage the effects of bank erosion and other river management issues	ORC	Ongoing	Information on permitted activities to be provided to the community at any opportunity
2.3. Enable works that improve the conveyance of floodwater and 'train' the river within its natural corridor, without compromising features that are of high value to the community					
	Physical works by ORC to address existing river management issues	The Waianakarua River is contained, as far as possible, within the natural river fairway/corridor, and convey small to-medium floods without overtopping	ORC	Ongoing	Locations and detail of work to be undertaken between October 2016 and 2019 included in Appendix 1

[13] For further information contact the Central South Island Fish and Game Council at csi@fishandgame.co.nz.

	Physical works by landowners and other agencies to address river management issues	The Waianakarua River is contained, as far as possible, within the natural river fairway/corridor, and convey small to-medium floods without overtopping	Landowners	Ongoing	ORC to provide guidance on suitable river-management methods (including resource consent requirements) through field days and other community programmes
	Provide information discussing the importance of community/stakeholder values	Works are undertaken in a manner that does not compromise features that are of high value to the community	ORC and the community	Complete	Values discussed in Section 4, these may be modified or adjusted as part of future reviews of this strategy
	Provide information discussing the importance of Mana Whenua values	Works are undertaken in a manner that does not compromise the values of Mana Whenua	ORC and Mana Whenua	Ongoing	Values discussed in Section 4 and Appendix 8, these may be modified or adjusted as part of future reviews of this strategy or future values reports.

Objective 3 Enable sustainable gravel extraction

Activity	How this can be done	Intended outcome	Who will lead it	Timing	Comment
3.1. Ensure sustainable quantities of gravel are extracted, for river management benefits					
	ORC will carry out site visits; analyse gravel takes and continue morphological studies of the Waianakarua River.	Gravel extraction that does not degrade the channel and results in an improvement in river management outcomes.	ORC	Ongoing	
3.2. Identify areas where gravel extraction may affect community values					
	Provide information discussing the importance of community/stakeholder values	Extraction is undertaken in a manner that does not compromise features of the location that are of high value to the community	ORC and the community	Completed	Values discussed in Section 4. These may be modified or adjusted as part of future reviews of this strategy
	Provide information discussing the importance of Mana Whenua values	Extraction is undertaken in a manner that does not compromise values of Mana Whenua	ORC and Mana Whenua	Ongoing	Values discussed in Section 4 and Appendix 8, these may be modified or adjusted as part of future reviews of this strategy or future values reports.

Objective 4 Promote activities that enhance the natural character and enjoyment of the river

Activity	How this can be done	Intended outcome	Who will lead it	Timing	Comment
4.1. Identify the location and characteristics of features that are of high value to the community					
	Community values obtained through consultation and clearly identified within the strategy	Consideration of community values when making decisions	ORC	Completed	Values discussed in Section 4. These may be modified or adjusted as part of future reviews of this strategy
	Mana Whenua values obtained through consultation and clearly identified within the strategy	Consideration of mana Whenua values when making decisions	ORC	Completed	Values discussed in Section 4 and Appendix 8, these may be modified or adjusted as part of future reviews of this strategy or future values reports.
4.2. Establish riparian plantings that serve a purpose, and are appealing					
	Produce guidelines for undertaking planting appropriate for river control and provision of habitat	Increased stability of riparian margins and riverbanks. Improved aquatic and terrestrial habitat	ORC	Completed. See also 2.2 above	Guidance included as Appendix 3
	Provide information about Mana Whenua positions on riparian planting	Improved aquatic and terrestrial habitat for native mahinga kai and taonga species.	Mana Whenua	Ongoing	Guidance included in Appendix 8.

4.3. Provide access for fishing activities and habitat for fish					
	Planting work that facilitates fishing activities and enhances fish habitat	The Waianakarua River supports a regionally important sports fishery, and important populations of native fish (including threatened and endangered species)	Central South Island and Otago Fish and Game Council, DoC	Ongoing	
	Consent conditions ensure that gravel extraction and physical works are undertaken in a way that does not damage habitat	The Waianakarua River supports a regionally important sports fishery, and important populations of native fish (including threatened and endangered species)	ORC, extractors and landholders	Ongoing	See Objective 3 also
	Encourage the creation of additional public access points	River-access opportunities are increased	ORC, WDC, Central South Island and Otago Fish and Game Council, landowners	Ongoing	
4.4. Adequate pest and weed control activities					
	Landowners (including LINZ) and other stakeholders work collaboratively to manage pest species	The Waianakarua River fairway and riparian margin are relatively free of pest species	Landowners, stakeholders, ORC	Ongoing	

4.5. Discourage dumping, and arrange the regular collection of rubbish					
	Collection of rubbish through regular/routine work at key locations. Signs warning of penalties for rubbish dumping to be erected if issues persist.	Improved visual amenity and enjoyment of recreational areas	WDC	Ongoing	
4.6. Protect and enhance the natural character of the Waianakarua River					
	Promote and encourage local restoration initiatives such as bank planting and wetland restoration	Riparian margins are planted/restored, look visually appealing, and provide aquatic and terrestrial habitat	Community and support from other agencies	Ongoing	

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Appendix 1. ORC river maintenance work within the Waitaki Special Rating District

Four locations (A, B, E, G) within the mapped river corridor have recently had works completed and two locations (C, D, F) have been identified as requiring work to maintain the fairway within its natural position (as mapped in Appendix 4) and/or to ensure the adequate conveyance of floodwater[14]. These locations are shown on Figure 20. These priority locations have been determined using the latest information available (April 2017) about specific locations that are experiencing river management issues. ORC intends commencing work at the three proposed locations during the 2017/2018 financial year. Ongoing observations and maintenance may also be required at some of these locations into the future.

This list and the need to undertake work at particular locations may change into the future, in response to flood events and to other river management issues that the community may identify through the process outlined in Section 2.3.

The river management work (outlined below) that is scheduled to take place in the Waianakarua River will need to consider the following:

- The principles outlined in Section 6
- The location and width of the natural river corridor and active fairway as described in Section 7, and other natural river processes as described in the strategy
- The objectives and associated activities listed in Section 7.3. In particular objective 2 (equip the community to live with the effects of changes in river morphology) and activity 2.3 (enable works that improve the conveyance of floodwater and 'train' the river within its natural corridor, without compromising features that are of high value to the community)
- The ecological, community and Māori values discussed in Section 4.

The increased program of work in the Waianakarua River and the development of river morphology and riparian management strategies for the Waianakarua and Shag Rivers; increased costs for the Waitaki Special Rating District (SRD) in the 2016/17 year. Revenue from rates within the SRD is projected to increase slightly from $350,000 in 2016/17 to $440,000 in 2019/2020, in order to fund additional in-stream work required to meet community river management expectations.

The dynamic nature of these two rivers and the inability to predict the timing or consequences of future flood events in the Waitaki District means there is a risk that this additional funding for river management work may still be insufficient. It is noted that all ratepayers within the Waitaki District contribute funding towards the Waitaki SRD.[15]

[14] Note that riparian management / planting work is not described here. As outlined in the overview section, it is intended that subsequent versions of the strategy will include further guidance and plans for undertaking planting on riparian margins, for river management purposes and for habitat enhancement.

[15] The river management rate is currently collected from 12,000 rating units across that part of the Waitaki District

The anticipated budget for river management operations (physical works) in the Waitaki SRD until 2020/21 is shown in Table 5 below. This shows that $259,000 is budgeted for this work during the 2017/18 year, up $47,000 from the previous year. As noted above, this budget is not solely for the Waianakarua River and includes other rivers in the Waitaki District, including the Shag, Kauru and Kākanui rivers.

Table 5. ORC river management budget for the Waitaki District

Year	ORC river management (operations) budget
2016/17	$212,000
2017/18	$259,000
2018/19	$324,000
2019/20	$332,000
2020/21	$341,000

Planned and Completed River Maintenance Work – Waianakarua River

A. Work completed at this location involved moving gravel to maintain the active channel fairway (Figure 20).

B. Work completed at this location involved moving gravel to maintain the active channel fairway (Figure 20).

C. Work at this location will involve spraying and controlling plants on the river bank and beaches (Figure 20).

D. The location will be monitored to prevent channel blockages from fallen vegetation. Older willows will be removed from the channel banks and replanted. Spraying will control invasive weed species along the banks of this reach (Figure 20).

E. Work completed at this location involved moving gravel to maintain the active channel fairway. This location will be monitored for possible gravel maintenance on the beach following significant build up (Figure 20).

F. Work at this location will involve spraying and controlling plants on the river bank and beaches. Plant clearing will maintain the active channel fairway, to enable clean flow (Figure 20).

G. Work completed at this location involved spraying and plant clearing to maintain the active channel fairway (Figure 20).

There are many locations along the river fairway where ORC will provide on a case by case basis; trees for planting within the corridor, to help prevent bank erosion and migration of the river from its fairway path.

which lies within the Otago Region, at a rate of 0.00007728 cents per $1 of capital value.

Figure 20. Locations of completed and proposed operations work along the Waianakarua River.

Appendix 2. Gravel accumulation areas

There are a number of areas within the Waianakarua riverbeds where gravel tends to accumulate. These areas can change position in response to flood events, land use, and sediment inputs. Currently there are multiple areas of natural gravel accumulation, one at the confluence of the north and south branches of the river, another approximately 900 metres downstream of the confluence, on the north branch within Sharps Bend and another on the south branch upstream of Herbert-Hampden road, as mapped in Figure 21. Commercial gravel extraction may be possible in these areas, provided it can be shown to be sustainable, will meet the values and principals outlined in this strategy, and can be managed in such a way as to not have negative effects on the river system.

Areas identified as having community values of high significance which may be negatively affected by gravel extraction, or where extraction will likely have negative effects on riverbed morphology have also been identified (shaded pink in Figure 22).[16] In these areas, large-scale gravel extraction is generally not appropriate, unless there are exceptional circumstances. These reaches include the river mouth and selected areas downstream of the confluence (between the North and South branches); between SH1 and the confluence along both branches and the upper reaches of the strategies area.

Sections of river where small-scale gravel accumulation may occur in localised areas have also been mapped (shaded blue in Figure 22). Gravel may accumulate on smaller pocket beaches (often found on the inside of meander bends) but is generally not available in significant quantities.

When gravel extraction or other river management work is being considered within the river corridor, it should be undertaken with reference to the information provided in this strategy. This includes the mapped fairway and corridor lines (Appendix 4) and the areas mapped in Figure's 21 and 22.

[16] It is noted that other sections of the river (outside those shaded yellow) also have a wide range of important community values which should be considered when assessing proposed gravel extraction activities.

Figure 21. **Areas where gravel tends to naturally accumulate in the Waianakarua River.**

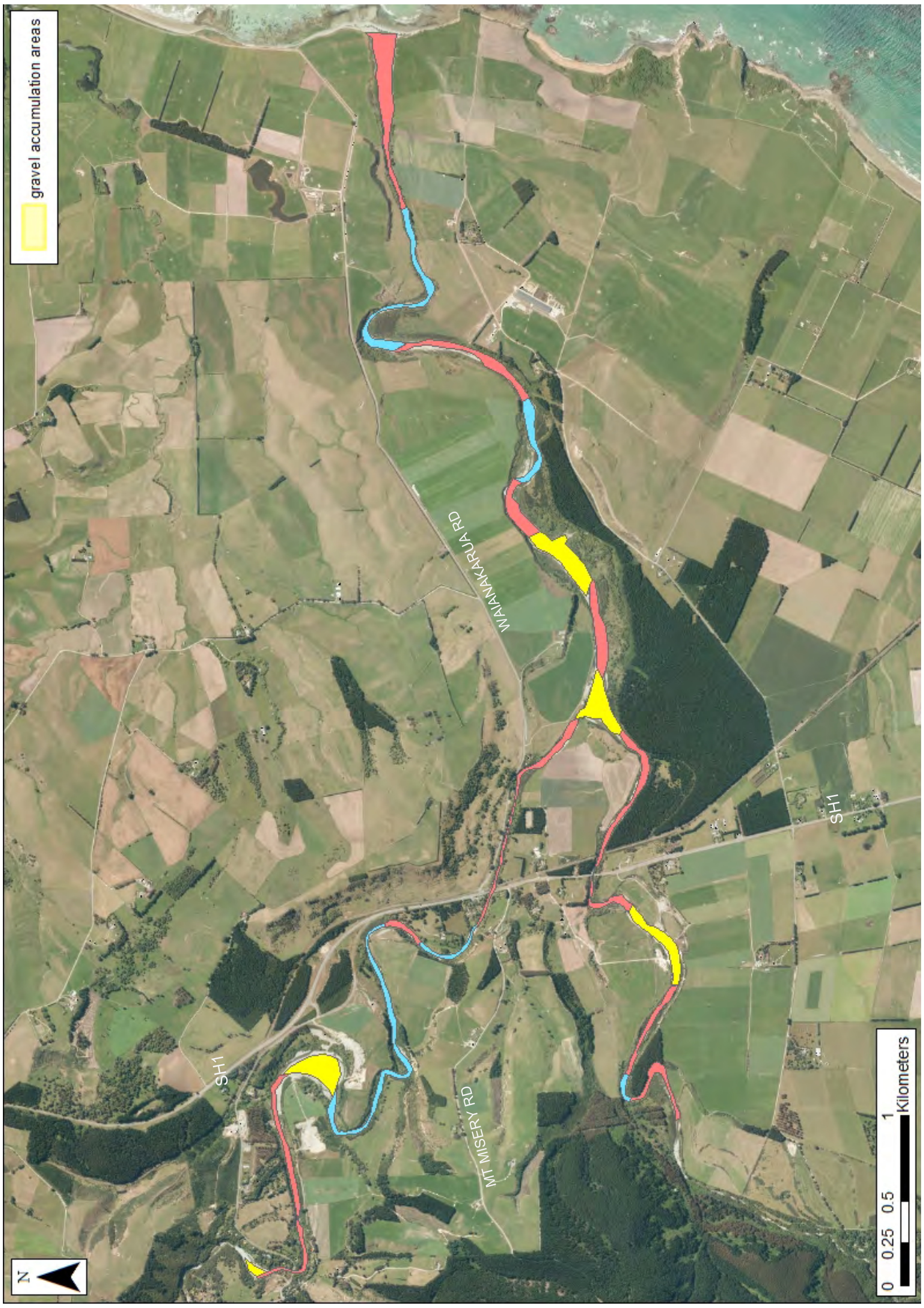

Figure 22. **Areas of natural gravel accumulation (yellow); areas where community values could be significantly affected by gravel extraction or where changes in river morphology such as bed degradation and bank erosion are occurring (pink); and areas where small-scale, localised gravel accumulation may occur (blue).**

Appendix 3. Planting guide

Benefits of riparian planting[17]

The benefits of well-planned and well-managed riparian planting areas on farms are considerable, and include:

- Increasing the quality and health of waterways
- Increasing the ability to filter nutrients before they reach waterways – Nitrogen, Phosphorus, and bacteria/viruses e.g. *E.Coli*
- Reducing sediment runoff and anchoring banks
- Reducing soil erosion of banks in waterways
- Providing shade, which reduces waterway temperatures and shelter for stock
- Minimising stock losses as animals are excluded from riparian strips by fences
- Increasing biodiversity – aquatic life, native plants, birds and insects
- Improving recreational opportunities (e.g. fishing)
- Enhancing and beautifying the river margins.

Both native and exotic species can be suitable for riparian planting. The species to be used will depend upon many factors, including environmental factors (exposure, soils, etc.) but also the width of the riparian strip, the height of plantings that is desired, and personal preference.

Using trees to stabilise stream banks[18]

Exotics

The most effective trees for stream bank erosion control are exotic willows and poplars. These are planted as stakes (less than 1 m high) or poles (1.5 – 3 m in height). Avoid invasive spreading species, such as crack willow, weeping willow, silver poplar and all non-sterile tree and shrub willows. Before planting fast-growing trees, consider their longer-term maintenance needs.

Winter is the best time to plant these species before stakes or poles sprout new growth. Plant about a third of the length below ground. On waterlogged ground, you can force them in by hand. On firm ground, you may be able to sharpen poles at one end and drive them in with a rammer or use a post auger. Stakes can be planted by putting them into a hole made

[17] Adapted from KCCP planting guide (2015)
[18] Adapted from ORC (2005)

with a length of reinforcing rod or similar. The most important thing is to make sure stakes and poles are firmly planted.

Guide to planting willow poles

Storage

It is recommended that poles are planted as soon as possible following delivery. Poles can be stored for a few weeks in water, standing up in a water trough or pond/creek. The bottoms of the poles should be kept wet to keep them alive and absorbing water. Poles should be stored away from stock.

Planting

Poles should ideally be planted on the outside of river bends, or sections of river where erosion is occurring. Plant poles in rows with 2 – 3 m spacing between them. Poles need to be planted 300-500 mm deep. Try and plant down to ground water level. Either a crow bar, post-hole borer or tractor forks/digger with a spike can be used to make a hole in the ground that the pole can be dropped into, and then packed firm.

Looking after plantings

Fence planting off from stock to protect plants; plant protectors can also be purchased and can help give protection. It is recommended that poles are watered the day after planting and at least once a week during dry weather until they are established.

To stabilise banks:

- Pair-plant along straight reaches – one tree on one bank, one tree on the opposite bank, five to seven meters apart
- Plant at two to three metre spacing at critical points, such as the outside of the bends where erosion is the greatest
- Avoid planting on the inside of bends – soil builds up rather than erodes here, so trees will trap sediment and force current against the outer bank
- Avoid planting narrow channels where trees might impede floodwaters.

By the time trees are four or five years old, there will be a solid mass of roots along the bank. At 10 to 20 years, trees can be thinned to 10 to 12 metre spacing, but no wider. If you use sleeves on poles to protect the willows and poplars, sheep can be grazed around the trees from the time they are planted.

Natives[19]

There are many advantages of utilising native plants. These include:

- Enhancing natural character and landscape values
- Forming a habitat corridor and potentially ecological linkage in the catchment
- Restoration of rare riparian forest (and other habitats)
- Creating/enhancing habitat for native birds and invertebrates (including pollinators)
- Restoration or enhancement of threatened plant habitats
- Do not grow as high or require maintenance (e.g. pruning or thinning)
- Self-regenerating and maintaining.

Planting natives for bank stability will enhance the natural biodiversity of your riparian margin and provide habitat for invertebrates and birds. While exotic tree species are proven to stabilise banks, new research shows that native trees, such as ribbonwood, cabbage tree and pittosporum species, are suitable for bank stabilisation. These species are deep rooting, with a good root spread. Planting native species alongside exotics will help to maintain a mostly native planting on your banks.

Tables 6 through 9 list suitable native vegetation to plant in the Waianakarua catchment, including trees, shrubs, tussock, and rare species. Guidance for the establishment of riparian buffer zones along reaches of the Waianakarua River is provided in Appendix 4 and Section 8.1 and 8.2. Additional technical assistance for identifying critical areas in need of plantings or vegetation management to improve bank protection can be provided by ORC staff or Fish and Game (Central South Island Council).

[19] Information on native planting provided curtesy of DoC

Table 6. Suitable native species for the Waianakarua catchment (trees)

Common name	Scientific name	Mix of plants[20]
Black mapou/kohuhu	Pittosporum tenuifolium	major
Lemonwood	Pittosporum eugenoides	major
Lowland ribbonwood	Plagianthus regius	major
Narrow-leaved lacebark	Hoheria angustifolia	major
South island kowhai	Sophora microphylla	major
Cabbage tree	Cordyline australis	major
Broadleaf	Griselinia littoralis	moderate
Marbleleaf	Carpodetus serratus	moderate
Manuka	Leptospermum scoparium	moderate
Chatham Island akeake	Olearia traversii	moderate
hybrid olearia	Olearia x dartonii	moderate
Silver beech	Lophozonia (Nothofagus) menziesii	major
Red beech	Fuscospora (Nothofagus) fusca	moderate
Mountain beech	Fuscospora (Nothofagus) cliffortioides	moderate
Kahikatea	Dacrycarpus dacrydioides	minor
Mountain totara	Podocarpus hallii	minor
Matai	Prumnopitys taxifolia	minor

[20] The major, moderate or minor is intended to direct the numbers/mix of plants used in a riparian/restoration planting. Therefore the bulk of the plants would compose the 'major' species, with some of the 'moderate' species and only a few of the 'minor' species. The species mix may be in the order of 10 of a 'major' species to 5 of a 'moderate' species to 1 of a 'minor' species.

Table 7. Suitable native species for the Waianakarua catchment (shrubs)

Common name	Scientific name	Mix of shrubs
Mingimingi	Coprosma propinqua	major
A coprosma	Coprosma dumosa/tayloriae	moderate
A coprosma	Coprosma rigida	moderate
Koromiko	Hebe salicifolia	major
Cottonwood	Ozothamnus vauvilliersii	moderate
Weeping mapu	Myrsine divaricata	minor

Table 8. Suitable native species for the Waianakarua catchment (tussock and tussock-like plants)

Common name	Scientific name	Mix of tussock and tussock like plants
Ballerina sedge	Carex secta	major
Toetoe	Austrodieria (Cortadieria) richardii	major
Lowland flax	Phormium tenax	major
Red tussock	Chionochloa rubra ssp. cuprea	moderate

Table 9. Suitable native species for the Waianakarua catchment (rare species)

Common name	Scientific name	Status
Pomahaka tree daisy	Olearia fimbriata	Nationally vulnerable
Hector’s tree daisy	Olearia hectorii	Nationally endangered

Linear-leaved tree daisy	Olearia lineata	At risk: declining
Fragrant tree daisy	Olearia fragrantissima	At risk: declining
Bloodwood	Coprosma wallii	At risk: declining
Teucridium	Teucridium parvifolium	At risk: declining

General planting tips

- Natives are preferable for the natural character of our landscapes; however, properly chosen exotics, which should not be a weed risk, can be more functional.
- Consider what environment you're planting in; the values you and others have in the waterway environment and what species are needed to achieve these. Some species achieve bank stabilisation in larger waterways (i.e. willows), however block smaller streams and affect the connectivity of flow. Consider the use of natives instead for small streams/creeks and planting natives alongside exotics in larger waterways.
- Winter is the best time to plant exotics (including willows and poplars), before stakes or poles sprout new growth. Importantly, stakes and poles should be firmly planted, with a third of the length below ground.
- The wider the riparian strip that is created and planted, a wider range of benefits will be achieved.
- Riparian strips can be of variable width dependent upon site factors such as access for machinery, height above the river (and flood levels), topography, and soils. An example being that wet areas or depressions behind a river bank or levee should be included, as sediments and nutrients may leak into the river.
- Habitat strips/wildlife corridors need to be wider than 5 m (ideally at least 8 m) in order to incorporate the equivalent of three rows of plantings.
- Plantings can be either in rows or randomly scattered to give a more natural appearance. The scattering of plants and natural appearance is more important for restoration plantings and Habitat strips/wildlife corridors.

- Closer plant spacing will provide greater mutual shelter, and so achieve faster growth, however will require more plants and therefore greater cost. They may also require some thinning later. This balance needs to be considered.

- When planting natives for bank stabilisation, plant at 1.5 – 3 metres spacing.

- The clear felling of existing vegetation and the creation of bare patches should be avoided when planting. Significant bank erosion can result after the removal of vegetation which previously binded the soil. Such practices should be avoided until the root systems of new plantations have become fully established.

- Riparian margins should provide a wide variance of habitat and function. As a part of a wider matrix of habitats in the landscape, creates overhanging or drooping vegetation and shaded pools.

- Additional advice on your site may be available from ORC, Fish and Game, DoC, local nurseries, websites and publications.

Tips for maintaining riparian margins

- Riparian margins should be maintained proactively, to ensure the best chance of planting success. Weed species are often fast growing and can quickly outcompete riparian plantings. Failure to carry out weed management can inhibit the growth and success of riparian plantings.

- Older tree species need to be maintained to prevent blockages and localised flooding associated with limbs and/or trunks that have fallen into the channel. This includes the removal of rotten limbs and large overhanging limbs which are unsupported.

Appendix 4. River corridor: maps

The river fairway and corridor mapping provides guidance for multi-purpose river management, and for the design and implementation of management measures, protection works and in-channel design. When physical works or activities are being considered within the fairway or on the riparian margin, these should be undertaken with reference to the mapped fairway and buffer zones. The method used to define the river corridor is explained in Section 7.

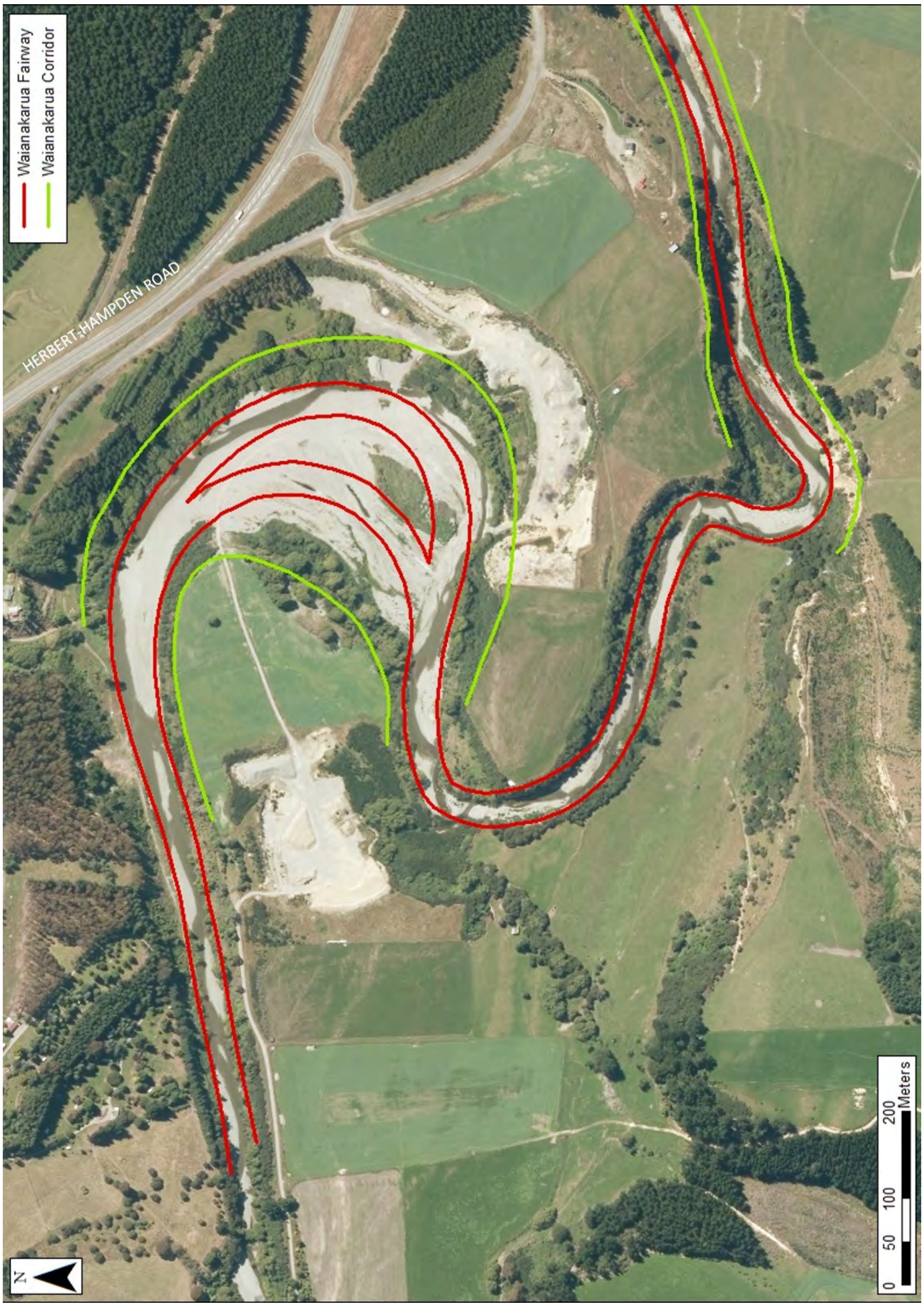

Figure 23. Waianakarua River fairway and corridor Map 1 (aerial photography collected 2014).

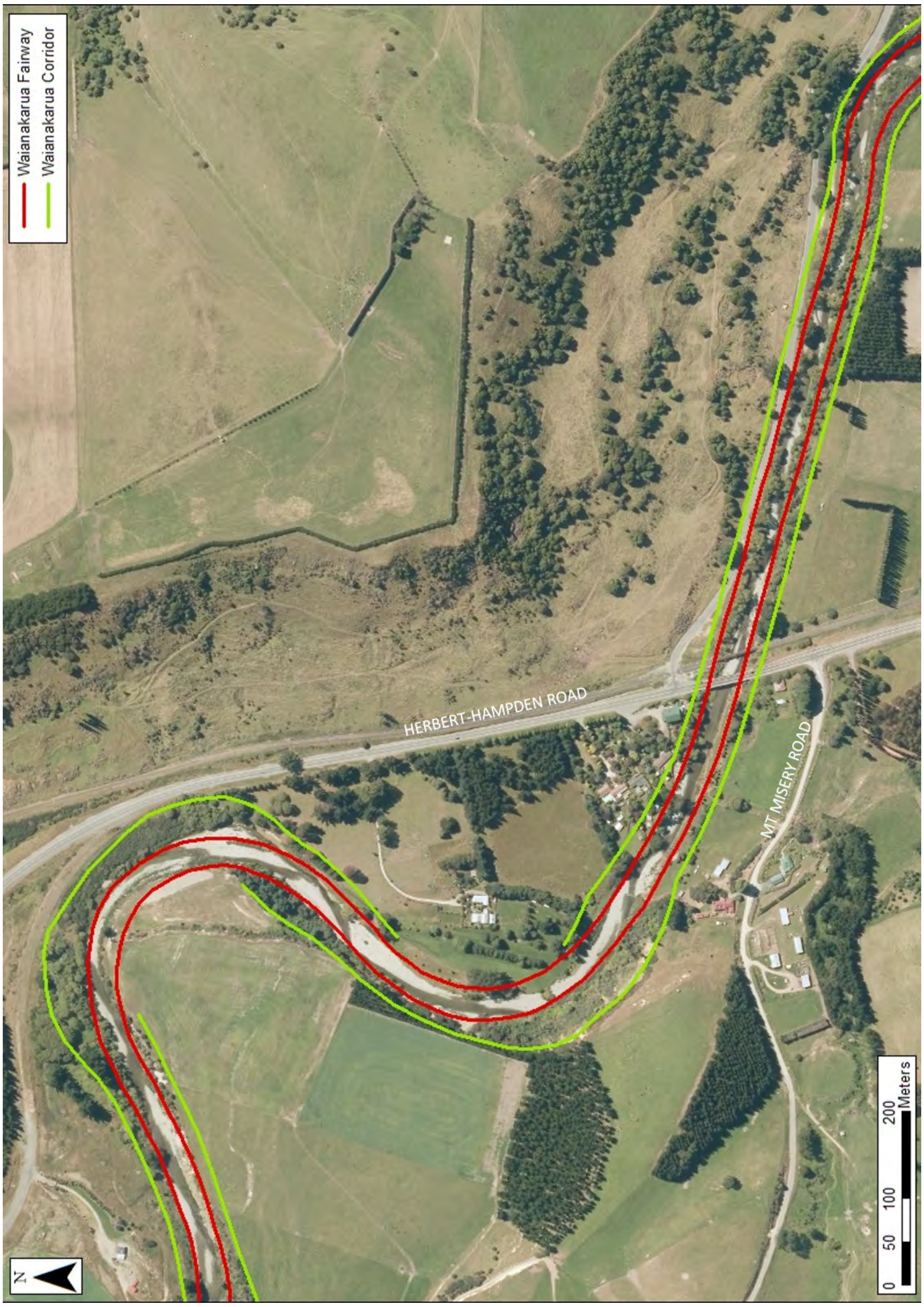

Figure 24. Waianakarua River fairway and corridor Map 2 (aerial photography collected 2014).

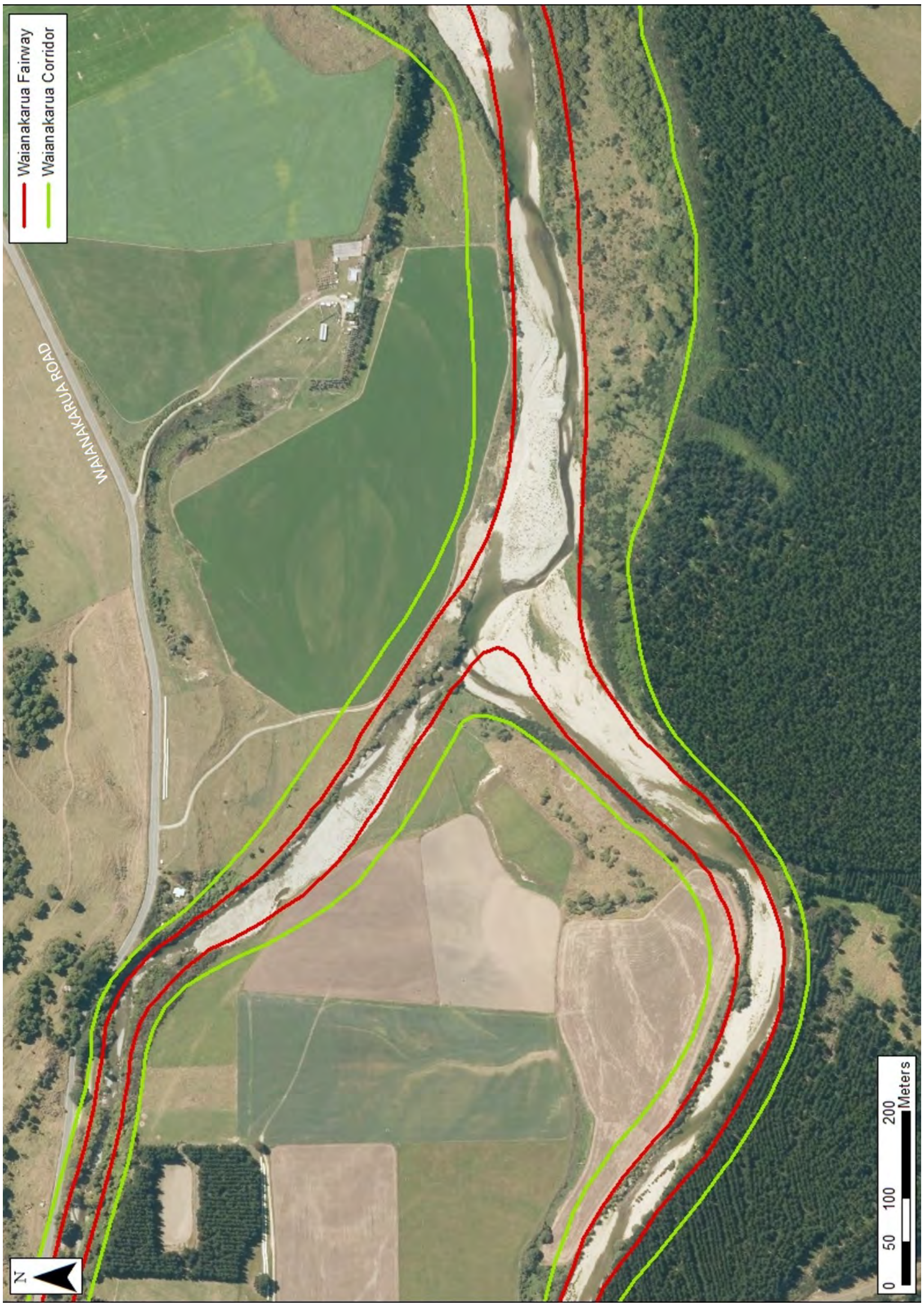

Figure 25. Waianakarua River fairway and corridor Map 3 (aerial photography collected 2014).

Figure 26. Waianakarua River fairway and corridor Map 4 (aerial photography collected 2014).

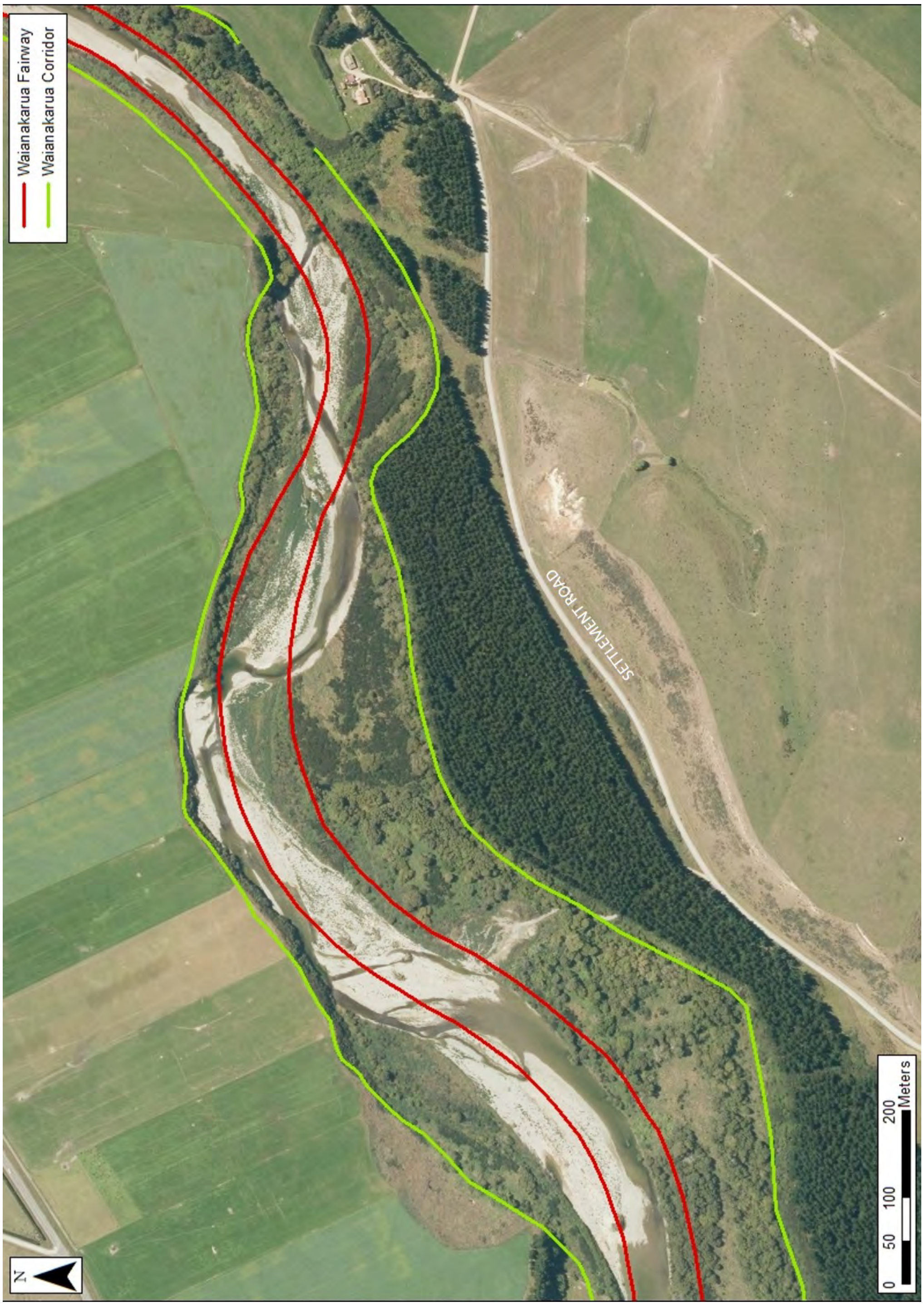

Figure 27. Waianakarua River fairway and corridor Map 5 (aerial photography collected 2014).

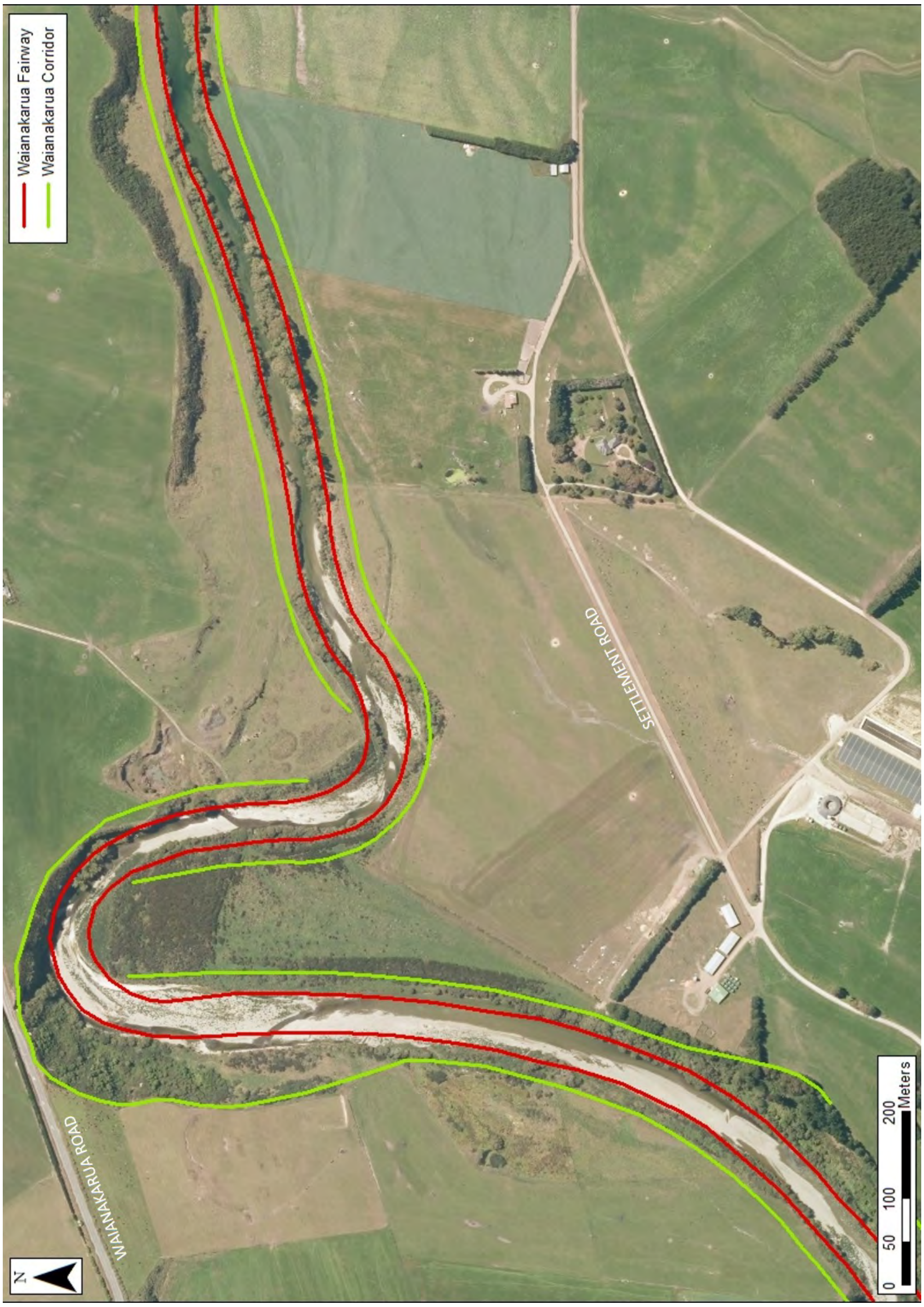

Figure 28. Waianakarua River fairway and corridor Map 6 (aerial photography collected 2014).

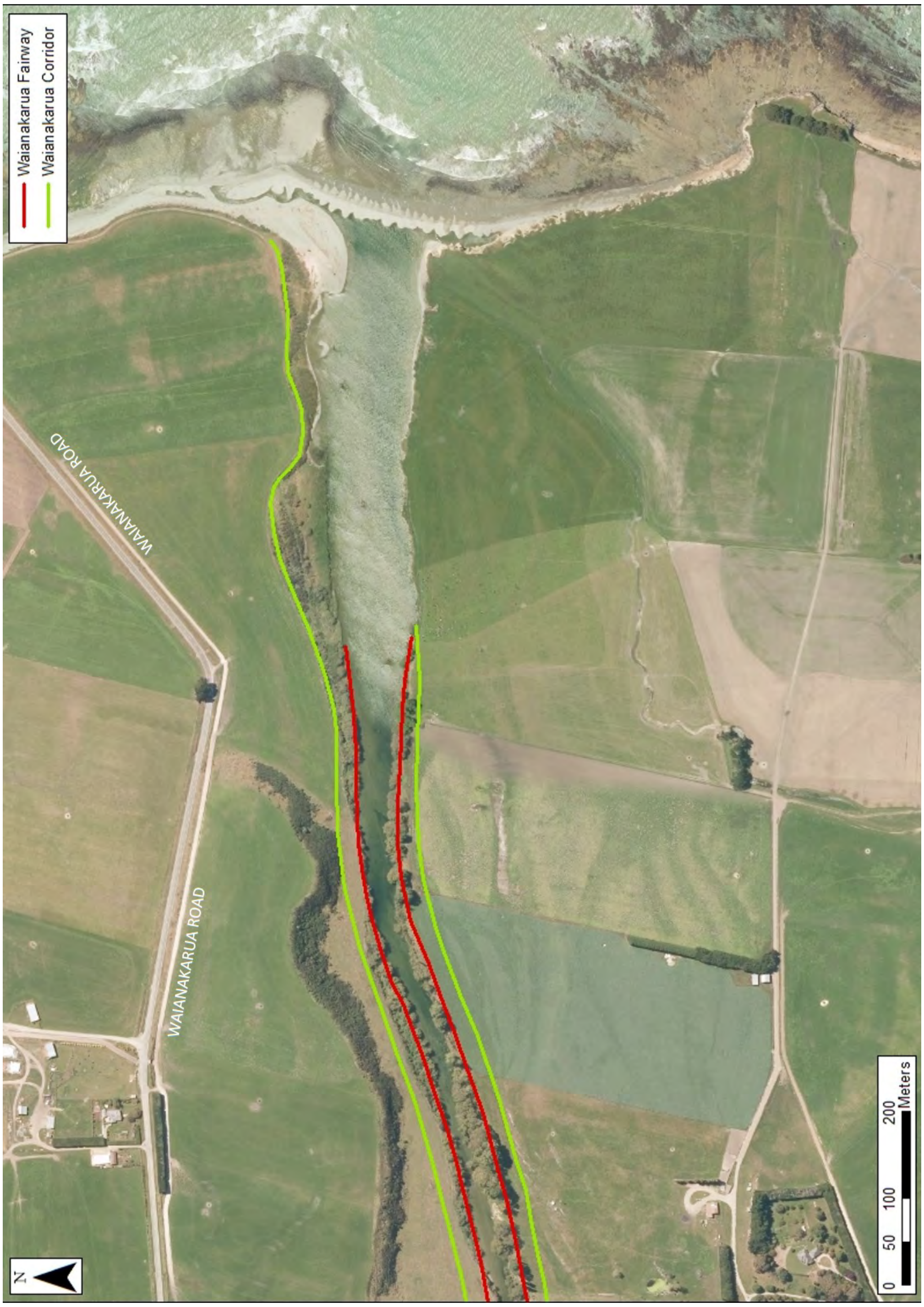

Figure 29. **Waianakarua River fairway and corridor Map 7 (aerial photography collected 2014).**

Appendix 5. Mapped community values

The maps in this section show the location of important values associated with the riverbed and riparian margins, as identified by the community and other stakeholders. The community consultation process is outlined in Section 4, Appendix 6 provides a summary of public submissions and Appendix 7 provides actual comments and summarised feedback from landowners and stakeholders.

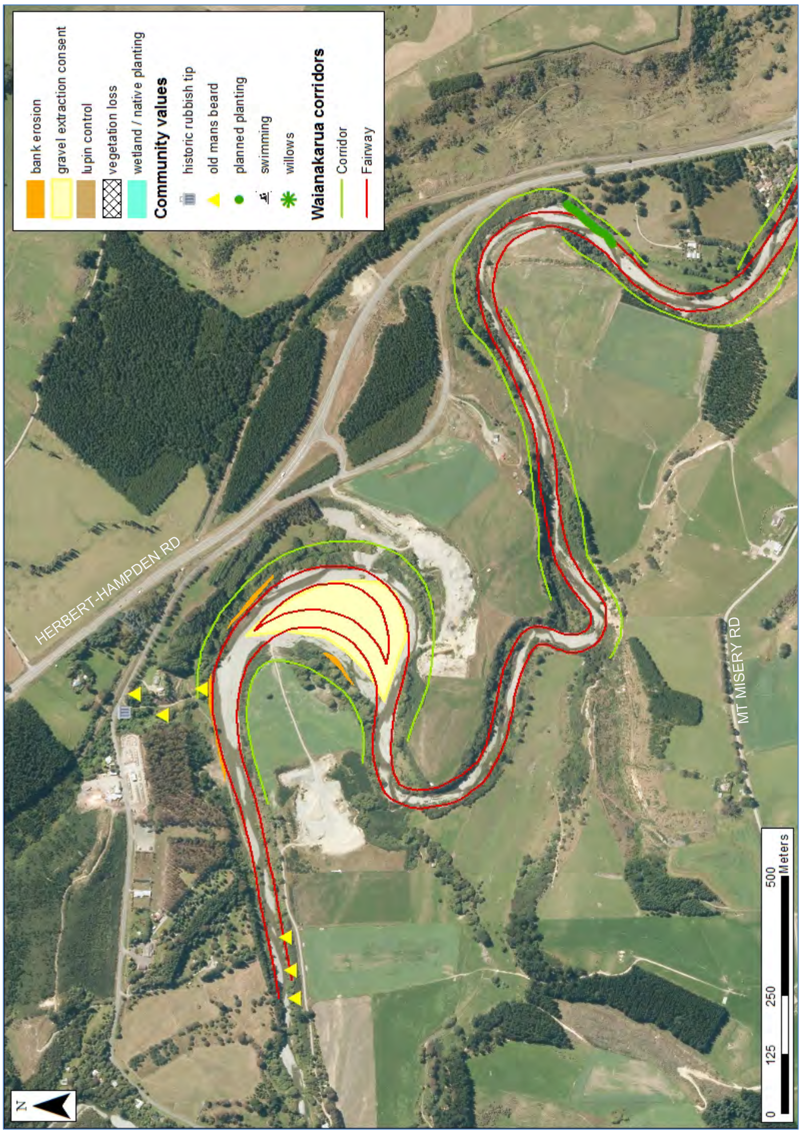

Figure 30. Mapped community values in the Waianakarua River Map 1 (aerial photography collected 2014).

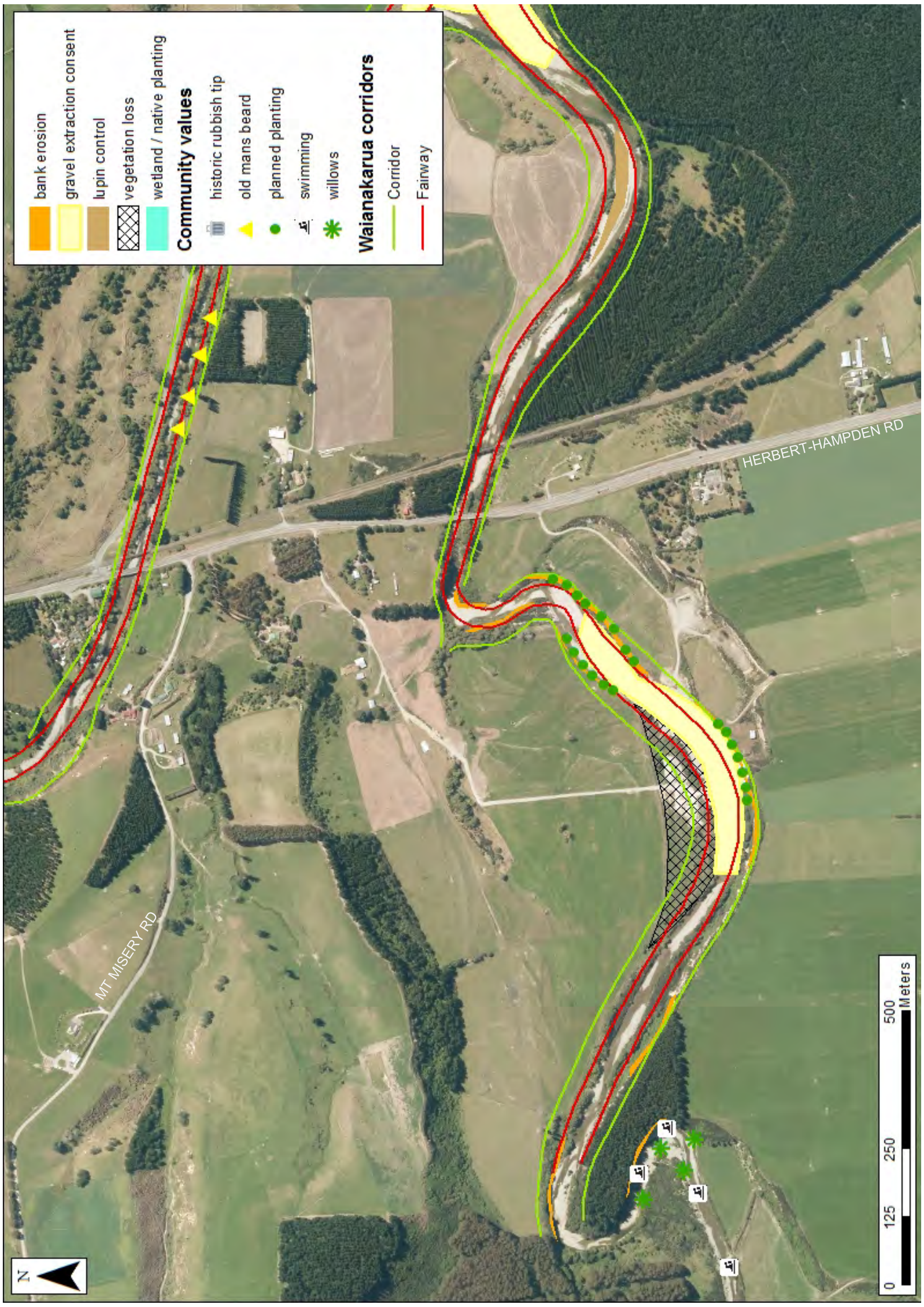

Figure 31. **Mapped community values in the Waianakarua River Map 2 (aerial photography collected 2014).**

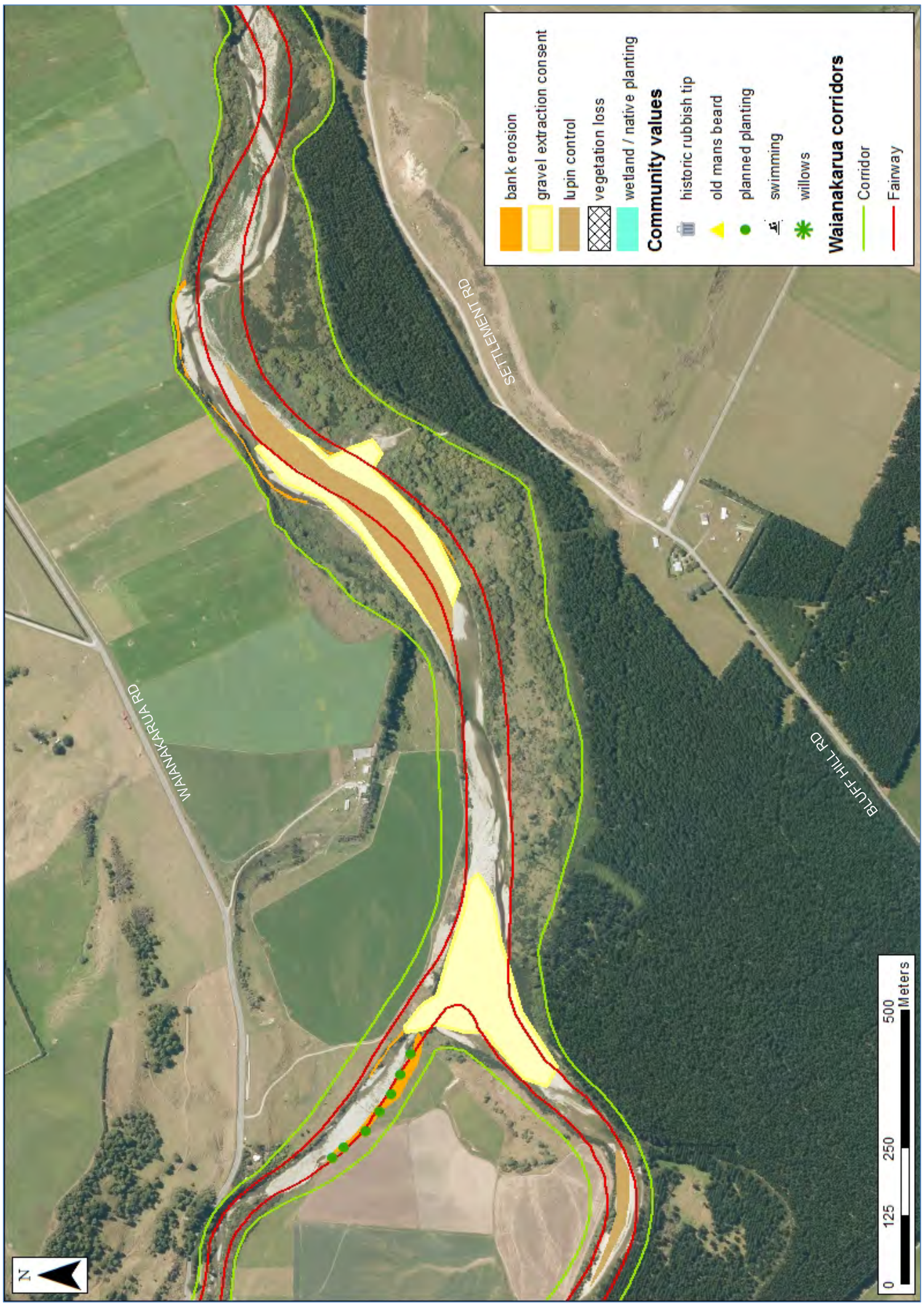

Figure 32. Mapped community values in the Waianakarua River Map 3 (aerial photography collected 2014).

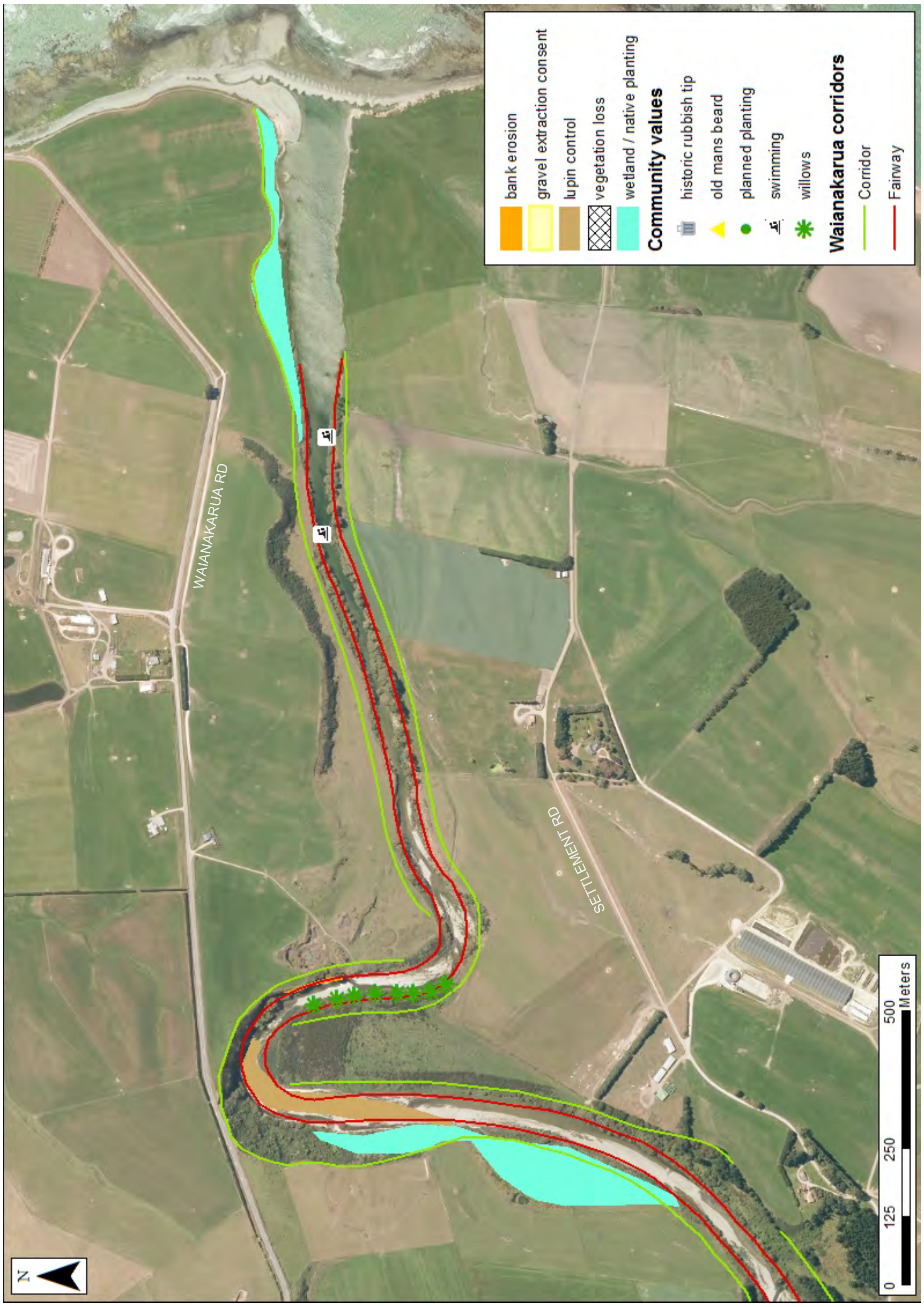

Figure 33. Mapped community values in the Waianakarua River Map 4 (aerial photography collected 2014).

Appendix 6. Community consultations – public submissions

The community consultation in October 2016 included an opportunity for the public to submit on their concerns, as well as a chance to state what they valued about the river and what they would like the strategy to achieve. A diverse range of views and concerns were put forward; some people were concerned about gravel build-up and decline in tree protection, while others were more concerned with the apparent increase in old man's beard, deterioration of supposed īnanga breeding locations, gravel beach spraying, water quality and leachate from the historic rubbish dump. The river channel should be able to shift laterally within an identified riparian margin. The prevention of erosion to land beyond the river margin and the containment of the main flood flows within the channel, were also highlighted. Residents wanted to be made aware of when weed spraying on the gravel beaches is to occur, this will be taken into account when and as this work progresses. There was some concern that gravel build-up on the true right of the north branch just before confluence has been causing high flows to ruin recently planted trees/protection work. There was further concern that upstream from Sharpe's Bend; sprayed/dead willows have been replaced with old man's beard or similar climbing plants, influencing the aesthetics of the river. Basalt boulder pools around Sharpe's Bend in the north branch of the Waianakarua River were remembered by some locals as a great breeding spot for īnanga back in the 1980-90s. Residents are worried that a decline in water quality and gravel accumulation in these pools has deteriorated the habitat.

Appendix 7. Community values - feedback from landowners and stakeholder groups

As discussed in Section 4, discussions were held with treaty partners, landowners and stakeholders in 2016-mid 2017. The consultation was framed around two particular topics: i) what concerns they have about the form and function of the Waianakarua River, and ii) how they would like the rivers to look in the future.

This section provides specific comments, and summarised feedback in response to these questions from landowners, DoC, the Waitaki Branch of Forest and Bird and the Central and Otago Fish and Game Councils.

1. The ability of the river to support social, spiritual, recreational and economic values.

- Landowners valued fishing the lower reaches of the Waianakarua River for whitebait and flounder.
- The river is a source of mahika Kai (specifically lamprey, short-fin eel and long-fin eel).
- Locally valued trout fishery.
- Surveys (i.e. the National Angler Survey 2016) show an increased usage of the river since the 2001/02 survey for fishing.

2. River form: riparian plantings, vegetation and fencing

- Want willows to stabilise banks and not result in blockages of the channel which impede flood flows. Can exacerbate flooding in certain reaches due to rapid growth.
- Want to see the benefits of retiring pastoral land for riparian plantings. Concern over using land for riparian plantings. 10-15m is a lot of grazing land lost.
- A preference for native trees rather than exotics such as willows for stabilization purposes.
- Want plantings to be the primary tool for bank stabilisation.
- Concern that willows don’t provide the same quality habitat as native plant species.
- If exotic trees are necessary, only sterile ad non-invasive species are wanted.
- Want riparian plantings in the lower/mid reaches to provide for whitebait habitats.
- Stock should be excluded from riparian margins to improve the effectiveness of the riparian plantings; protect whitebait habitats; and to reduce the effects on bank stabilisation and water quality.

- In addition to improving the amenity values of the area, riparian plantings can help filter nutrients, act as sediment traps, anchor banks, and provide habitat for both terrestrial and aquatic species.
- Certain riparian species are invasive and costly to manage in the long run; therefore careful selection of species needs to be made.

River form and function: human modification

- Landowners want to ensure that personal gravel takes will be beneficial for the river morphology. Stated that they needed to be able to trust the document.
- Concern that flood issues will just move downstream and that the river will still flood, despite ORC's homework (value careful modification of the river)
- Hard structures should be used as a last resort for land stabilisation and should utilise more natural features (such as piled gravel which is then replanted) to improve the aesthetic look.
- Adequate river flows and appropriate substrate enables spawning success.
- Over extraction of gravel removes potential spawning sites and limits spawning success in a catchment. This has flow on effects on the success of the fishery and recreational opportunities.
- Gravel extraction should only occur in areas of natural accumulation.

4. River form: gravel accumulation

- Want to see surface water flow through areas of high gravel accumulation (where flow can be predominantly through the sub-surface.
- Large gravel beaches have accumulated in the lower reaches of the Waianakarua.

5. River form and function: management education

- Landowners want to know the purpose of willows.
- What is the purpose of controlling weeds on the river banks?
- Ensuring works are appropriately timed, to consider ecological cycles.
- Gravel and substrate plays an important role in ecosystem functions.

Appendix 8 Consultation with Aukaha

Cultural Values Report, Aukaha 2018

Cultural Values Report

Waianakarua Morphology and Riparian Management Strategy

Contents

Introduction

Otago Regional Council (ORC) has asked Aukaha to provide feedback on its draft Waianakarua Morphology and Riparian Management Strategy (the Strategy) on behalf of Mana Whenua.

Aukaha writes this report on behalf of Te Rūnanga o Moeraki, the kaitiaki Rūnanga for the Waianakarua. The purpose of this report is to describe cultural values in the Waianakarua catchment and provide recommendations on how to recognise these values in the Waianakarua Morphology and Riparian Management Strategy.

Mana Whenua Values and Perspectives on Freshwater

Ko te wai te ora ngā mea katoa. Water is the life giver of all things.

Ngāi Tahu see water as a taonga left by the ancestors to provide and sustain life. Water plays a significant role in Ngāi Tahu spiritual beliefs and cultural traditions, the condition of water is seen as a reflection of the health of Papatūānuku. The ability to gather and share food, which is a cornerstone of Ngāi Tahu society, tradition and mana is reliant on healthy ecosystems and especially water that is fit for human consumption and that is able to support mahinga kai species (KTKO, 2005; Tipa and Nelson, 2013).

Ngāi Tahu have a holistic view of environmental management that recognises the intrinsic relationship between the survival of natural resources and the way they are managed and used. Ngāi Tahu have a kaitiaki responsibility to ensure that resources are preserved for future generations – *mō tātou, ā mō kā uri, ā muri ake nei*.

Kaitiakitanga

Kaitiakitanga is the responsibility of Mana Whenua to ensure that the life-supporting capacity (mauri) of the natural resources of their takiwā is sustained. Te Rūnanga o Moeraki are the kaitiaki Rūnanga of the Waianakarua, and are responsible for ensuring that natural resources in the catchment are available for Ngāi Tahu to use now and in the future (KTKO, 2016).

Mahinga kai

Mahinga kai is a cornerstone of Ngāi Tahu cultural identity. Mahinga kai is a term that literally means “food workings” and refers to the places where food is gathered or produced, the traditions and collection methods associated with gathering natural resources for cultural use and the resources themselves. For Ngāi Tahu Whānui today, participation in mahinga kai activities is an important expression of cultural identity. Continuation of traditional practices is an important means of passing values down to children and grandchildren, ensuring their survival through the generations. This is expressed in the Ngāi Tahu proverbial saying - "Mō tātou, ā mō kā uri i muri ake nei - for us and for the generations that come after us". Healthy waterbodies continue to be a direct source of mahinga kai. Ensuring the health and wellbeing of freshwater is a prerequisite for ensuring the continued health and wellbeing of mahinga kai resources and ultimately the people (Te Rūnanga o Ngāi Tahu, 2002; KTKO, 2005; KTKO, 2016).

Ki uta ki tai

Mana Whenua believe that a holistic approach should be taken to the management of the natural environment. This world view is articulated in the philosophy of 'Ki Uta Ki Tai', which is a holistic, culturally based 'mountains to the sea' natural resource management framework.

Mauri

All things, both living and non-living possess a mauri or life force. The primary management principle for Māori is the protection of the mauri of an ecosystem. If the mauri of the natural environment is degraded it no longer has the capacity to support cultural uses and values (KTKO, 2016).

Association with the Waianakarua

The Waianakarua River and estuary are recognised as culturally significant areas. They provide significant habitat for many wading bird species and kōhanga (nurseries) for juvenile fish such as pātiki, īnaka and kanakana.

The catchment forms part of a wider cultural landscape of ara tawhito (seasonal trails) along the East coast where whānau and hapū travelled gathering mahinga kai (KTKO, 2005).

Ngāi Tahu Claims Settlement Act 1998

The Ngāi Tahu Claims Settlement Act included as cultural redress a number of mechanisms to recognise and give practical effect to Ngāi Tahu mana over taonga resources and cultural landscapes. These include Taonga Species and Nohoanga.

Taonga species

The Ngāi Tahu Claims Settlement Act 1998 lists a number of species with which Ngāi Tahu are recognised to have a cultural, spiritual, historic and traditional relationship. The list of Ngāi Tahu Taonga Species is attached as Appendix 1. Ngāi Tahu do not see this list of species as exhaustive (KTKO, 2016).

Nohoanga

Nohoanga provide Ngāi Tahu with an opportunity to experience the landscape as their tīpuna (ancestors) did, and to rekindle the traditional practices of gathering mahinga kai.

The term nohoanga (literally meaning a place to sit) traditionally refers to the seasonal occupation sites which were an integral part of the mobile lifestyle of Ngāi Tahu Whānui as they moved around Te Waipounamu (the South Island) in pursuit of food and other natural resources (Te Rūnanga o Ngāi Tahu, 2017).

This traditional concept has been given contemporary effect as a result of the Settlement of the Ngāi Tahu Claim through the allocation of specific nohoanga sites to support mahinga kai activities.

Under the Ngāi Tahu Claims Settlement Act 1998, nohoanga sites are specific areas of Crown owned land adjacent to lakeshores or riverbanks, which can be used to facilitate the gathering of food and other natural resources by Ngāi Tahu Whānui. They are usually one hectare in size.

Ngāi Tahu Whānui (tribal members) have temporary, but exclusive rights to occupy these sites for up to 210 days a year between the middle of August and the end of April each year.

There is a nohoanga site on the Waianakarua River. The Waianakarua (Glencoe Reserve) nohoanga is located just west of Herbert, approximately 30mins south of Oamaru.

Figure 1: Waianakarua nohoanga site

Culturally significant sites

Ngāi Tahu has identified many culturally significant sites throughout their takiwā. Several of these sites are located within the Waianakarua catchment and the area the Strategy applies to. The locations of these sites is known by Ngāi Tahu and is not shared publicly. Sites throughout the Waianakarua are significant for their mahinga kai values, and several species including eels, lamprey, inaka (whitebait), pānako (a type of fern), and āruhe (fernroot) were gathered.

Other values for the area include kāinga nohoanga (settlements), kāinga mahinga kai (temporary settlements where people stayed seasonally while gathering mahinga kai) and place names that record tribal histories. Some significant sites in the Waianakarua carry the names of ancestors from the Ārai-te-uru waka that capsized off the coastline near Matakaea (Shag Point). After capsizing many of the passengers went on shore to explore the land, but they needed to be back at the waka before daylight. Most did not make it in time and instead transformed into many of the geographical features of Te Waipounamu.

Maori Archaeological Sites

The New Zealand Archaeological Association has recorded several Māori archaeological sites in the lower Waianakarua (see Figure 2 below). These include ovens, middens, rock shelters and sites where artefacts and other signs of occupation have been found.

Figure 2: Māori Archaeological Sites within the Waianakarua Catchment

Te Rūnanga o Moeraki aspirations relevant to the Strategy

Te Rūnanga o Moeraki have many aspiration for the rivers across their takiwā. The following Rūnanga aspirations are especially relevant for the Waianakarua catchment and to the Strategy:

- The waters of the Otago Catchment are healthy and support Ngāi Tahu customs
- To protect and restore the mauri of all water
- The rangatiratanga and kaitiakitanga of Ngāi Tahu is recognised and supported
- Ki uta ki tai management of catchments occurs
- Mahinga kai resources are healthy and abundant
- Enhancement of native fish populations and spawning areas
- That fish passage is provided for at all times
- To encourage the planting of native vegetation to help reduce erosion and provide habitat for taonga species

Issues for Te Rūnanga o Moeraki relevant to the Strategy

Te Rūnanga o Moeraki have identified the following issues as relevant to the Waianakarua catchment and the Strategy:

- Negative effects of gravel extractions including alteration of flow and gravel supply downstream, sedimentation, preventing fish passage and affecting freshwater species habitat
- Negative effects on spawning and nursery areas for native fish as a result of sedimentation and grazing (KTKO, 2005)
- Channelisation and channel modification activities are of particular concern to Ngāi Tahu (Te Rūnanga o Ngāi Tahu, 2002a)
- Lack of catchment-wide erosion and riparian management. Although this Strategy does not apply to the whole of the catchment, Te Rūnanga o Moeraki appreciate that it does intend to address issues in a holistic way within the area it applies to.

Recommendations

Te Rūnanga o Moeraki make the following recommendations:

- That a mihi be included at the beginning of the document.
- An introductory section introducing Mana Whenua, explaining who Ngāi Tahu is and who the kaitiaki Rūnanga are is included in the Strategy
- That Mana Whenua are recognised as Treaty partners rather than stakeholders.
- Native riparian vegetation is an important habitat for mahinga kai. This should be included in references to the value and benefits of planting riparian margins.

- That the following positions held by Te Rūnanga o Moeraki are included in this Strategy:
  - Native riparian planting by landowners is encouraged/supported by Te Rūnanga o Moeraki
  - Te Rūnanga o Moeraki prefer that taonga species are used for riparian planting where possible.
  - Where practicable, riparian vegetation should provide habitat for mahinga kai species such as īnanga spawning habitat.
  - Activities in the bed and on the banks of the river should not be undertaken during spawning seasons or during periods when native fisheries are considered sensitive.
  - That any fish disturbed/stranded during any works within any watercourse are rescued and returned/relocated to the watercourse.
  - That fish passage is provided for at all times. Many native freshwater species need to migrate upstream and downstream at different lifecycle stages.
  - That all practical measures are undertaken during works in the bed and on the banks of the river to minimise sedimentation in the waterway and impacts on taonga species and mahinga kai species.

Te Rūnanga o Moeraki and Aukaha staff will continue to work with ORC to incorporate these recommendations into the Waianakarua Morphology and Riparian Management Strategy.

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Appendix 1: Ngāi Tahu Claims Settlement Act Taonga Species

Taonga fish species		
Ingoa Maori	**English name**	**Scientific name**
Kāeo	Sea tulip	*Pyura pachydermatum*
Koeke	Common shrimp	*Palaemon affinis*
Kōkopu/Hawai	Giant bully	*Gobiomorphus gobioides*
Kōwaro	Canterbury mudfish	*Neochanna burrowsius*
Paraki/Ngaiore	Common smelt	*Retropinna retropinna*
Piripiripōhatu	Torrentfish	*Cheimarrichthys fosteri*
Taiwharu	Giant kōkopu	*Galaxias argenteus*

Taonga shellfish species		
Ingoa Maori	**English name**	**Scientific name**
Pipi/Kākahi	Pipi	*Paphies australe*
Tuaki	Cockle	*Austrovenus stutchburgi*
Tuaki/Hākiari, Kuhakuha/Pūrimu	Surfclam	*Dosinia anus, Paphies donacina, Mactra discor, Mactra murchsoni, Spisula aequilateralis, Basina yatei,* or*Dosinia subrosa*
Tuatua	Tuatua	*Paphies subtriangulata, Paphies donacina*
Waikaka/Pūpū	Mudsnail	*Amphibola crenata, Turbo smaragdus, Zedilom* spp

Taonga marine mammal species		
Ingoa Maori	**English name**	**Scientific name**
Ihupuku	Southern elephant seal	*Mirounga leonina*
Kekeno	New Zealand fur seals	*Arctocephalus forsteri*
Paikea	Humpback whales	*Megaptera novaeangliae*
Parāoa	Sperm whale	*Physeter macrocephalus*
Rāpoka/Whakahao	New Zealand sea lion/Hooker's sea lion	*Phocarctos hookeri*
Tohorā	Southern right whale	*Balaena australis*

Taonga bird species		
Ingoa Maori	**English name**	**Scientific name**
Hoiho	Yellow-eyed penguin	*Megadyptes antipodes*
Kāhu	Australasian harrier	*Circus approximans*
Kākā	South Island kākā	*Nestor meridionalis meridionalis*
Kākāpō	Kākāpō	*Strigops habroptilus*
Kākāriki	New Zealand parakeet	*Cyanoramphus* spp
Kakaruai	South Island robin	*Petroica australis australis*
Kakī	Black stilt	*Himantopus novaezelandiae*
Kāmana	Crested grebe	*Podiceps cristatus*
Kārearea	New Zealand falcon	*Falco novaeseelandiae*
Karoro	Black-backed gull	*Larus dominicanus*
Kea	Kea	*Nestor notabilis*
Kōau	Black shag, Pied shag, Little shag	*Phalacrocorax carbo, Phalacrocorax varius varius, Phalacrocorax melanoleucos brevirostris*
Koekoeā	Long-tailed cuckoo	*Eudynamys taitensis*
Kōparapara *or* Korimako	Bellbird	*Anthornis melanura melanura*
Kororā	Blue penguin	*Eudyptula minor*
Kōtare	Kingfisher	*Halcyon sancta*
Kōtuku	White heron	*Egretta alba*
Kōwhiowhio	Blue duck	*Hymenolaimus malacorhynchos*
Kūaka	Bar-tailed godwit	*Limosa lapponica*
Kūkupa/Kererū	New Zealand wood pigeon	*Hemiphaga novaeseelandiae*
Kuruwhengu/Kuruwhengi	New Zealand shoveller	*Anas rhynchotis*
Mātā	Fernbird	*Bowdleria punctata punctata* and*Bowdleria punctata stewartiana* and*Bowdleria punctata wilsoni* and *Bowdleria punctata candata*
Matuku moana	Reef heron	*Egretta sacra*
Miromiro	South Island tomtit	*Petroica macrocephala macrocephala*
Miromiro	Snares Island tomtit	*Petroica macrocephala dannefaerdi*
Mohua	Yellowhead	*Mohoua ochrocephala*
Pākura/Pūkeko	Swamp hen/Pūkeko	*Porphyrio porphyrio*
Pārera	Grey duck	*Anas superciliosa*

Pateke	Brown teal	*Anas aucklandica*
Pīhoihoi	New Zealand pipit	*Anthus novaeseelandiae*
Pīpīwharauroa	Shining cuckoo	*Chrysococcyx lucidus*
Pīwakawaka	South Island fantail	*Rhipidura fuliginosa fuliginosa*
Poaka	Pied stilt	*Himantopus himantopus*
Pokotiwha	Snares crested penguin	*Eudyptes robustus*
Pūtakitaki	Paradise shelduck	*Tadorna variegata*
Riroriro	Grey warbler	*Gerygone igata*
Roroa	Great spotted kiwi	*Apteryx haastii*
Rowi	Ōkārito brown kiwi	*Apteryx mantelli*
Ruru koukou	Morepork	*Ninox novaeseelandiae*
Takahē	Takahē	*Porphyrio mantelli*
Tara	Terns	*Sterna* spp
Tawaki	Fiordland crested penguin	*Eudyptes pachyrhynchus*
Tete	Grey teal	*Anas gracilis*
Tīeke	South Island saddleback	*Philesturnus carunculatus carunculatus*
Tītī	Sooty shearwater/Muttonbird/Hutton's shearwater Common diving petrel South Georgian diving petrel Westland petrel Fairy prion Broad-billed prion White-faced storm petrel Cook's petrel Mottled petrel	*Puffinus griseus* and *Puffinus huttoni* and*Pelecanoides urinatrix* and *Pelecanoides georgicus* and *Procellaria westlandica* and*Pachyptila turtur* and *Pachyptila vittata*and *Pelagodroma marina* and *Pterodroma cookii* and *Pterodroma inexpectata*
Tītitipounamu	South Island rifleman	*Acanthisitta chloris chloris*
Tokoeka	South Island brown kiwi	*Apteryx australis*
Toroa	Albatrosses and Mollymawks	*Diomedea* spp
Toutouwai	Stewart Island robin	*Petroica australis rakiura*
Tūī	Tūī	*Prosthemadera novaeseelandiae*
Tutukiwi	Snares Island snipe	*Coenocorypha aucklandica huegeli*
Weka	Western weka	*Gallirallus australis australis*
Weka	Stewart Island weka	*Gallirallus australis scotti*
Weka	Buff weka	*Gallirallus australis hectori*

Taonga plant species		
Ingoa Maori	**English name**	**Scientific name**
Akatorotoro	White rata	*Metrosideros perforata*
Aruhe	Fernroot (bracken)	*Pteridium aquilinum* var *esculentum*
Harakeke	Flax	*Phormium tenax*
Horoeka	Lancewood	*Pseudopanax crassifolius*
Houhi	Mountain ribbonwood	*Hoheria lyalli* and *H. glabata*
Kahikatea	Kahikatea/White pine	*Dacrycarpus dacrydioides*
Kāmahi	Kāmahi	*Weinmannia racemosa*
Kānuka	Kānuka	*Kunzia ericoides*
Kāpuka	Broadleaf	*Griselinia littoralis*
Karaeopirita	Supplejack	*Ripogonum scandens*
Karaka	New Zealand laurel/Karaka	*Corynocarpus laevigata*
Karamū	Coprosma	*Coprosma robusta, coprosma lucida, coprosma foetidissima*
Kātote	Tree fern	*Cyathea smithii*
Kiekie	Kiekie	*Freycinetia baueriana* subsp *banksii*
Kōhia	NZ Passionfruit	*Passiflora tetranda*
Korokio	Korokio Wire-netting bush	*Corokia cotoneaster*
Koromiko/Kōkōmuka	Koromiko	*Hebe salicfolia*
Kōtukutuku	Tree fuchsia	*Fuchsia excorticata*
Kōwahi Kōhai	Kōwhai	*Sophora microphylla*
Mamaku	Tree fern	*Cyathea medullaris*
Mānia	Sedge	*Carex flagellifera*
Mānuka Kahikātoa	Tea-tree	*Leptospermum scoparium*
Māpou	Red matipo	*Myrsine australis*
Mataī	Mataī/Black pine	*Prumnopitys taxifolia*
Miro	Miro/Brown pine	*Podocarpus ferrugineus*
Ngaio	Ngaio	*Myoporum laetum*
Nīkau	New Zealand palm	*Rhopalostylis sapida*
Pānako	(Species of fern)	*Asplenium obtusatum*
Pānako	(Species of fern)	*Botrychium australe* and *B. biforme*
Pātōtara	Dwarf mingimingi	*Leucopogon fraseri*
Pīngao	Pīngao	*Desmoschoenus spiralis*
Pōkākā	Pōkākā	*Elaeocarpus hookerianus*
Ponga/Poka	Tree fern	*Cyathea dealbata*
Rātā	Southern rātā	*Metrosideros umbellata*
Raupō	Bulrush	*Typha angustifolia*
Rautāwhiri/Kōhūhū	Black matipo/Māpou	*Pittosporum tenuifolium*
Rimu	Rimu/Red pine	*Dacrydium cypressinum*
Rimurapa	Bull kelp	*Durvillaea antarctica*

Taramea	Speargrass, spaniard	*Aciphylla* spp
Tarata	Lemonwood	*Pittosporum eugenioides*
Tawai	Beech	*Nothofagus* spp
Tētēaweka	Muttonbird scrub	*Olearia angustifolia*
Tī rākau/Tī Kōuka	Cabbage tree	*Cordyline australis*
Tīkumu	Mountain daisy	*Celmisia spectabilis* and *C. semicordata*
Tītoki	New Zealand ash	*Alectryon excelsus*
Toatoa	Mountain Toatoa, Celery pine	*Phyllocladus alpinus*
Toetoe	Toetoe	*Cortaderia richardii*
Tōtara	Tōtara	*Podocarpus totara*
Tutu	Tutu	*Coriaria* spp
Wharariki	Mountain flax	*Phormium cookianum*
Whīnau	Hīnau	*Elaeocarpus dentatus*
Wī	Silver tussock	*Poa cita*
Wīwī	Rushes	*Juncus* all indigenous *Juncus* spp and *J. maritimus*

Taieri River Morphology and Riparian Management Strategy (Strath Taieri)

Version 1.0 – May 2016

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Overview

The Taieri River morphology and riparian management strategy has been prepared by the Otago Regional Council (ORC), with input from the local community, to help protect the recreational, cultural and ecological values of the Taieri riverbed and to enable long-term sustainable use of the land that borders the river. The strategy, as summarised in the two diagrams overleaf, is intended to help achieve this by guiding work programs, decision making, and activities for the community, stakeholders, and ORC. It is therefore recommended that people who live, work or play within the Taieri River catchment consider, and give effect to, the principals, objectives, and actions listed in this strategy.

The strategy is not a statutory document; rather it is intended to present the aspirations of the community and the various stakeholder agencies. However, the statutory processes that do influence river management activities[1] are more likely to be used effectively and efficiently if there is a general consensus on what is valued about the river, with commonly understood objectives.

The strategy is intended to be a living document, which will evolve in response to new information, changes in the environment, the needs of the community, and the work of the ORC and other stakeholders. The strategy will be reviewed regularly, and this process will involve landowners with property alongside the river, other stakeholders, and ORC,[2] and will help to set priorities and work programmes for all of these groups. The strategy document will also record progress made towards achieving the stated objectives. It is intended that version 2 of the strategy will include further guidance and plans for undertaking planting on riparian margins, for river management purposes and for habitat enhancement.

[1] Including the Local Government Act (in regards to funding considerations), and the Resource Management Act (in regards to environmental effects)

[2] In particular, staff with responsibilities for river and waterway management and natural hazards

Otago Regional Council

Taieri River morphology and riparian management strategy - overview

Purpose

- To provide guidance to landowners, stakeholders, and the community for good decision-making and appropriate activities within the riverbed and on the riparian margins of the Taieri River.

Vision

- The long-term sustainable use and enjoyment of the Taieri River and its riparian margins.

Functions

Appropriate guidance and active engagement to empower good decision-making and to ensure that activities are undertaken in a sustainable and appropriate manner.

The wise use of resources to:
- Manage the risk to property and assets
- Enable sustainable gravel extraction
- Protect and enhance community values
- Improve community resilience.

Understand natural river processes and morphological characteristics, and the potential effects of those on the river and its margins.

A shared vision of the river's values and features to be utilised, preserved and enhanced.

Taieri River morphology and riparian management strategy - overview

Objectives & associated activities (these are further refined in Section 8 - implementation)

Objective 1.
To recognise and characterise natural river processes.

- Collect information about flood and erosion processes
- Report on changes in channel morphology
- Provide information to the community
- Identify the location of river corridors, within which the river will naturally meander.

Objective 2.
To equip the community to live with the effects of changes in river morphology.

- Promote land-use practices and the placement of assets that reduce the risk associated with changes in riverbed morphology
- Consider all available options to manage the effects of bank erosion, including structural and non-structural options
- Enable works that will, where necessary, improve the conveyance of floodwater and 'train' the river within its natural corridor, without compromising the features that are of high value to the community and iwi.

Objective 3.
To enable sustainable gravel extraction.

- Identify areas where gravel accumulation can naturally occur
- Identify areas where permanent removal of gravel may have a detrimental effect on assets, riverbed morphology or community values
- Identify minimum bed levels/profiles, below which extraction will not occur.

Objective 4.
To promote activities that enhance the natural character and enjoyment of the river.

- Provide maps showing the location and characteristics of features that are of high value to the community
- Encourage the establishment of riparian plantings that are practical and appealing
- Provide access and habitat for fishing and white-baiting activities
- Support pest and weed control activities
- Discourage dumping, and arrange the regular collection of rubbish.

Contents

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1. Introduction

Changes in the morphology (physical form) of riverbeds occur as a result of natural processes that are often uncontrollable, and also from human intervention. The Taieri riverbed is an integral part of the wider Taieri River catchment (Figure 1). The Taieri riverbed is part of a dynamic river system, and has experienced changes in morphology in recent decades. These changes will have occurred in response to naturally occurring flood events, as well as gravel extraction activities and historic river management decisions. Changes to riverbed morphology have included degradation[3] and sedimentation within the main channel and significant bank erosion in places (Figure 2). In some cases these changes have negatively affected the values placed upon the river by the community and stakeholders (landowners, iwi, Fish & Game New Zealand, Department of Conservation (DoC), Dunedin City Council (DCC), and residents).

Land alongside the river channel is often referred to as the ‘riparian margin’. More intensive use of the land that borders the river has occurred in recent decades, with valuable farmland replacing what was previously rough vegetation. As a result, changes in the position and form of the riverbed can cause issues for landowners and other river users.

The Otago Regional Council (ORC) has proposed the Taieri River morphology and riparian management strategy (‘the strategy’) to help provide guidance (for all users of the rivers) for good decision-making and appropriate activities on the riverbed and riparian margins of the Taieri River. The strategy has a vision of long-term sustainable use and enjoyment of the Taieri riverbed and its riparian margins. It is also important when undertaking activities within the riverbed and on the riparian margins of the Taieri River that people recognise, and allow for, the traditional, spiritual, and cultural values of the local iwi.

The strategy’s key objectives are to:

- Recognise and characterise the natural river and catchment processes that occur in the Taieri River
- Equip the community to understand, and live with, the effects of changes in river morphology
- Enable sustainable gravel extraction
- Promote activities that enhance the natural character and enjoyment of the river.

The strategy is also intended to guide the natural extent of land-use, so that the negative effects of morphological changes in the riverbed do not increase and, where possible, are progressively reduced. It provides a framework for decision-making, so that activities undertaken by people occur in such a way that result in:

- A visually appealing river system
- A habitat that supports existing wildlife, fish, and preferred plant species
- Limited effects on assets as a result of flood events
- Resilient infrastructure (roads, bridges, water supply).

[3] The term ‘degradation’ in this case refers to the wearing down of the channel by the erosive action of water

Otago Regional Council

Many of the actions listed in this strategy are voluntary and will rely on interactions between the key stakeholders and the community to be successful. It is therefore recommended that people who live, work, or play in the Taieri River catchment consider, and give effect to, the principles, objectives, and actions listed in the strategy.

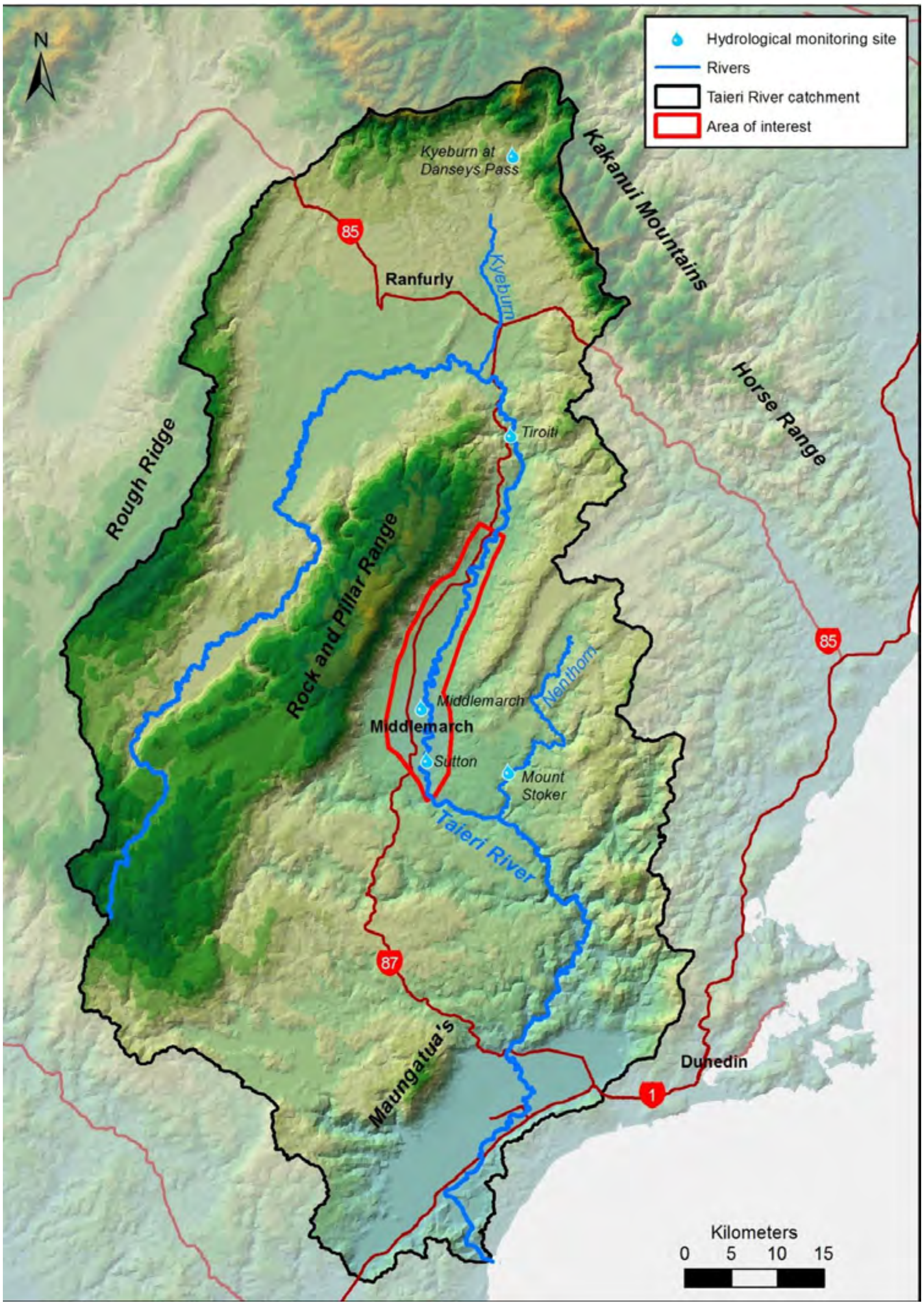

Figure 1. **Taieri River catchment boundary, showing main tributaries and the area of interest**

Figure 2. Examples of changes in channel morphology. Top: Bank erosion at 0.8 km downstream of the Moonlight Road bridge (November 2015); bottom: bank erosion and channel migration 5 km upstream of Ngapuna (November 2015)

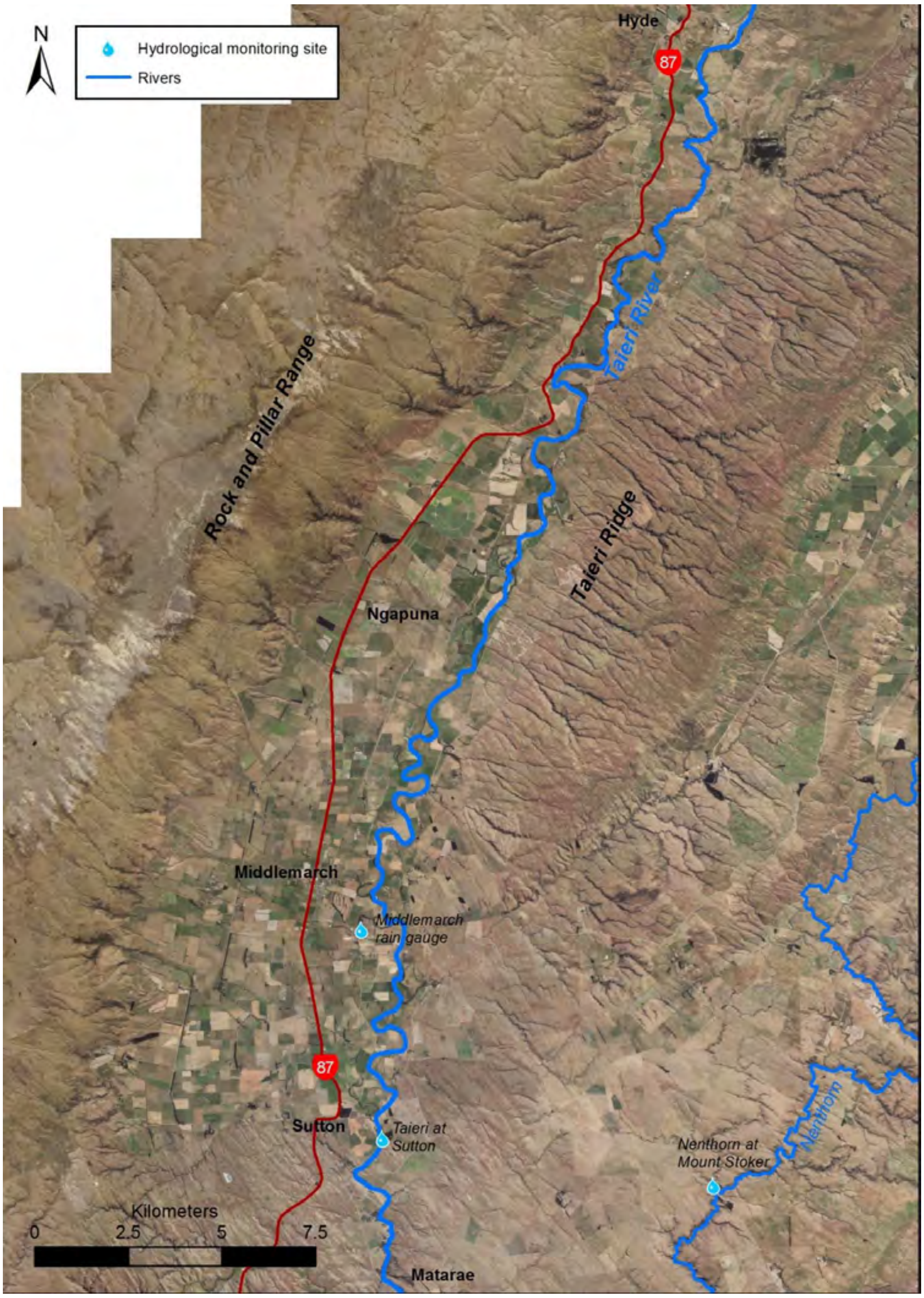

Figure 3. **Map showing the reach of the Taieri River, to which this strategy applies, and other main tributaries of the Taieri River**

2. Scope

2.1. Study reach

The geographical scope of the strategy is the reach of the Taieri River between the gorge downstream of Hyde (Hyde Gorge) and Matarae (Figure 3). Activities that occur in the upper catchment of the Taieri River and in other tributary streams may have an effect on the study reach. The Strath Taieri area (study area) slopes from about 300 m above sea level (asl) in the north to 150 m asl in the south. Numerous short watercourses join the Taieri River in this reach and are sourced from the Rock and Pillar Range. The upper reaches and tributary streams were not investigated, because most concerns previously raised by the community concerned the study reach. The focus was therefore on this location. Other areas in the Taieri River catchment may also experience problems and issues associated with river processes, however these are not examined here.

2.2. Risk

The strategy has a focus on the risks and effects associated with changes in riverbed morphology (including channel degradation and bank erosion, sedimentation, and flooding) in the study reach of the Taieri River. However, it is acknowledged that heavy rainfall events may lead to a range of other risks, including widespread flooding and surface runoff.

There are several other environmental issues and hazards in the Taieri River catchment. These include natural hazards such as seismic activity, as well as water quality and quantity issues. While numerous other issues do exist, this strategy is primarily concerned with the negative effects of changes in river form on the values associated with the Taieri River. Guidance and regulations relating to other issues can be obtained from the ORC. [4]

2.3. Strategy development

The strategy is intended to be a living document, which will evolve in response to new information and changes in river morphology,[5] the needs of the community, and the work of the ORC and other stakeholders. It will be reviewed regularly as part of council's annual and long term planning process, or in response to large flood events. The review process will involve landowners with property alongside the river, other stakeholders, and ORC staff with responsibilities for rivers and waterway management and natural hazards. The review is proposed to monitor the effectiveness of the strategy, the workability of its stated objectives and to note progress towards achieving those objectives. It will also help ORC to set priorities when considering funding and undertaking river-maintenance work in the rivers concerned.

[4] For example, The Otago Natural Hazards Database, the Water Info website and the Regional Plan: Water; all available from www.orc.govt.nz

[5] Including additional understanding gathered during future flood events

Before the review process, ORC will arrange and facilitate a workshop with the local community and invited stakeholder groups. This will consist of two parts:

- An opportunity for participants to present to the group any issues they face as to changes in channel morphology or riparian management; work they have undertaken or would like to see undertaken; or to discuss, question or suggest changes to the strategy itself.
- A facilitated process to coordinate activity and work towards achieving the principals and objectives outlined in the strategy.

3. Environmental setting

The natural and social settings of the Taieri River catchment are described in this section, with a particular focus on the special characteristics that give rise to the risks associated with changes in riverbed morphology.

3.1. Geological setting

The reach of the Taieri River, to which this study applies, is located on the floodplain between the Hyde Gorge and Matarae. Sediment has subsequently been eroded from the hill catchments upstream and at the study area to create the wide, flat floodplain within which the river sits. The geology of the floodplain and adjacent fans are described as Quaternary age (2.5 million years before present) gravels (Forsyth, 2001). The hills surrounding the study area are made up of schist of Permian age (299 to 252 million years before present) with some volcanic intrusions of Miocene age (23 to 5.3 million years before present) (Forsyth, 2001).

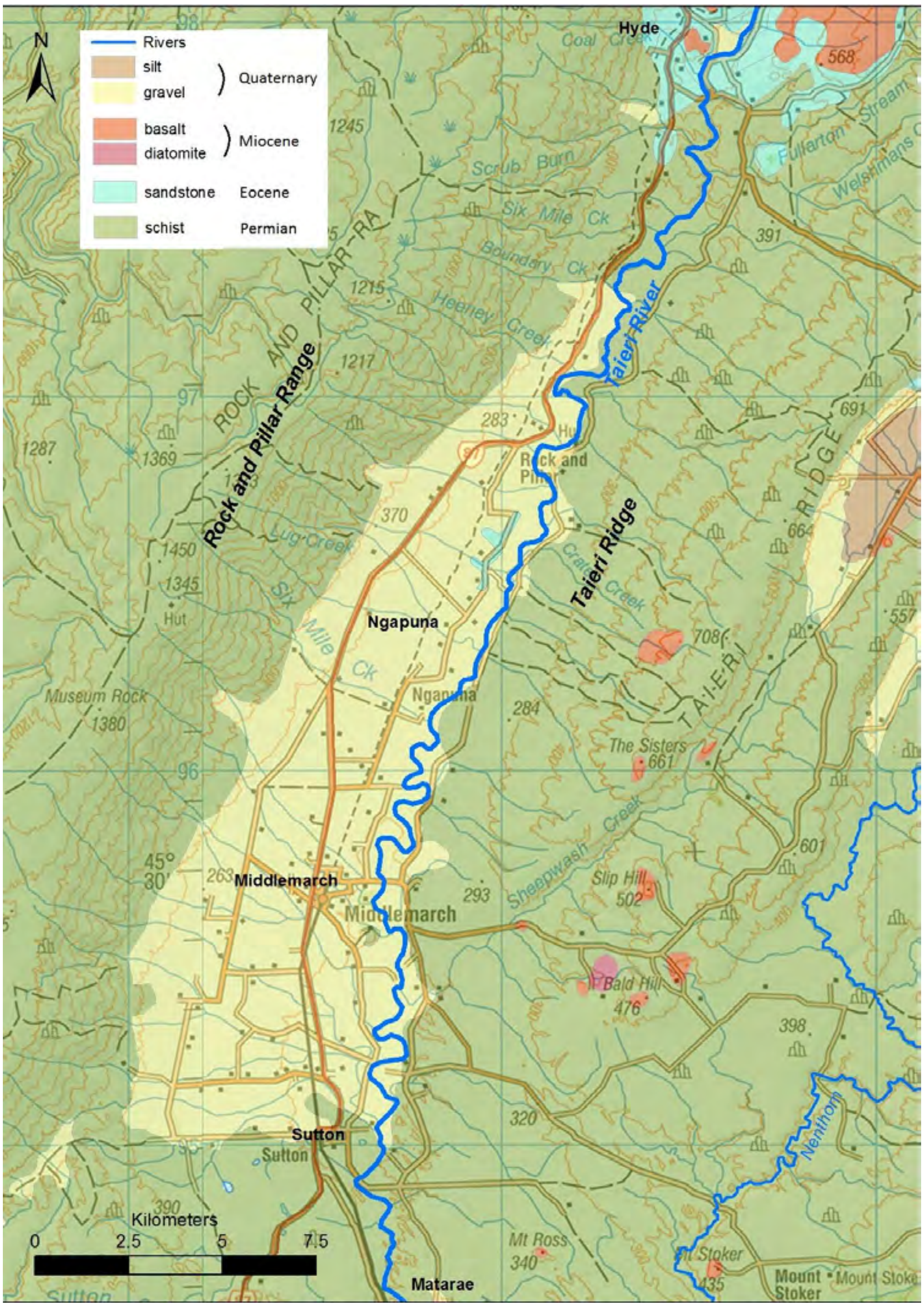

Figure 4. Geological map showing the reach of the Taieri River, to which this strategy applies. The period the rocks were formed in is shown.

3.2. Geographical setting

The Taieri River begins in the Lammermore and Lammerlaw Ranges (Figure 5) and flows north towards Ranfurly before turning south at Waipiata and flowing through the Strath Taieri region and out towards the Taieri Plain and its confluence with the Pacific Ocean at Taieri Mouth. The Taieri River has a total catchment area of about 5,700 km^2 and has a varied topography that comprises low mountain ranges, areas of steep hill country, large areas of gently rolling hill country, and three major plains (ORC, 1991). Farming is the major land-use in the catchment, with sheep and beef farming occurring in the steeper areas of the catchment and more intensive sheep and cattle farming, as well as dairying, occurring in the flatter plains areas.

The major tributaries of the Taieri River are the Loganburn (which drains from the Loganburn Reservoir), the Kyeburn, Sutton Stream, Deep Stream, Lee Stream, Nenthorn Stream, and the Silverstream and Waipori River, which join the on the Taieri Plain. The only main tributary which joins the Taieri River in the study area is Sutton Stream, which flows into the Taieri about 1 km upstream of Matarae.

Figure 5. Upper Taieri River catchment in the Lammermoor Range (Google Earth) (May 2014)

3.3. Meteorological setting

The Taieri River catchment is located on the east coast of the South Island, within the Central Otago and Dunedin City Districts. Flood events in the Taieri River catchment are generally caused by southerly or easterly flood-producing storms, and are associated with slow moving depressions that may stall over the Taieri catchment (ORC, 2013). Due to the horseshoe shape of the Taieri River, as well as the combination of wetlands/scroll plains, gorges, and floodplains, the pattern of flood flows can vary considerably throughout its length (ORC, 2013).

The Taieri River at Sutton hydrological site generally experiences two flood peaks during flood events but may experience up to four peaks during large floods (OCB, 1983). This is a factor associated with the ability of the scroll plains in the upper catchment to retain flood water as well as additional inputs between the upper catchment and Sutton e.g. Kyeburn.

The nearest long-term automatic rain gauges are located at Danseys Pass, Middlemarch, and Mount Stoker. Annual average and peak 24 hour rainfall intensities for these sites are listed in Table 1.

Table 1. **Annual average and maximum observed rainfall intensities for rain gauges in the area around the Strath Taieri**

Hydrological monitoring site (rain) (date record commences)	Annual average rainfall (mm)	Peak 24 hour rainfall (mm)	Date of peak 24 hour rainfall
Kyeburn at Danseys Pass (May 1996)	780	119	16-17 Jun 2013
Taieri at Middlemarch (Aug 2000)	468	51	29-30 Jul 2007
Nenthorn at Mount Stoker (Aug 1993)	455	83	12-13 Jan 1996

3.4. Hydrological setting

Information on river flow is available from two long-term monitoring sites in the vicinity of the Strath Taieri (with other sites also available in the Taieri catchment). The Taieri River at Tiroiti and Taieri River at Sutton sites have been operating since May 1982 and August 1960 respectively. The ten largest flows on record for these sites are shown in Figure 6 and Figure 7. The Taieri River can rise rapidly during flood events, with a rate of rise greater than 52 m^3/sec. Average velocities observed at these sites during flood events range from 2 to 5 m/sec with velocities likely to be even higher in the steeper, more confined sections of the Taieri River.

Table 2. **Summary of hydrological information for the sites within the Strath Taieri reach of the Taieri River**

Hydrological monitoring site (River flow) (date record commences)	Maximum observed flow (m^3/sec)	Annual flood (2.3 year return period) (m^3/sec)	Median flow (m^3/sec)
Taieri at Tiroiti (May 1982)	380 (20 Jul 1961)	100	10
Taieri at Sutton (Aug 1960)	560 (24 Dec 1993)	133	13

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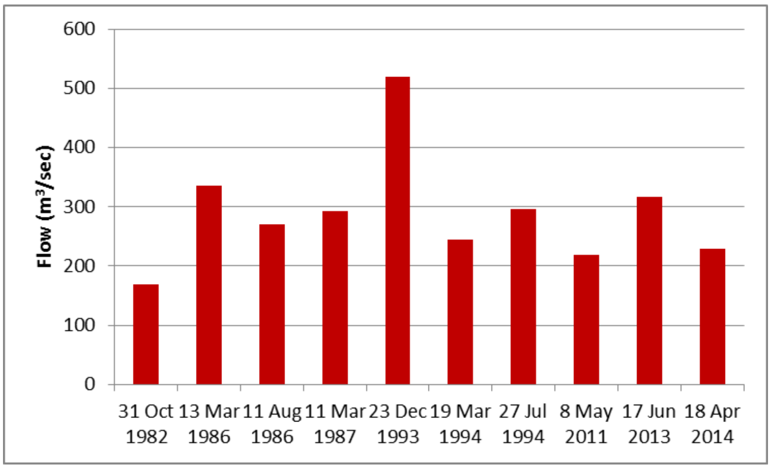

Figure 6. **Ten highest flows in the Taieri River at the Tiroiti recorder since flows began in 1982**

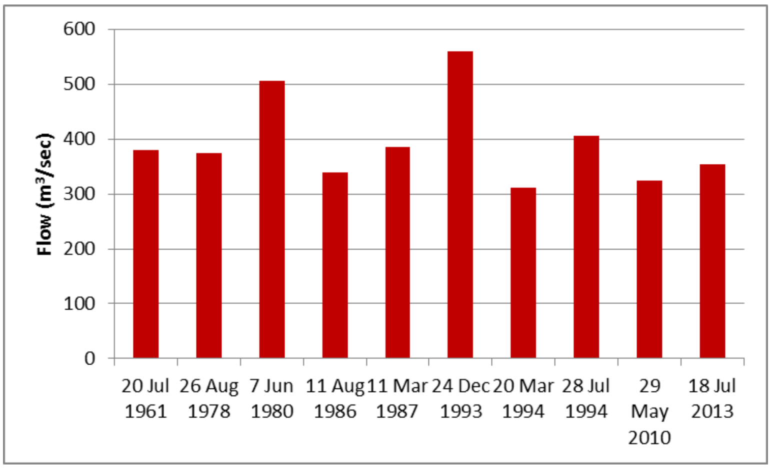

Figure 7. **Ten highest flows in the Taieri River at the Sutton recorder since records began in 1960**

3.5. Flooding

Changes in the morphology of the Taieri River channel are, in part, driven by the hydrological characteristics of the river, including the magnitude and frequency of flood flows. Between 2007 and 2015 there were three flood events in the study area that ranked in the top ten largest flood events at the Tiroiti flow recorder (Figure 6). The Sutton flow recorder has two events in the top ten for this same period (Figure 7). The Taieri River has experienced large flood events in the past, with the December 1993 event being the largest on record (Tiroiti and Sutton flow recorders) as well as in recent times (Figure 8). The December 1993 event caused flooding of land adjacent to the Taieri River as well as road damage (ODT, 27 December 1993) with three families having to evacuate their homes (ODT, 24 December 1993). The mapped flood hazard area for the Taieri River in the study area can be seen in Figure 9.

Figure 8. **June 2013 flood event, looking north along the Strath Taieri (Middlemarch can be seen on the left) (photograph taken 18 June 2013, after the peak of the flood (411 m^3/sec at the Sutton recorder))**

Figure 9. Taieri River flood hazard area extent (ORC, 1993)

3.6. Riverbed morphology

The active channel of the Taieri River is a dynamic system where flood events and sediment transport movement regularly cause changes in riverbed morphology. Changes in the longitudinal profile of the riverbed occur due to aggradation and degradation along the channel, and as a result of lateral bank erosion. Significant changes often occur over longer timeframes. Human activities, such as gravel extraction and physical works, can also result in significant morphological change, particularly near these works, but they can also occur across the wider river system.

ORC undertakes work to describe these changes in morphology using visual inspections, aerial and ground photography, and cross-section analysis. As the ORC cross-sections in the Strath Taieri area have only been surveyed twice, the first analysis of these are contained in this report (Appendix 4).

A comparison between aerial photography collected between 1945 to 1947 and 2013 to 2014 highlights the dynamic nature of the Taieri River. In places the active river channel has changed positions and eroded into farmland, while in other places the channel movement has allowed land to become farmable. The 1945 to 1947 aerial photography shows larger areas of gravel accumulation with the several meander loops occupying areas that are now abandoned oxbow channels (Figure 10).

Figure 10. **Taieri River - left 1947, right 2013/2014**

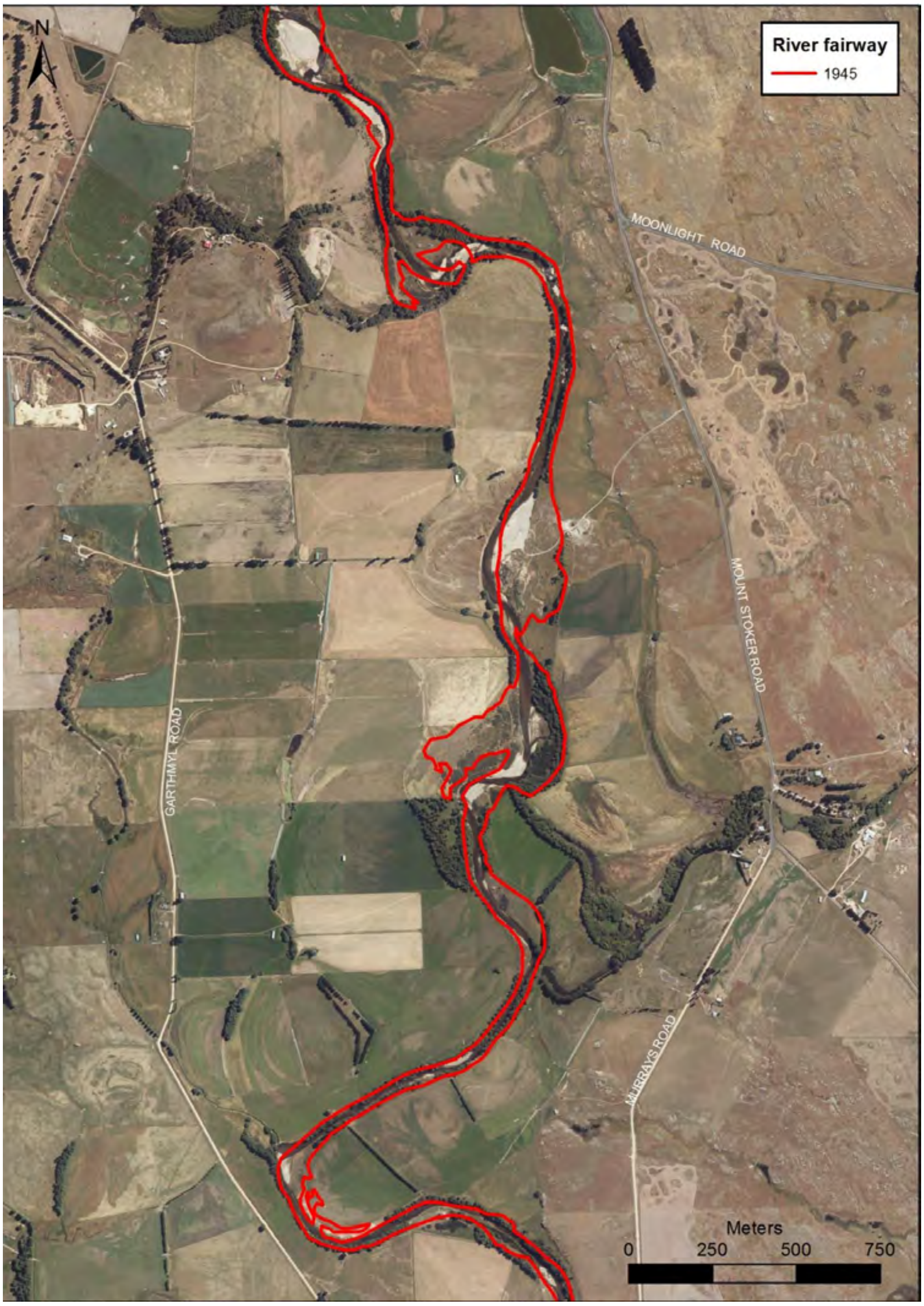

Figure 11. **Comparison of the Taieri River betwen 1945 and 2013 between 0.7 km and 5.7 km downstream of Middlemarch (aerial photography collected in 2012 and 2013)**

3.7. Riparian margins

The riparian margin is the area beside waterways that forms the interface between water and land. As noted in the introduction, more intensive use of the land that borders the Taieri River has occurred in recent decades. In some parts of the catchment, farmland has encroached onto what was previously a more natural area of rough vegetation (Figure 10). This has resulted in a narrowing (or in some cases, complete removal) of the riparian margin that separates the active river fairway from land that is used for farming or that accommodates community infrastructure. It is worth noting that the Taieri River in the study area has a good coverage of riparian vegetation, however some areas do not have any coverage. Channel widening, bank collapse and erosion processes that have historically occurred and will continue to occur in the Taieri River catchment. The loss of agricultural land and physical property adjacent to eroding banks is very costly and the need for their protection has long been recognised.

Historically the permanent removal of gravel from the Taieri River system has been used as a tool in an attempt to address bank erosion issues. The strategy identifies that gravel extraction, and other management tools (such as the movement of gravel within the channel, and spraying), should still be considered for river management purposes where appropriate. However, a number of authors have identified that the most effective means of controlling river bank erosion is to establish a vegetative cover of strongly rooting plants (Slui 1991, Marden *et al*. 2005, ORC 2005, Phillips & Daly 2008). In general terms, vegetation roots increase bank stability by protecting soils against entrainment from flood flows, and root mass and density provide soil shear strength, thereby protecting against gravity collapse of undercut banks.

Other indirect benefits of riparian planting include trapping nutrients and fine sediment, shade, shelter, and filtering qualities for the aquatic eco-system, as well as aesthetic and recreational value. If well managed, riparian margins can help to improve water quality, provide food and habitat for freshwater life, and improve diversity (ORC, 2005). A strong desire to see the form of the river include riparian plantings, particularly native species, was also identified during the development of the strategy.

4. Values

Information on the values that the community and stakeholders have for the Taieri River was collected through community meetings (Appendix 6). The Taieri River fulfils a number of important roles within the community at a local, district, and regional scale. These roles include (but are not limited to):

- A source of water for irrigation, stock, and people
- A source of gravel for roading and construction purposes
- For recreation purposes, including swimming, walking, fishing, hunting, boating, picnicing, and camping
- A habitat for native and introduced species
- Amenity and landscape values.

The below sections discuss the ecological, community, and Māori cultural values that are held for the Taieri River. Limited information was provided/collected on the spatial location of the values discussed and presented by the community and stakeholders. The lack of geographical information on the values discussed in this strategy therefore means all values should be considered whenever activities are planned for the beds and banks of the Taieri River at any location.

4.1. Ecological values

Fish

The Taieri River between the Hyde Gorge and Matarae provides an important habitat for a range of native and exotic freshwater species, including longfin eels (*Anguilla dieffenbachii*), lamprey (*Geotria australis*), upland bullies (*Gobiomorphus breviceps*), and common bullies (*Gobiomorphus cotidianus*). Brown trout (*Salmo trutta*) is an introduced species and is the most common fish in the study reach. Central Otago roundhead galaxias (*Galaxias anomalus*) can frequent this reach but are likely expatriates from the Sow Burn and Kye Burn. Chinook salmon (*Oncorhynchus tshawytscha)* pass through this reach as they travel upstream. The tributary streams in this reach also support a wide range of native and exotic fish species. The Regional Plan: Water for Otago also lists many ecosystem values for the Taieri River, including important bed composition, spawning sites for trout and development of juvenile trout, and a significant presence of eels.

The Strath reach of the Taieri River supports a regionally important brown trout fishery. The national angler survey suggests that angler effort in the reach of the Taieri River between Kokonga to the Outram bridge has increased in recent surveys (2001/2002 to 2007/2008) (Table 3).

Table 3. Angler effort on the Taieri River (angler days +/- sandard error) based on the national angler survey (Unwin, 2009)

River	Angler usage (angler days +/- SE)	
	2001/2002	2007/2008
Taieri River (Kokonga to Outram bridge)	1050 +/- 270	2730 +/- 1260

4.2. Community

To help identify aspects of the wider river environment that is important to the local community, ORC consulted with a wide range of stakeholders in 2016. These included landowners, local iwi, Fish & Game New Zealand, Department of Conservation (DoC), and Dunedin City Council (DCC).

The values that the community and other stakeholder groups identified within the Taieri River environment and its form and function, as well as desired outcomes, are summarised in the box below.

That the ***function*** of the river continues to support social, cultural, spiritual, recreational, and farming activities – as well as continuing to provide for the taking of gravel as a resource.

That the ***form*** of the river includes riparian management, including planting (both native vegetation and willows) where appropriate.

- The river supports recreational activities such as swimming, fishing, and picnicing
- Important river for mahika kai
- Regionally important brown trout fishery
- Important habitat for native fish (longfin eel, and galaxiids)
- The river can be used for gold mining.

Desired outcomes

- The habitat of existing wildlife must be maintained and enhanced
- Access must be able to continue
- Riparian margins are maintained
- Gravel extraction should be encouraged in appropriate places
- The river channel is able to shift laterally within an identified riparian margin, but:
  - farmland beyond that margin is not eroded, and
  - main flood flows are kept in the channel
- Infrastructure (eg, roads, bridges and water takes) is resilient and able to be quickly reinstated following flood events.

4.3. Maori cultural values

There are a range of Maori cultural values for the Strath reach of the Taieri River. Work and discussions are underway to try and gather these values which will be included when the strategy is reviewed in the future.

4.4. Gravel extraction

The removal of gravel from the riverbed of the Taieri River has occurred for many decades with extracted material generally used for roading and construction purposes. Gravel extraction typically occurs from locations where sediment naturally accumulates e.g. where there is a decrease in the gradient of the river, leading to a reduction in the velocity of flood flows, or in an attempt to mitigate issues such as bank erosion. In either case, extraction from the bed of the river will tend to increase the conveyance of water during flood events by widening the channel and reducing MBL at that location. It can also lead to a decrease in the sinuosity of the river channel as bends are straightened in an attempt to reduce the effects of bank erosion.

Records provided by gravel extractors to the ORC show that approximately 27,239 m^3 of gravel was extracted from the Strath reach of the Taieri River between 1998 and 2016. Gravel has not been extracted from the Strath reach since 2013.

Ongoing channel degradation can allow increased water velocities (particularly during flood events) to scour the river bed, deepening the channel, which can result in continued bed degradation. As the channel deepens, flood flows become confined within the channel and continue to scour the bed. This ongoing degradation decouples the channel from the floodplain and alters the floodplain catchment interactions (Fuller *et al.*, 2014). Deeper channels contain larger floods and concentrate flows, leading to more incised channels, potentially generating higher sediment transport rates (due to bank erosion and further removal of material from the riverbed). This process gives the appearance of more prominent gravel bars within the active channel due to the deeper channel. As the channel deepens and gravel bars become more prominent, pressure is often exerted by adjacent landowners to remove the obvious (but in fact non-existent) excess gravel accumulation, which in turn exacerbates the degradation trend (Fuller *et al.*, 2014).

The permanent removal of gravel from the Taieri River system can result in the undermining of river protection works and other assets (e.g. water intakes, bridges, and roads), as well as degrading ecological values. Gravel extraction can have a negative effect on the local ecology, with the severity of effects dependent on the extraction methods used and the environment from which the gravel is being extracted. Gravel extraction activities can lead to a reduction in habitat heterogeneity/diversity, an increase in fine sediment, as well as bed compaction that can have a negative impact on the native and exotic animals residing in and on the banks of the Taieri River (Canterbury Regional Council, 2015). The potential beneficial and adverse effects of significant gravel extraction are summarised in Table 4.

Table 4. Potential beneficial and adverse effects of gravel extraction (Canterbury Regional Council, 2015)

Potential beneficial effects	***Potential adverse effects***
Channel capacity increased, flood levels lowered	Disturbance of fish and bird habitat
Concentration of flow against riverbanks, resultant lateral erosion, and localised bed scour is minimised	Accidental discharge of fuels and lubricants from machinery
Stable channel alignment and optimum bed level is maintained	Disturbance of the natural meander patter and channel stability
Open gravel beaches can provide a good habitat for indigenous birds	Overall degradation of the riverbed
A renewable gravel resource for local construction may be utilised	Increased bank erosion
	Sediment is discharged, increasing turbidity and smothering habitat
	Temporary reduction in recreational access
	Mauri (life force) of the riverbed affected
	Disturbance of fish spawning sites
	Dust generation
	Reduced river bed heterogeneity

ORC will investigate the possibilities, benefits, and legality of a consent held by the ORC to allow for the management of gravel extraction and river management activities in the Strath reach of the Taieri River (Hyde to Matarae). ORC will aim to use the consent to enable landholders to achieve river management objectives, i.e. to help mitigate bank erosion/scouring or excessive gravel accumulation.

5. Legislative context

The manner and degree to which the issues in the Taieri River can be managed by the community, stakeholders and local councils is influenced by the obligation, powers and restrictions set out in various statues. No legislation confers the exclusive power or the right to manage the Taieri River to ORC or DCC. Whether through works or services, individuals are empowered to initiate their own measures provided they operate within the law. They are also allowed to develop and promote proposals for bank protection works, to apply for and hold the necessary resource consents, and to privately fund works and services should they wish to.

The law provides for a range of methods that both councils and the community can use to manage the Taieri River. These methods do not only relate to physical works, but also to planning, information, emergency preparedness and response. They can only be implemented after taking environmental effects into account (under the Resource Management Act (RMA)) and funding consideration (under the Local Government Act (LGA)). The latter includes consideration of the distribution of benefits between the community as a whole, any identifiable part of the community, and individuals.

The Otago Regional Policy Statement (RPS) provides a high-level policy framework for the sustainable integrated management of Otago's resources, as well as giving effect to the requirements of the RMA. This includes the management of the values of water bodies, natural resource systems and the form and function of Otago's rivers, whilst still enabling communities to provide for their needs.

This strategy is concerned with the form and function of the Taieri River. Any activities in or on the bed and banks of the Taieri River need to be focused on maintaining or enhancing that form and function. The strategy is not a statutory document; rather it is intended to present the aspirations of the community and the various stakeholder agencies. However, the statutory processes that do influence river management activities are more likely to be used effectively and efficiently if there is a general consensus on what is valued about the river, and commonly understood objectives. The strategy sets out the values identified by the community, and the outcomes they seek from managing river form and function, and will be used to inform resource consent decision-making.

6. Principles

The strategy provides a framework to guide activities and decision-making, based on an agreed set of principles. It is intended to help protect the recreational, cultural and ecological values of the Taieri River, and to enable long-term sustainable use of the riverbed and its riparian margins.

ORC has developed the framework, in consultation with the local community and other stakeholders. The principles and associated strategic elements are outlined below, and these are intended to protect or enhance the important values and features of the river identified by the community and other stakeholders.

Principle 1: Ensure sustainable river management

Ensure that:

- There is clear and consistent communication between the ORC and other parties
- There is recognition that certain river and catchment processes, such as flooding, bank and channel erosion and sedimentation, will occur naturally, and an understanding of the potential effects of those processes
- Any practices undertaken limit exposure to negative natural-river and catchment processes
- There is an awareness and acknowledgement of the benefits and the risks (including the risk associated with 'super-design' events) that exist for activities such as farming that occur in areas prone to natural-river and catchment processes
- Any negative effects of natural-river processes do not increase beyond their current levels, and are actively reduced where there is opportunity to do so
- Activities are managed in a way that result in:

- Limited effects on assets during flood events
- Essential community infrastructure that is resilient (roads, bridges, water supply)
- Acceptable level of effects to farming caused by river processes
- Sustainable use of river resources
- There is a recognition of the kaitiaki responsibilities of the local iwi.

Principle 2: Plan ahead

Ensure that:

- There is clear and consistent communication between the ORC and other parties
- There is an adaptive approach to river management that will allow for the dynamic nature of the Taieri River
- Resources are used wisely to ensure that the location and form of community assets and essential infrastructure will result in a more resilient community

- The impacts of climate change and natural climate variability are considered so that future generations do not have to cope with the results of poor decisions made today
- The risk associated with natural-river processes are reduced over time by taking a broad-scale, adaptive approach over the longer term.

Principle 3: Maintain and enhance the natural environment

Ensure that:

- There is clear and consistent communication between the ORC and other parties
- Activities are managed in a way that results in:
- A habitat that supports existing wildlife, fish, and suitable plant species
- A more visually appealing river system
- The ability of the local community and visitors to access and enjoy the river is maintained and/or enhanced
- Traditional and cultural use is enabled, maintained and enhanced.

7. River form and habitat enhancement

7.1. River corridor design and management

ORC has undertaken work to identify the location and width of the active fairway (or riverbed), as well as appropriate buffer zones, which together form a corridor within which the river would naturally lie. The widths of fairway and buffer zones were completed by assessing the appropriate meander form in relation to the nature and width of the river channel. The design channel has been drawn up using a consistent meander length or wavelength oscillation, while taking into account the existing channel location, channel areas and natural controls and restraints. This work has been undertaken in the Taieri River between the Hyde Gorge and the Matarae (Williams, 2016). An example is shown in Figure 12, and a full set of river corridor maps is provided in Appendix 5.

The river fairway and corridor mapping provides guidance for multi-purpose river management, and for the design and implementation of management measures, protection works and in-channel design. When physical works or activities are being considered within the fairway or on the riparian margin, these should be undertaken with reference to the mapped fairway and buffer zones. Guidance for managing the river within this corridor and across the wider floodplain is summarised in Figure 13.

ORC will work towards maintaining the Taieri River to the mapped corridor lines in the Strath reach where reasonable and practicable. The fairway management will be achieved through river-management processes such as sediment movement (i.e. cross-blading, bank reinstatement, targeted vegetation spraying and, in extreme cases, channel realignment). Keeping the fairways to the mapped lines will be undertaken as a pre-emptive process with the aim of limiting the degree of movement/deviation from these areas in flood events. This work will take into account the community values (as discussed in Section 4). Maintenance work undertaken in the Taieri River (as discussed above) will be provided for through the budget set in the ORC Annual Plan.

In some locations, the mapped corridor crosses land that does not currently form part of the active channel of the Taieri River (e.g. Figure 12). This is due to the fact that the mapped corridors show an ‘envelope’ within which the river would migrate under natural conditions. In many instances they do not reflect the current position of the Taieri River. In these situations ORC will not actively move the fairway into these mapped areas; however, if the channel switches its location into these areas (e.g. in response to a large flood event), ORC may decide not to undertake work to reverse the new alignment if the channel still lies within the mapped corridor.

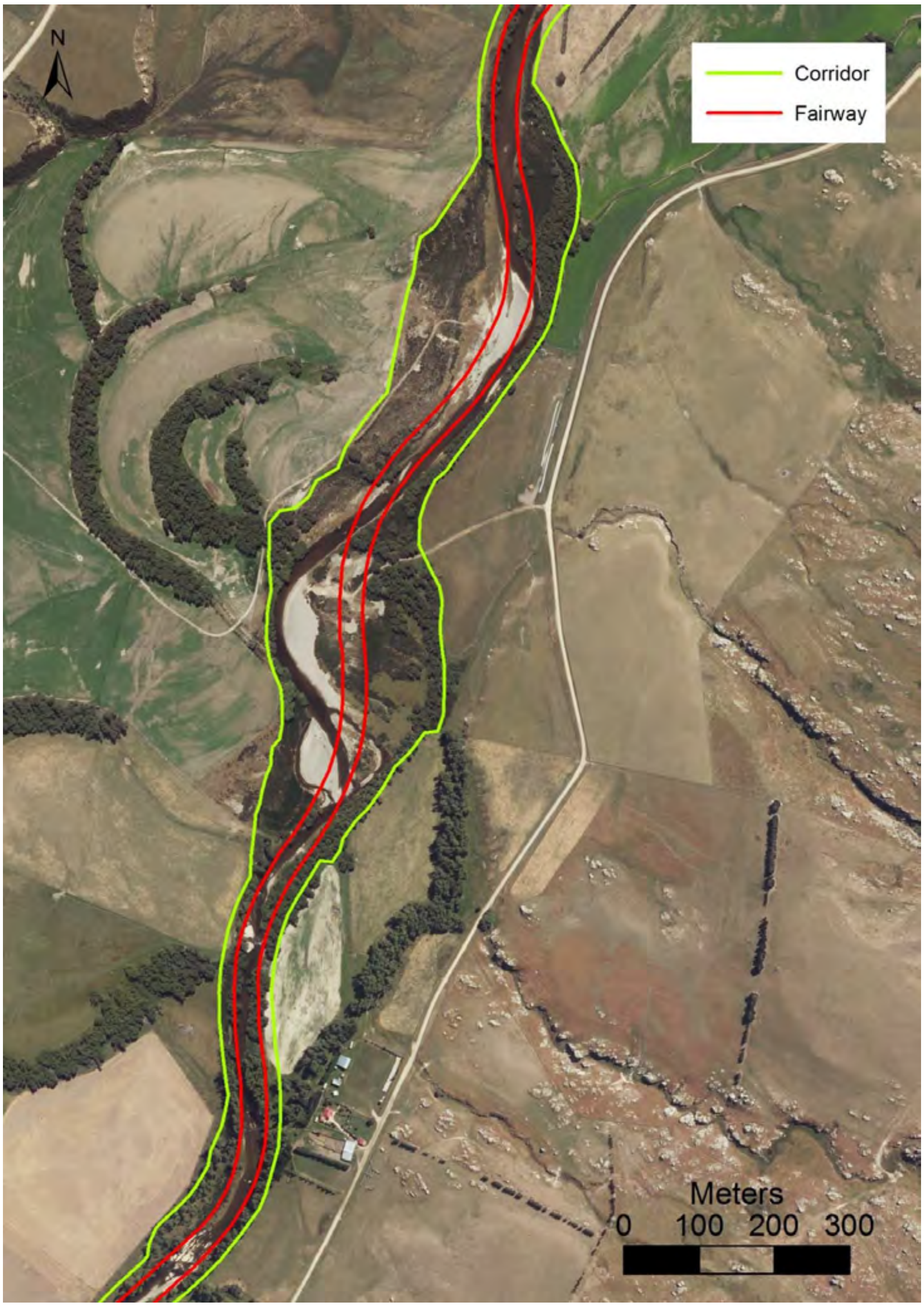

Figure 12. **Taieri River mapped fairway and corridor lines**

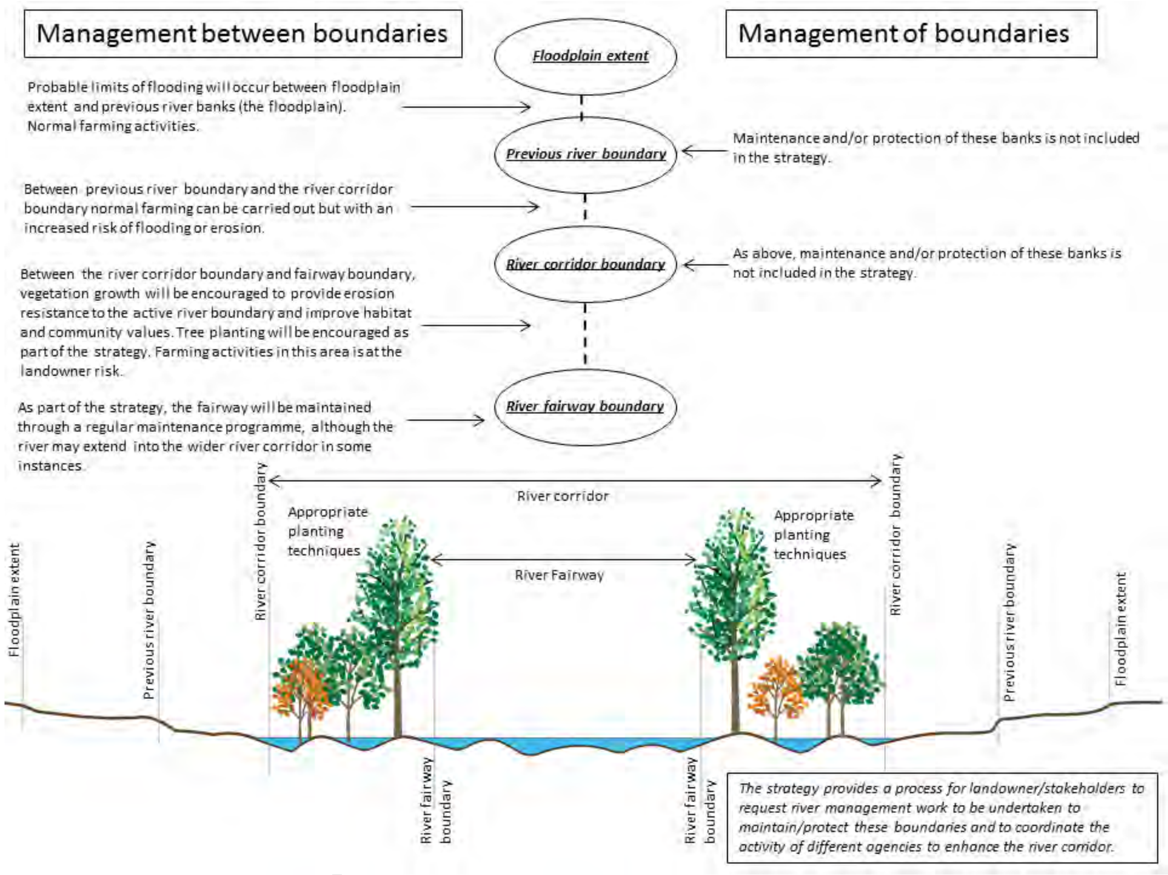

Figure 13. **Policy diagram for management of river boundaries and appropriate land-use on floodplain areas of the Taieri River**

7.2. Riparian plantings

As identified in Section 3.7, careful management of riparian margins is key to achieving positive river management outcomes. In addition, one of the key values identified by the community and stakeholders was that they would like to see additional planting and management of riparian plantings included in the strategy as a means of improving the amenity and habitat values of the Taieri River, and to help to reduce the effects of erosion (Section 3.7). The principles identified in Section 6 reflect the importance of sustainable river management and enhancing the natural environment.

Research (Slui, 1991; Phillips & Daly, 2008) shows that to achieve bank protection, the Taieri River riparian margins should be planted in vegetation that assists with bank stabilisation. Planting these buffer areas would provide the banks of the rivers with greater stability and assist with limiting bank erosion, as well as providing vegetative cover to slow flood flows and limit the amount of sediment deposited out of the main channel, while also providing habitat for aquatic life. The wider the area of buffer zone planting, the more effective this will be.

Willow species (particularly moutere and kemuti willow) are more suitable for planting close to the river margin due to their rapid growth, ease of propagation and usefulness for vegetative groynes or bank-lining layering. Other vegetation can also be used, including poplars and alders on the relatively higher/drier land. Native vegetation can be used further back from the active river margin and can be useful, especially when part of other/wider riparian planting.

Development of the buffer areas can be undertaken as a staged approach, with planting of the active river margin occurring in areas where there is bank exposure, as well as at possible river breakout locations. Planting of the back area can be undertaken where direct river attack (i.e. bank erosion) is less likely to occur and the native species will have time to become established. Buffer development is about establishing a wide and dense vegetated margin that can absorb river attack and provide habitat for aquatic life.

Planting of the banks of the Taieri River is generally seen as a beneficial process in most locations. There are several methods to plant the banks of the two rivers, with the best method being dependent on the environment where the planting is to take place (Appendix 2).

8. Implementation

The objectives of the strategy are listed at the start of this document (in the overview section). The mechanisms that can be used to achieve, or implement, these objectives are shown in the following tables. These have been derived using the principles outlined in Section 6. The tables below highlight the actions that should be undertaken to maintain and enhance the values associated with the Taieri River, as well as the key parties responsible for undertaking the listed actions.

In some cases, ORC has already undertaken work to help achieve objectives, and this work is described within this document (for example, mapping of natural-river corridors and identifying target profiles). It is noted that many of the actions listed below are voluntary, and will rely on interactions between the key stakeholders and the community to be successful. It is also noted that many of the activities will be ongoing, and progress will depend on funding, not only through the ORC Annual Plan process, but also from other agencies and the wider community.

ORC has prepared the strategy, with input from the local community, to help protect the recreational, cultural and ecological values of the Taieri riverbed, and to enable long-term, sustainable use of the land that borders the river. The objectives and actions listed below are intended to help achieve this by guiding work programmes, decision-making and activities for the community, stakeholders, and ORC. It is therefore recommended that people who live, work or play within the Taieri catchment consider, and give effect to, the principles, objectives and actions listed in this strategy.

Due to the dynamic nature of the Taieri River, parts of this strategy are likely to change as the rivers themselves change; this strategy must therefore be treated as a ‘live’ document (Section 2.3). This means that some sections and maps in the strategy may change in response to changes in the Taieri River (e.g. areas of gravel accumulation may shift).

Objective 1 Recognise and characterise natural-river processes

Activity	How this can be done	Intended outcome	Who will lead it	Timing	Comment
1.1. Collect information about flood and erosion processes					
	Map, describe and report on changes in channel morphology	Improved understanding of natural river processes	ORC	Ongoing	Previous reports describing changes in channel morphology are available
	Identify locations where erosion is occurring	Avoid high-value assets in erosion-prone areas	ORC	Ongoing	
	Make information publicly available, including through the Natural Hazards Database	Improved decision-making around placement of assets and land-use activities	ORC	Ongoing	Information is currently available through the Natural Hazards Database
1.2. Identify the location of river corridors, within which the river will naturally meander					
	Determine the natural meander form of the river, considering the existing channel location, and natural controls and restraints	Improved decision-making around placement of assets and land-use activities	ORC	Complete	Maps included in Appendix 5

Objective 2 Equip the community to live with the effects of changes in river morphology

Activity	How this can be done	Intended outcome	Who will lead it	Timing	Comment
2.1. Asset management and land-use practices (e.g. fences, vegetation clearance, and irrigation structure placement) are undertaken in such a way that reduces the risk associated with natural river processes					
	Land-use practices and other activities have greater regard to natural river processes	A reduction in risk over time	Landowners	Ongoing	ORC to provide guidance and information through field-days and other community programmes
	Consider implementation of land-use controls through the District Plan in areas with greater erosion risk	No net increase in risk over time	DCC	Long-term (5-10 years)	Elements are incorporated into the proposed DCC Second Generation District Plan (2GP)
	Identify mechanisms to modify/protect infrastructure assets that consider natural river processes	Infrastructure is resilient	ORC, DCC	Ongoing	ORC to provide information as necessary. DCC to consider this
2.2. Consider all available options to manage the effects of bank erosion, including structural and non-structural options					
	Less intensive use of riparian margins	A reduction in risk over time	Landowners	Ongoing	
	Planting of native and exotic species on riparian margins	Increased stability of riparian margins and riverbanks, improve habitat and community values	Landowners	Ongoing	ORC to provide support, as determined through the ORC Annual Plan process
	Produce guidelines for undertaking planting appropriate for river control and provision of habitat	Increased stability of riparian margins and riverbanks	ORC	Complete	Guidance included as Appendix 2

	Produce maps showing priority planting locations	Community requirements and natural river processes are considered before planting is undertaken	ORC	Ongoing	
	Proactive river management programme	Bank erosion and other river management issues addressed early	ORC	Ongoing	Maintenance work undertaken as provided for through the budget set in the ORC Annual Plan
	Provide information on the Regional Plan: Water permitted activity rules	The community is enabled to complete activities that manage the effects of bank erosion and other river management issues	ORC	Ongoing	Information on permitted activities to be provided to the community at any opportunity
2.3. Enable works that improve the conveyance of floodwater and 'train' the river within its natural corridor, without compromising features that are of high value to the community					
	Physical works by ORC to address existing river management issues	The Taieri River is contained, as far as possible, within the natural river fairway/corridor, and convey small-to-medium floods without overtopping	ORC	Ongoing	Locations and detail of work to be undertaken between October 2016 and 2019 included in Appendix 1
	Physical works by landowners and other agencies to address river management issues	The Taieri River is contained, as far as possible, within the natural river fairway/corridor, and convey small to medium floods without overtopping	Landowners	Ongoing	ORC to provide guidance on suitable river management methods (including resource consent requirements) through field days and other community programmes
	Provide information discussing the importance of community/stakeholder values	Works are undertaken in a manner that does not compromise features that are of high value to the community	ORC and the community	Complete	Discussed in Section 4, these may be modified or adjusted as part of future reviews of this strategy. Values also mapped in the proposed DCC 2GP.

Objective 3 Enable sustainable gravel extraction

Activity	How this can be done	Intended outcome	Who will lead it	Timing	Comment
3.1. Enable sustainable gravel extraction for river management benefits					
	ORC will investigate the possibilities, benefits and legal ramifications of holding a consent to extract gravel	Gravel extraction is completed in a sustainable manner	ORC	Feb 2017 (to inform the 2017/18 draft Annual Plan)	
3.2. Identify areas where gravel extraction may affect community values					
	Provide information discussing the location and importance of community/stakeholder values	Extraction is undertaken in a manner that does not compromise features of the location that are of high value to the community	ORC and the community	Completed	Values discussed in Section 4; these may be modified or adjusted as part of future reviews of this strategy. Values also mapped in the proposed DCC 2GP.

Objective 4 Promote activities that enhance the natural character and enjoyment of the river

Activity	How this can be done	Intended outcome	Who will lead it	Timing	Comment
4.1. Identify the location and characteristics of features that are of high value to the community					
	Community values obtained through consultation and clearly identified within the strategy	Consideration of community values when making decisions	ORC	Completed	Values discussed in Section 4. These may be modified or adjusted as part of future reviews of this strategy. Values also mapped in the proposed DCC 2GP.
4.2. Establish riparian plantings that serve a purpose, and are appealing					
	Produce guidelines for undertaking planting appropriate for river control and provision of habitat	Increased stability of riparian margins and riverbanks Improved aquatic and terrestrial habitat	ORC	Completed. See also 2.2 above	Guidance included as Appendix 2
4.3. Provide access for fishing activities and habitat for fish					
	Planting work that facilitates fishing activities and enhances fish habitat, and does not impede access	The Taieri River supports a regionally important sports fishery, and important populations of native fish (including threatened and endangered species)	Fish & Game, DoC[6]	Ongoing	
	Consent conditions ensure that gravel extraction and physical works are undertaken in a way that	The Taieri River supports a regionally important sports fishery, and important populations of native fish (including threatened and	ORC, DCC, extractors and landholders	Ongoing	ORC and DCC staff to consider as part of resource consents

[6] DoC will take an advocacy role for this action

Otago Regional Council

	does not damage habitat	endangered species)			See Objective 3 also
	Encourage the creation of additional public access points	River-access opportunities are increased	ORC, DDC, landowners	Ongoing	The proposed 2GP identifies esplanade strips and access points
4.4. Adequate pest and weed control activities					
	Landowners (including LINZ) and other stakeholders work collaboratively to manage pest species	The Taieri River fairway and riparian margin are relatively free of pest species	Landowners, stakeholders, ORC	Ongoing	
4.5. Discourage dumping, and arrange the regular collection of rubbish					
	Collection of rubbish through regular/routine work at key locations.[7] Signs warning of penalties for rubbish dumping to be erected if issues persist	Improved visual amenities and enjoyment of recreational areas	ORC/DCC	Ongoing	Work to be completed by relevant parties for their area of jurisdiction
4.6. Protect and enhance the natural character of the Taieri River					
	Promote and encourage local restoration initiatives such as bank planting and wetland restoration	Riparian margins are planted/restored, look visually appealing, and provide aquatic and terrestrial habitat	Community, with support from other agencies	Ongoing	

[7] No new additional work to be completed

Appendix 1. ORC river maintenance work within the Dunedin Special Rating District

Twelve locations within the mapped river corridor have been identified as requiring work to maintain the fairway within its natural position (as mapped in Appendix 5) and/or to ensure the adequate conveyance of floodwater. These locations are shown on Figure 14 and Figure 15. These priority locations have been determined using the latest information available (November 2015) about specific locations that are experiencing river management issues. ORC intends commencing work at these locations during the 2016/2017 financial year, and funding has been provided through the long-term plan process to complete work at these locations within the next three years (i.e. by 2018/2019). Ongoing maintenance may also be required at some of these locations into the future.

This list and the need to undertake work at particular locations may change into the future, in response to flood events and to other river management issues that the community may identify through the processes outlined in Section 2.3.

The river management work (outlined below) that is scheduled to take place in the Taieri River will need to consider the following:

- The principles outlined in Section 6
- The location and width of the natural river corridor and active fairway as described in Section 7.1, and other natural river processes as described in the strategy
- The objectives and associated activities listed in Section 8. In particular objective 2 (equip the community to live with the effects of changes in river morphology) and activity 2.3 (enable works that improve the conveyance of floodwater and 'train' the river within its natural corridor, without compromising features that are of high value to the community)
- The ecological, community, and Māori values discussed in Section 4.

The increased program of work in the Taieri River by ORC will result in increased costs for the Dunedin Special Rating District (SRD). Revenue from rates within the SRD is not expected to increase, however the reserve level will decrease as additional funding is required to complete instream work required to meet community river management expectations. The anticipated budget for river management operations (physical works) in the Dunedin SRD until 2019/20 is shown in Table 5 below. This shows that $256,000 is budgeted for this work during the 2016/17 year, up from $174,000 in 2014/15. This budget is not solely for the Taieri River and includes other rivers in the Dunedin District.

The dynamic nature of the Taieri River and inability to predict the timing or consequences of future flood events in the Dunedin District means there is a risk that this additional funding for river management work may still be insufficient. As noted above, all ratepayers within the Dunedin District contribute towards the Dunedin SRD.

Table 5. ORC river management budget for the Dunedin District

Year	ORC river management (operation) budget
2014/15	$174,000
2015/16	$254,000
2016/17	$256,000
2017/18	$268,000
2018/19	$275,000
2019/2020	$282,000

Planned river maintenance work – Taieri River

A. Work at this location will involve raking gravel to remove vegetation build up and allow sediment to move during flood events as well as willow planting to limit the effects of bank erosion.

B. Work at this location will involve raking gravel to remove vegetation build up and allow sediment to move during flood events.

C. Work at this location will involve raking gravel to remove vegetation build up and allow sediment to move during flood events.

D. Work at this location will involve willow planting to limit the effects of bank erosion.

E. Work at this location will involve willow planting to limit the effects of bank erosion.

F. Work at this location will involve raking gravel to remove vegetation build up and allow sediment to move during flood events.

G. Work at this location will involve raking gravel to remove vegetation build up and allow sediment to move during flood events.

H. Work at this location will involve raking gravel to remove vegetation build up and allow sediment to move during flood events.

I. Work at this location will involve raking gravel to remove vegetation build up and allow sediment to move during flood events as well as willow planting to limit the effects of bank erosion.

J. Work at this location will involve raking gravel to remove vegetation build up and allow sediment to move during flood events.

K. Work at this location will involve raking gravel to remove vegetation build up and allow sediment to move during flood events.

L. Work at this location will involve raking gravel to remove vegetation build up and allow sediment to move during flood events.

Figure 14. Priority locations for operations work - map 1

Figure 15. **Priority locations for operations work - map 2**

Appendix 2. Planting guide

Benefits of riparian planting[8]

The benefits of well-planned and well-managed riparian planting areas on farms are considerable, and include:

- Increasing the quality and health of waterways
- Increasing the ability to filter nutrients before they reach waterways – Nitrogen, Phosphorus, and bacteria/viruses e.g. *E.Coli*
- Reducing sediment runoff
- Reducing soil erosion of banks in waterways
- Providing shade, which reduces waterway temperatures and shelter for stock
- Minimising stock losses as animals are excluded from riparian strips by fences
- Increasing biodiversity – aquatic life, native plants, birds and insects
- Improving recreational opportunities (e.g. fishing)
- Enhancing and beautifying the river margins.

Both native and exotic species can be suitable for riparian planting. The species to be used will depend upon many factors including environmental factors (exposure, soils, etc.) but also the width of the riparian strip, the height of plantings that is desired, and personal preference.

Using trees to stabilise stream banks[9]

Exotics

The most effective trees for stream bank erosion control are exotic willows and poplars. These are planted as stakes (less than 1 m high) or poles (1.5 – 3 m in height). Avoid invasive spreading species, such as crack willow, weeping willow, silver poplar and all non-sterile tree and shrub willows. Before planting fast-growing trees, consider their longer-term maintenance needs.

Winter is the best time to plant these species before stakes or poles sprout new growth. Plant about a third of the length below ground. On waterlogged ground you can force them in by hand. On firm ground you may be able to sharpen poles at one end and drive them in with a rammer or use a post auger. Stakes can be planted by putting them into a hole made with a length of reinforcing rod or similar. The most important thing is to make sure stakes and poles are firmly planted.

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[8] Adapted from KCCP planting guide (2015)

[9] Adapted from ORC (2005)

Guide to planting willow poles

Storage

It is recommended that poles are planted as soon as possible following delivery. Poles can be stored for a few weeks in water, standing up in a water trough or pond/creek. The bottoms of the poles should be kept wet to keep them alive and absorbing water. Poles should be stored away from stock.

Planting

Poles should ideally be planted on the outside of river bends, or sections of river where erosion is occurring. Plant poles in rows with 2 – 3 m spacing between them. Poles need to be planted 300-500 mm deep. Try and plant down to ground water level. Either a crow bar, post-hole borer or tractor forks/digger with a spike can be used to make a hole in the ground that the pole can be dropped into, and then packed firm.

Looking after plantings

Fence planting off from stock to protect plants; plant protectors can also be purchased and can help give protection. It is recommended that poles are watered the day after planting and at least once a week during dry weather until they are established.

To stabilise banks:

- Pair-plant along straight reaches – one tree on one bank, one tree on the opposite bank, five to seven meters apart
- Plant at two to three metre spacing at critical points, such as the outside of the bends where erosion is the greatest
- Avoid planting on the inside of bends – soil builds up rather than erodes here, so trees will trap sediment and force current against the outer bank
- Avoid planting narrow channels where trees might impede floodwaters.

By the time trees are four or five years old, there will be a solid mass of roots along the bank. At 10 to 20 years, trees can be thinned to 10 to 12 metre spacing, but no wider. If you use sleeves on poles to protect the willows and poplars, sheep can be grazed around the trees from the time they are planted.

Natives[10]

There are many advantages of utilising native plants. These include:

- Enhancing natural character and landscape values
- Forming a habitat corridor and potentially ecological linkage in the catchment

[10] Information on native planting and previous Taieri River catchment vegetation provided curtesy of DoC

- Restoration of rare riparian forest (and other habitats)
- Creating/enhancing habitat for native birds and invertebrates (including pollinators)
- Restoration or enhancement of threatened plant habitats
- Do not grow as high or require maintenance (e.g. pruning or thinning)
- Self-regenerating and maintaining.

Planting natives for bank stability will enhance the natural biodiversity of your riparian margin and provide habitat for invertebrates and birds. While exotic tree species are proven to stabilise banks, new research shows that native trees, such as ribbonwood, cabbage tree and pittosporum species, are suitable for bank stabilisation. These species are deep rooting, with a good root spread. Planting native species alongside exotics will help to maintain a mostly native planting on your banks. Table 6 lists suitable native vegetation to plant in the Taieri catchment, including trees, shrubs, and non woody plants. Table 7 lists nationally threatened species to use in the Strath reach; incorporating these species will add diversity to riparian plantings and contribute to the conservation and recovery of those species.

Original Taieri River catchment vegetation cover

An appreciation of the likely original vegetation of the Taieri River between Hyde and Matarae is helpful in guiding riparian restoration goals. Unfortunately this is difficult to attain now that the patterns of natural vegetation have been so disrupted by human occupation and, as a result, little native vegetation remains.

Previous areas of swamps contained stands of kahikatea on floodplains; totara, mountain totara, rimu, matai and kahikatea on the better drained low terraces; and kowhai and lowland ribbonwood along river banks. Pre-European burning would have extended areas of harakeke, tutu and other grasses.

The downlands of north Otago (including the Taieri River between Hyde and Matarae) were once covered with forests of totara and matai, and trees such as broadleaf, ribbonwood, narrow-leaved lacebark and kowhai. The highest, driest, more inland parts once supported forests of mountain totara and mountain toatoa, but these forests are now all but destroyed. The prevailing pre-European cover was grassland of fescue and silver tussocks, but with red tussock on cooler and damper sites. There was also scrub of matagouri and small-leaved coprosma and abundant cabbage trees, with Carex secta along water courses.

Table 6. Suitable native species for the Taieri River catchment (Hyde to Matarae)

Trees **Common name**	**Scientific name**	**Mix of plants**[11]
kohuhu	Pittosporum tenuifolium	major
lowland ribbonwood	Plagianthus regius	major
narrow-leaved lacebark	Hoheria angustifolia	major
South Island kowhai	Sophora microphylla	major
Cabbage tree	Cordyline australis	major
broadleaf	Griselinia littoralis	major
kanuka	Kunzea robusta	major
marbleleaf	Carpodetus serratus	moderate
manuka	Leptospermum scoparium	moderate
mountain totara	Podocarpus laetus	moderate
matai	Prumnopitys taxifolia	minor
kahikatea	Dacrycarpus dacrydioides	minor
Shrubs		
mingimingi	Coprosma propinqua	major
small-leaved coprosma	Coprosma dumosa	major
small-leaved coprosma	Coprosma rigida	major
koromiko	Hebe salicifolia	major
cottonwood	Ozothamnus vauvilliersii	major
mountain akeake	Olearia avicenniifolia	major
Small-leaved tree daisy	Olearia bullata	major
mountain wineberry	Aristotelia fruticosa	moderate
weeping mapou	Myrsine divaricata	minor

[11] The major, moderate or minor is intended to direct the numbers/mix of plants used in a riparian/restoration planting. Therefore the bulk of the plants would compose the 'major' species, with some of the 'moderate' species and only a few of the 'minor' species. The species mix may be in the order of 10 of a 'major' species to 5 of a 'moderate' species to 1 of a 'minor' species.

Non-woody plants		
toetoe	Austroderia richardii	major
lowland flax	Phormium tenax	major
purei	Carex secta	major
red tussock	Chionochloa rubra subsp. cuprea	moderate
Buchanans sedge	Carex buchananii	minor

Table 7. Suitable native species for the Taieri River catchment (Hyde to Matarae) (rare species)

tree daisy	Olearia fimbriata
Hectors tree daisy	Olearia hectorii
tree daisy	Olearia lineata
bloodwood	Coprosma wallii
climbing broom	Carmichaelia kirkii
native verbena	Teucridium parvifolium

Appendix 3. River morphology trends

Bedload sediment in the Strath reach of the Taieri River is mainly sourced from the Kyeburn catchment, with the majority of sediment being sourced from the western side of the catchment in the greywacke dominated geology (Forsyth, 2001). This report contains the first analysis of changes in ORC cross-section profiles for the Strath reach of the Taieri River (Appendix 4). Due to issues associated with the initial survey data collected in 2007, a quantitative analysis cannot be completed (i.e. MBL analysis), however Appendix 4 describes the changes in general terms at the cross-section locations.

An analysis of hydrological data for the monitoring site, Taieri at Tiroiti, highlights changes in river morphology at the site as well as in the general area of Tiroiti. At the Tiroiti site there is a significant downward trend in stage levels (water levels) between 1983 and 2015. This can be used as a proxy to indicate that the bed level is decreasing at the site, indicating that limited gravel is moving downstream and becoming deposited at the site, however it may also indicate that gravel is passing through the system and not becoming deposited at this location.

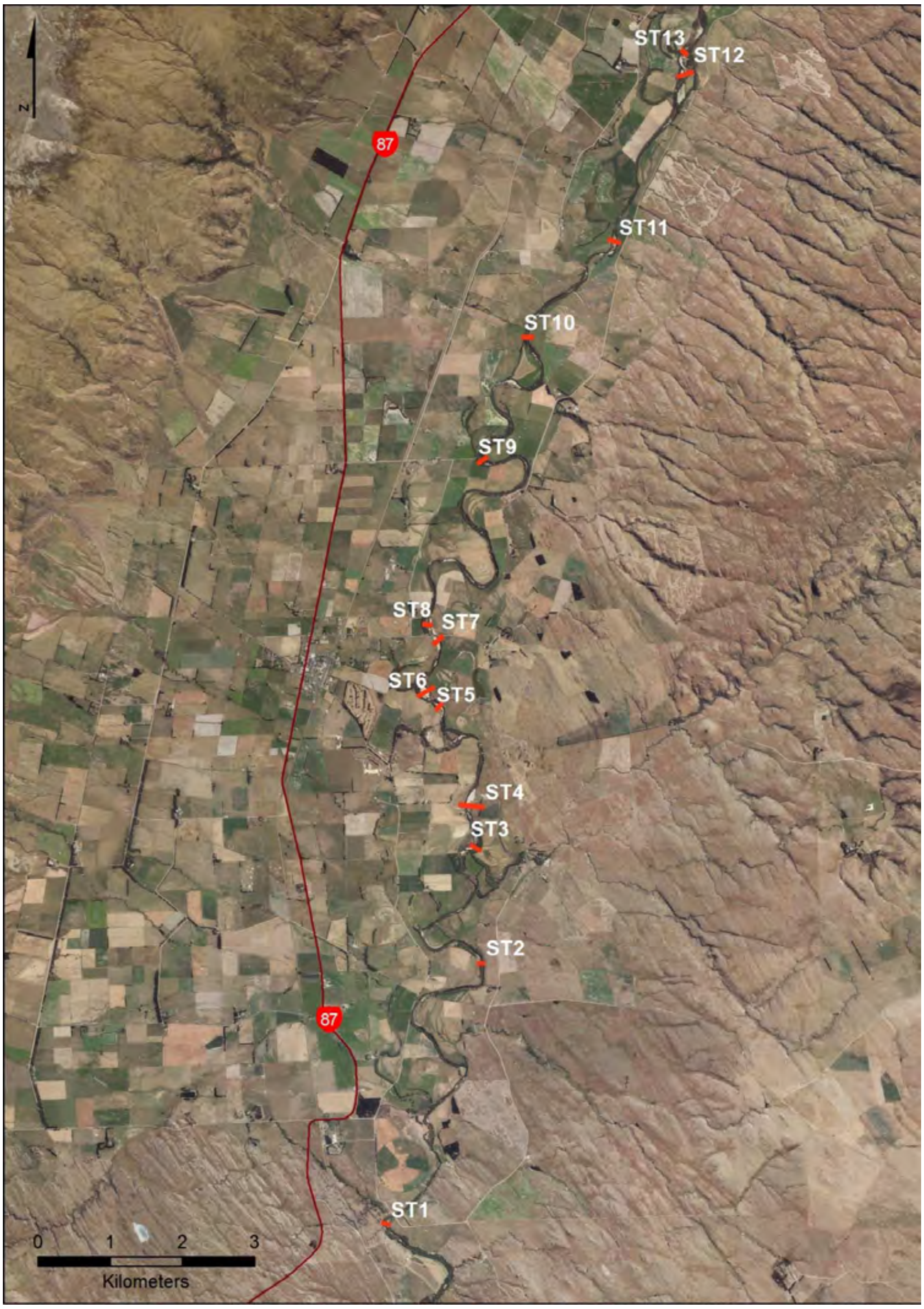

Figure 16. **Taieri River cross-section locations (aerial photograph taken 2013)**

Figure 17. Taieri River cross-section locations (aerial photography taken 2013)

Appendix 4. Taieri River cross-sections

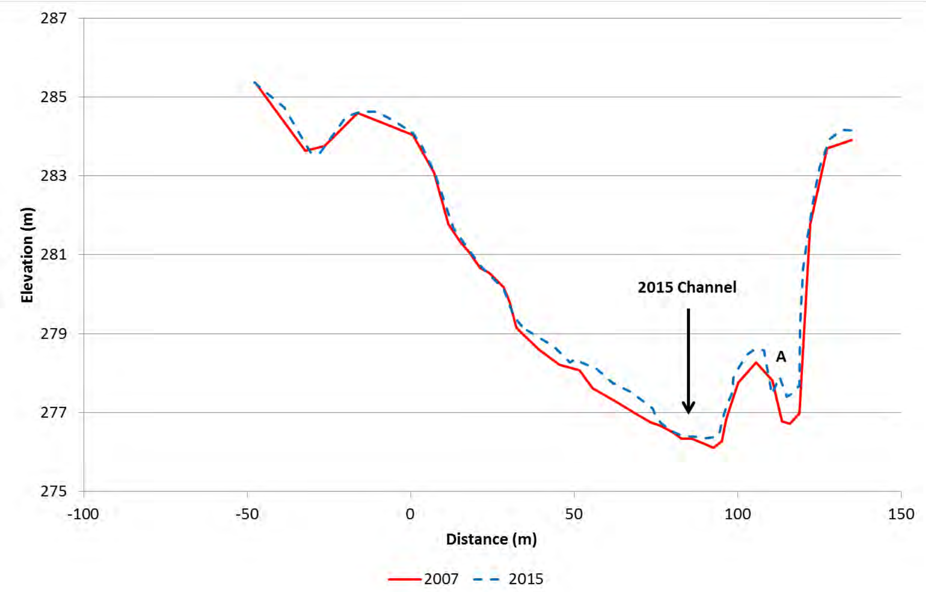

Figure 18. Taieri River cross-section ST1, looking downstream

Figure 19. Cross-section ST1, looking downstream, November 2015

Cross-section ST1 is located 0.14 km downstream of the Sutton-Mount Ross Road bridge. The main channel has remained in a similar position with some aggradation occurring on the true left berm area and in the secondary channel (point labelled A) between 2007 and 2015.

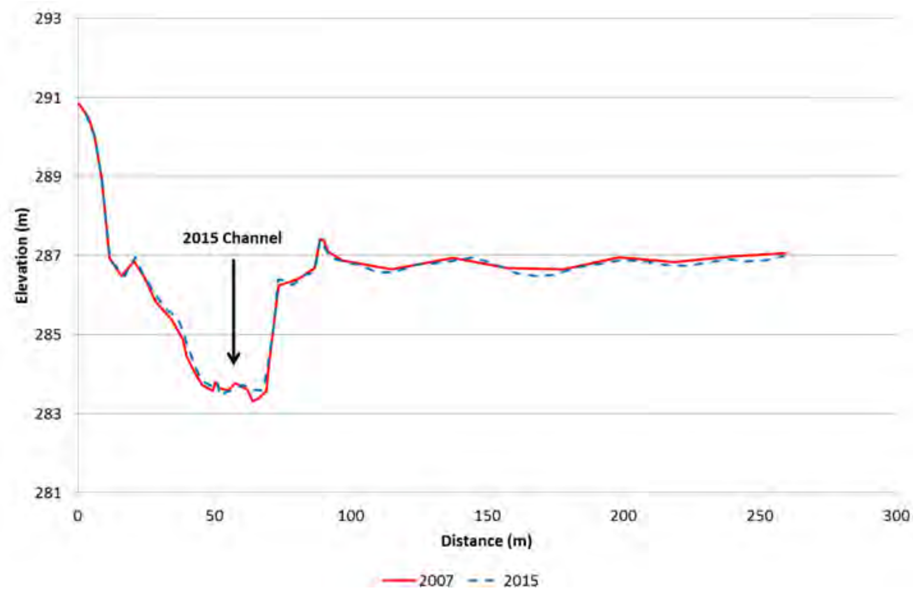

Figure 20. Taieir River cross-section ST2, looking downstream

Figure 21. Cross-section ST2, looking from the true right to true left bank, November 2015

Cross-section ST2 is located 5.2 km upstream of the Sutton-Mount Ross Road bridge. The channel and wider floodplain has remained in a similar position between 2007 and 2015.

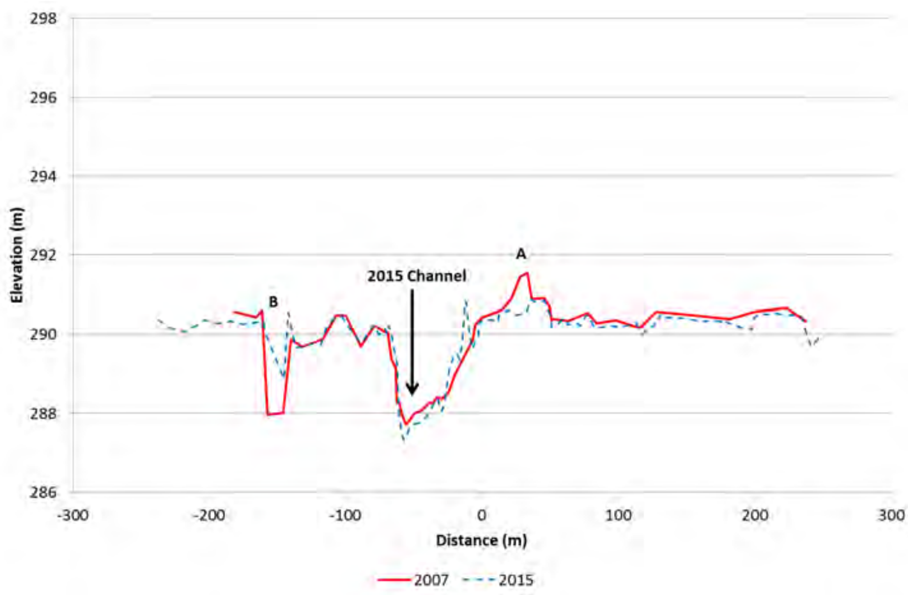

Figure 22. Taieri River cross-section ST3, looking downstream

Figure 23. Cross-section ST3, looking upstream, November 2015

Cross-section ST3 is located 3.7 km downstream of the Moonlight Road bridge. The main channel has remained in a similar position between 2007 and 2015, with degradation occurring in the main channel. The true right bank has degraded (at the point labelled A) with minor degradation occurring on the true right floodplain. The secondary channel (at the point labelled B) has aggraded between 2007 and 2015.

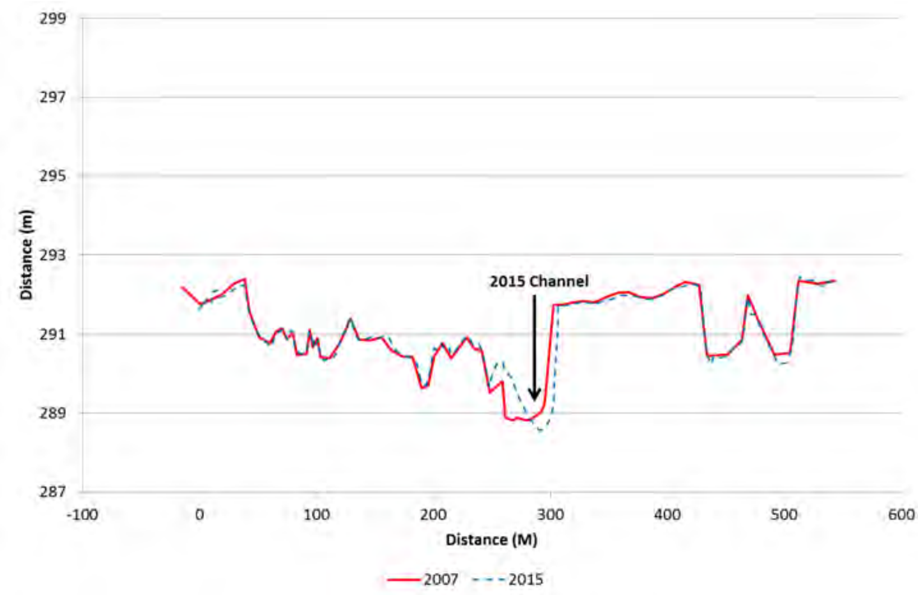

Figure 24. Taieri River cross-section ST4, looking downstream

Figure 25. Cross-section ST4, looking upstream, November 2015

Cross-section ST4 is located 3.1 km downstream of the Moonlight Road bridge. The berm area and wider floodplain has remained similar between 2007 and 2015. The main channel has degraded and eroded the true right bank but has aggraded on the true left bank.

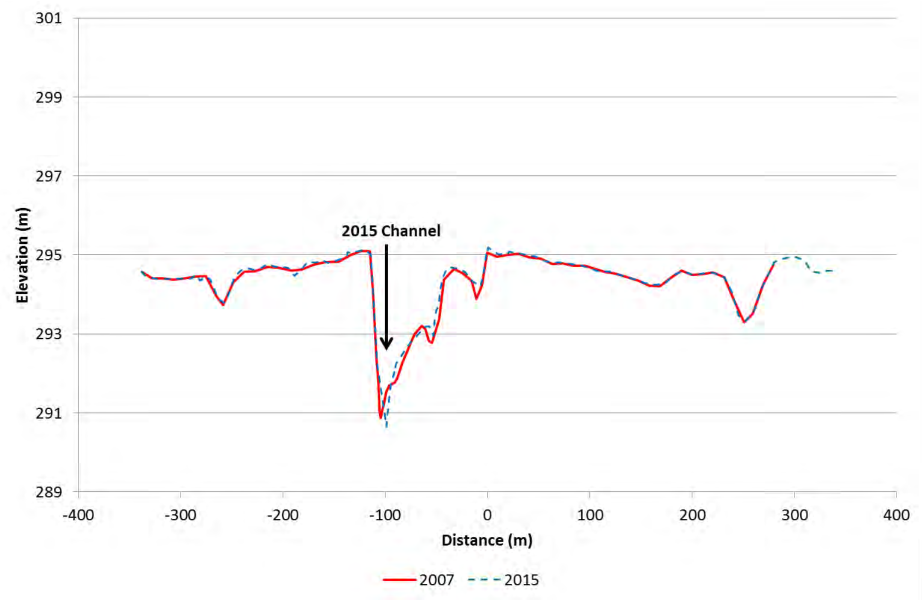

Figure 26. **Taieri River cross-section ST5, looking downstream**

Figure 27. **Cross-section ST5, looking downstream, November 2015**

Cross-section ST5 is located 1.2 km downstream of the Moonlight Road bridge. Between 2007 and 2015 the main channel became more confined, with little change occurring across the wider berm area and floodplain.

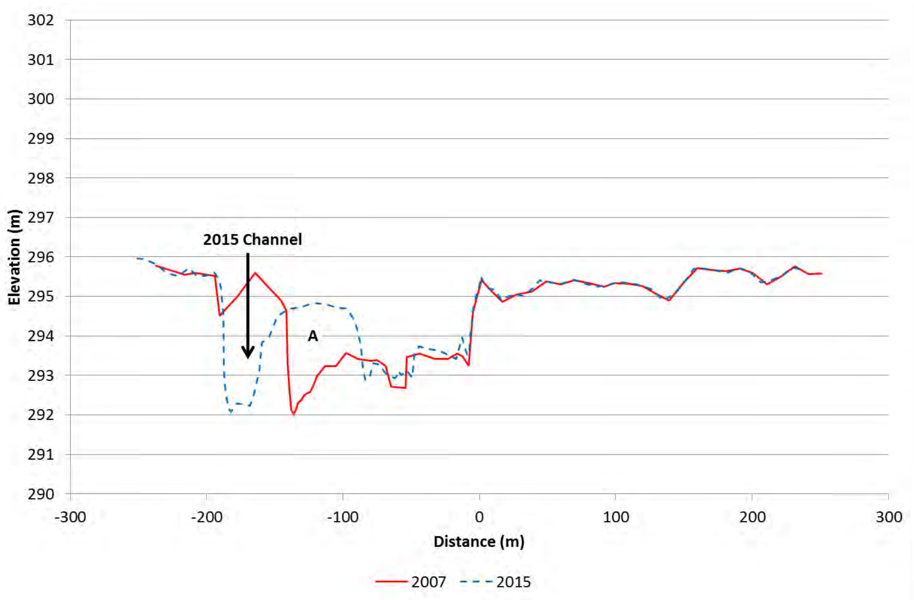

Figure 28. Taieri River cross-section ST6, looking downstream

Figure 29. Cross-section ST6, looking upstream, November 2015

Cross-section ST6 is located 0.93 km downstream of the Moonlight Road bridge. Between 2007 and 2015 the main channel shifted towards the true left and eroded the bank by about 54 m. A gravel island has built up between 2007 and 2015 (at the point labelled A), with minimal change occurring across the wider floodplain.

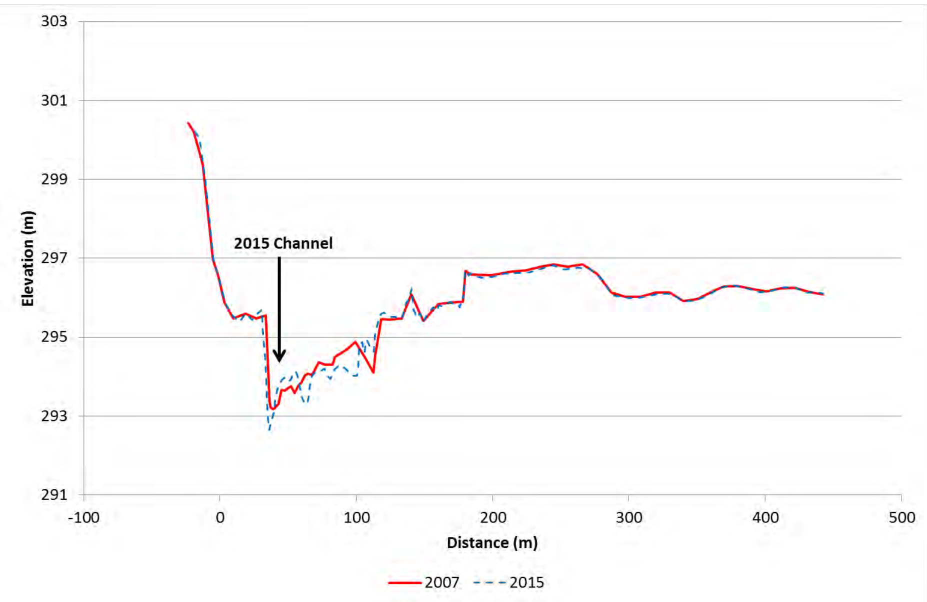

Figure 30. Taieri River cross-section ST7, looking downstream

Figure 31. Cross-section ST7, looking upstream, November 2015

Cross-section ST7 is located at the Moonlight Road bridge. The main channel has become more confined between 2007 and 2015 as well as more undulating. The true right berm area has degraded, with minimal change occurring across the wider floodplain between 2007 and 2015.

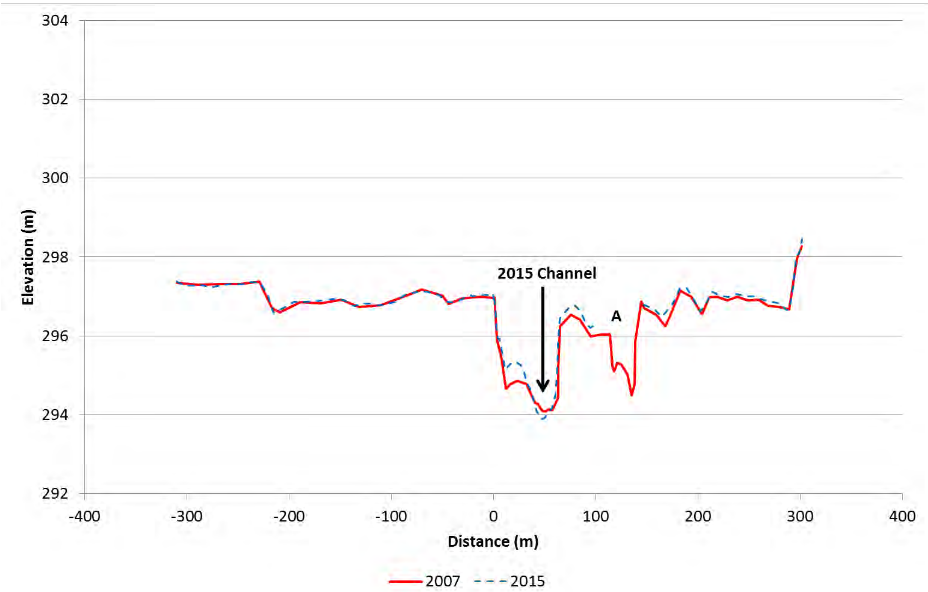

Figure 32. Taieri River cross-section ST8, looking downstream

Figure 33. Cross-section ST8, looking from the true left to true right bank, November 2015

Cross-section ST8 is located 0.18 km upstream of the Moonlight Road bridge. Between 2007 and 2008 the main channel has become more confined. A secondary channel (at the point labelled A) does not contain sufficient survey points in the 2015 survey to allow a comparison to be made. The wider floodplain has remained similar between 2007 and 2015.

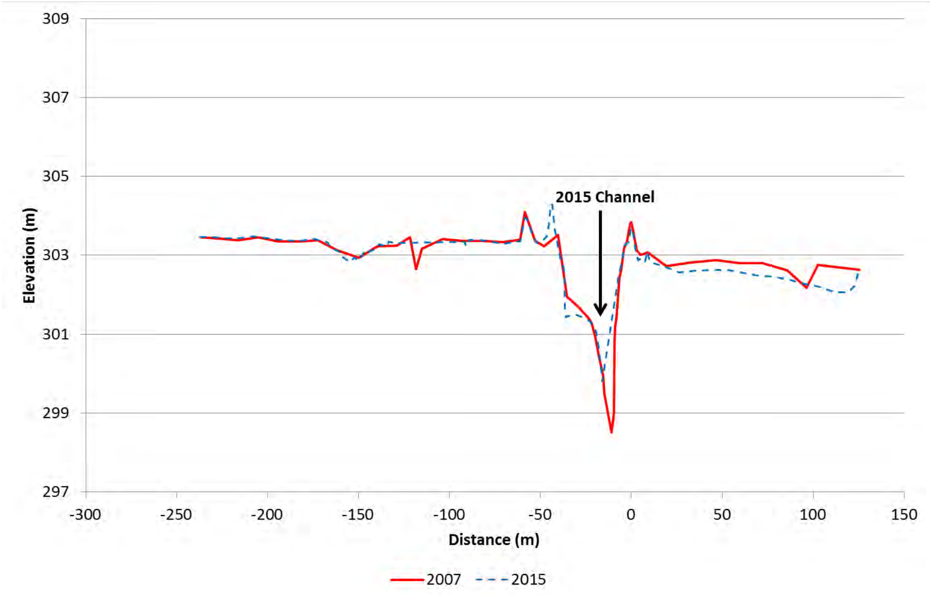

Figure 34. Taieri River cross-section ST9, looking downstream

Figure 35. Cross-section ST9, looking downstream, November 2015

Cross-section ST9 is located 5.4 km upstream of the Moonlight Road bridge. The main channel has aggraded between 2007 and 2015. The true right floodplain has experienced degradation between 2007 and 2015.

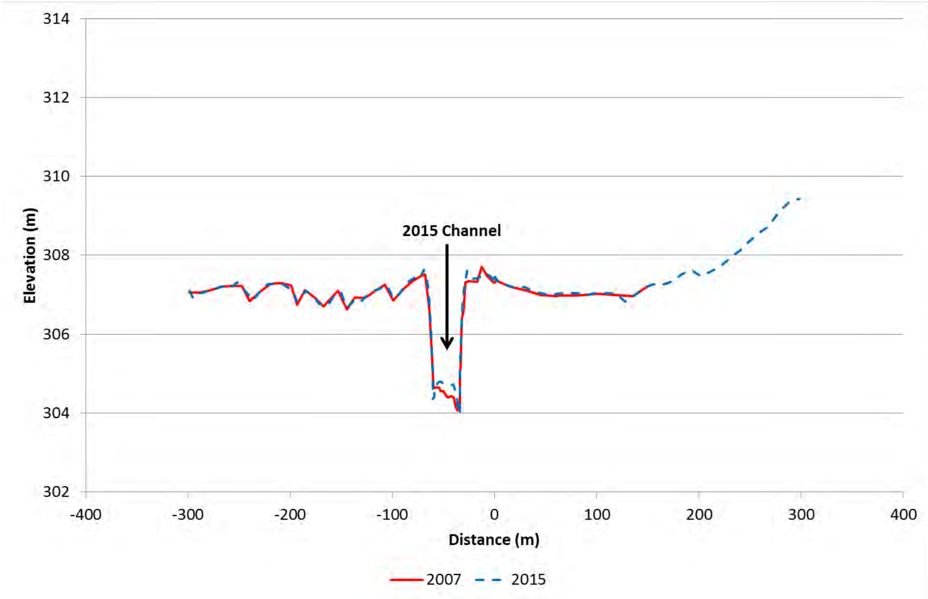

Figure 36. Taieri River cross-section ST10, looking downstream

Figure 37. Cross-section ST10, looking upstream, November 2015

Cross-section ST10 is located at the end of Pugh Road, 8.2 km upstream of the Moonlight Road bridge. Aggradation has occurred in the main channel between 2007 and 2015, with minimal change occurring across the wider floodplain.

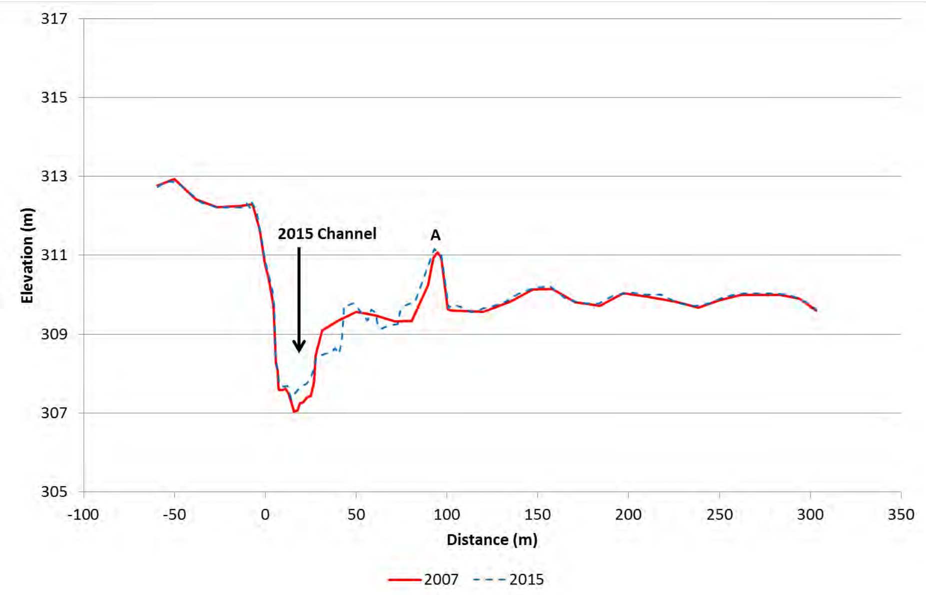

Figure 38. **Taieri River cross-section ST11, looking downstream**

Figure 39. **Cross-section ST11, looking downstream, November 2015**

Cross-section ST11 is located 10.2 km upstream of the Moonlight Road bridge. Between 2007 and 2015 the main channel has aggraded, with some erosion occurring on the true right channel bank. A feature (at the point labelled A) has become wider and minimal change has occurred across the wider floodplain.

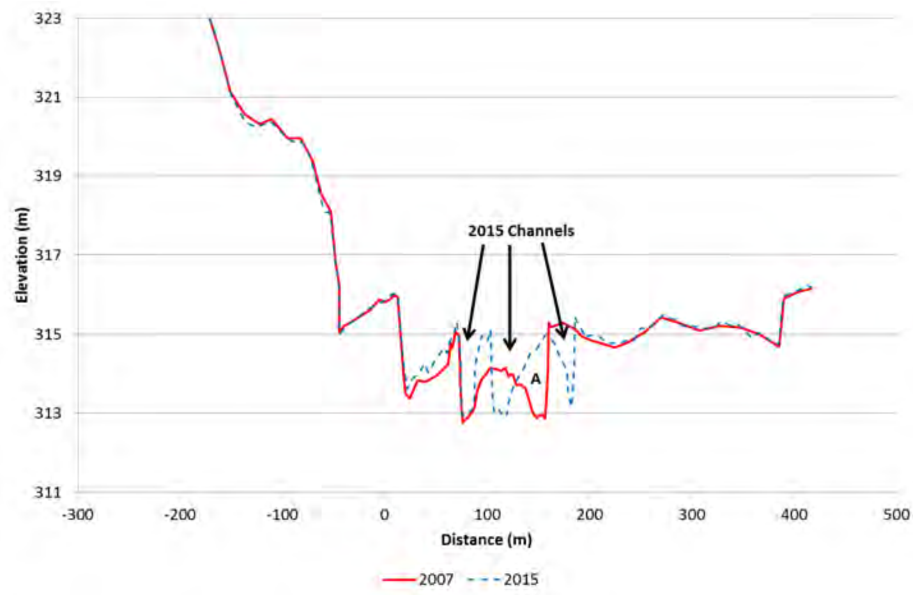

Figure 40. Taieri River cross-section ST12, looking downstream

Figure 41. Cross-section ST12, looking upstream, November 2015

Cross-section ST12 is located 12.9 km upstream of the Moonlight Road bridge. Between 2007 and 2015 the true left berm area experienced aggradation. In 2007 there were two main low flow channels. In 2015 the main channel has split into three low flow channels, which has caused the true right bank to erode, as well as creating more confined channels separated by a gravel bar (at the point labelled A). The wider floodplain has experienced minimal change between 2007 and 2015.

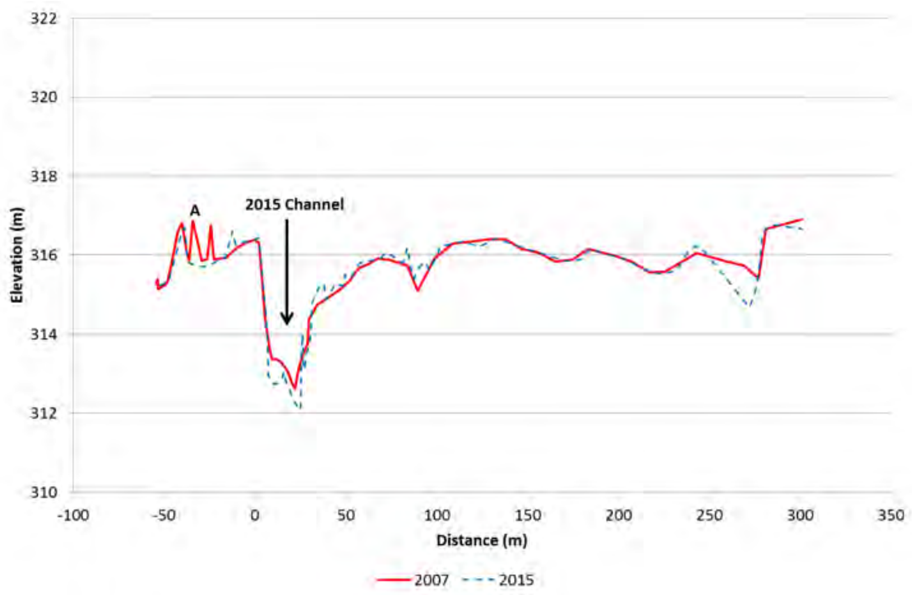

Figure 42. **Taieri River cross-section ST13, looking downstream**

Figure 43. **Cross-section ST13, looking upstream, November 2015**

Cross-section ST13 is located 13.2 km upstream of the Moonlight Road bridge. Features located on the true left berm (at the point labelled A) in 2007 have been eroded and are not present in 2015. The main channel has degraded, with both aggradation and degradation occurring across the wider floodplain.

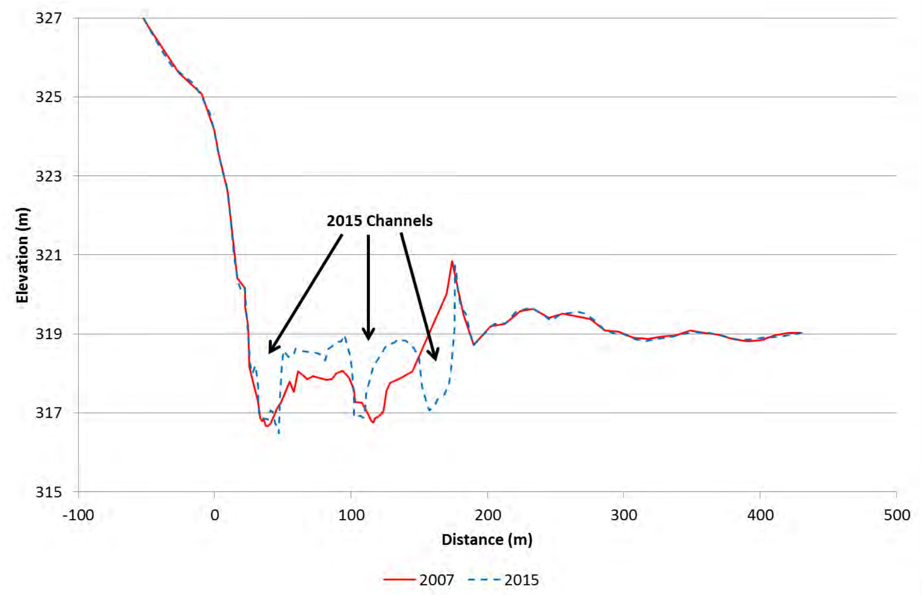

Figure 44. **Taieri River cross-section ST14, looking downstream**

Figure 45. **Cross-section ST14, looking from the true right to true left bank, November 2015**

Cross-section ST14 is located 14.9 km upstream of the Moonlight Road bridge. In 2007 there were two low flow channels at this location. In 2015 three low flow channels have developed, causing some erosion of the true right bank and both aggradation and degradation within the active fairway.

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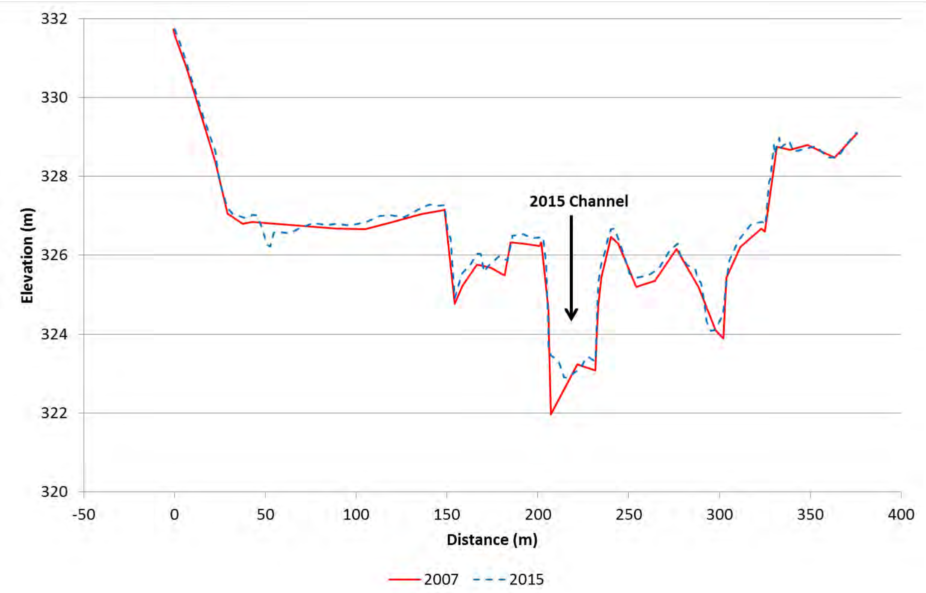

Figure 46. Taieri River cross-section ST15, looking downstream

Figure 47. Cross-section ST14, looking downstream, November 2015

Cross-section ST15 is located 18.3 km upstream of the Moonlight Road bridge. Between 2007 and 2015 the main channel experienced aggradation. The wider floodplain also experienced aggradation, with some minor degradation between 2007 and 2015.

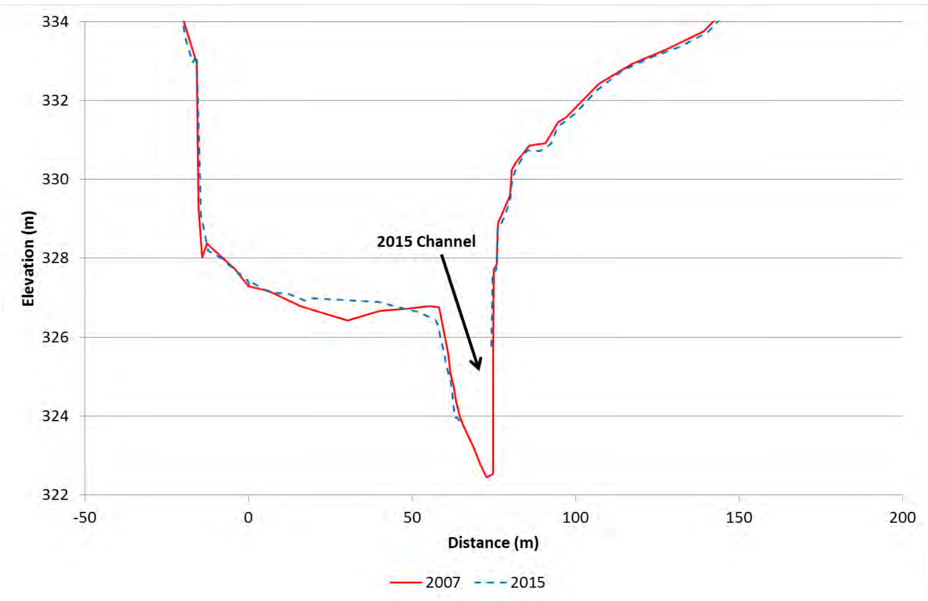

Figure 48. Taieri River cross-section ST16, looking downstream

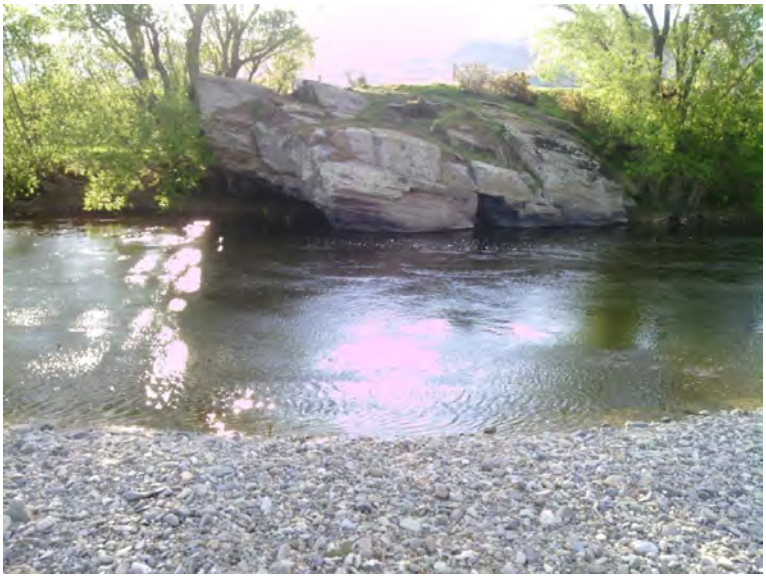

Figure 49. Cross-section ST16, looking from the true right to true left bank, November 2015

Cross-section ST16 is located 14.1 km downstream of the Hyde-Macraes Road bridge. The main channel does not contain sufficient survey points in the 2015 survey to allow a comparison to be made. The true left berm has experienced aggradation, with some minor erosion of the channel edge between 2007 and 2015.

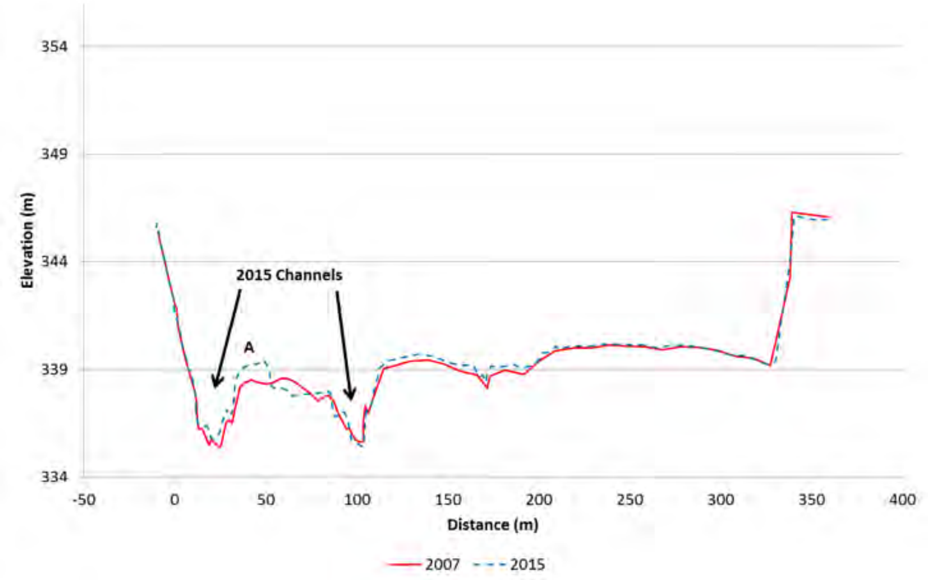

Figure 50. Taieri River cross-section ST17, looking downstream

Figure 51. Cross-section ST17, looking downstream, November 2015

Cross-section ST17 is located 9 km below the Hyde-Macraes Road bridge. The true left low flow channel and the mid channel bar (at the point labelled A) has aggraded between 2007 and 2015, with some degradation present on the true right of the bar. The true right floodplain has experienced aggradation and minimal change between 2007 and 2015.

Otago Regional Council

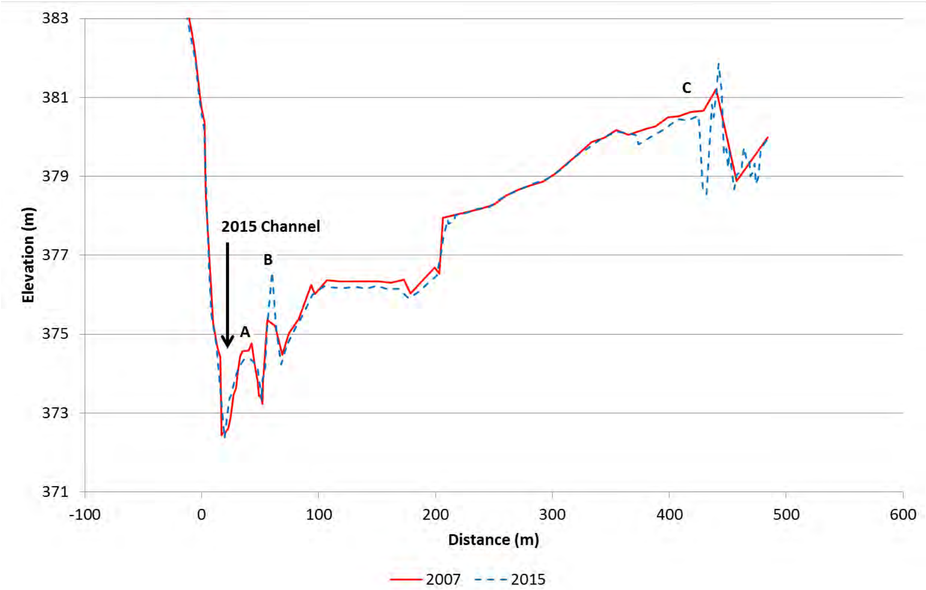

Figure 52. Taieri River cross-section ST18, looking downstream

Figure 53. Cross-section ST18, looking upstream, November 2015

Cross-section ST18 is located 2.1 km upstream of the Hyde-Macraes Road bridge. The main channel has remained in a similar position between 2007 and 2015, with some degradation occurring on the gravel bar (at the point labelled A). A feature on the true right of the channel (at the point labelled B) has aggraded, and degradation has occurred on the true right berm area between 2007 and 2015. The right side of the cross-section (at the point labelled C) is showing degradation between 2007 and 2015 and can be associated with industrial activity.

Appendix 5. Taieri River corridor/fairway maps.

The river fairway and corridor provides guidance for multi-purpose river management, and for the design and implementation of management measures, protection works and in-channel design. When physical works or activities are being considered within the fairway or on the riparian margin, these should be undertaken with reference to the mapped fairway and buffer zones. The method used to define the river corridor is explained in Section 7.1.

Figure 54. Taieri River fairway and corridor Map 1 (aerial photography collected 2013)

Figure 55. Taieri River fairway and corridor Map 2 (aerial photography collected 2013)

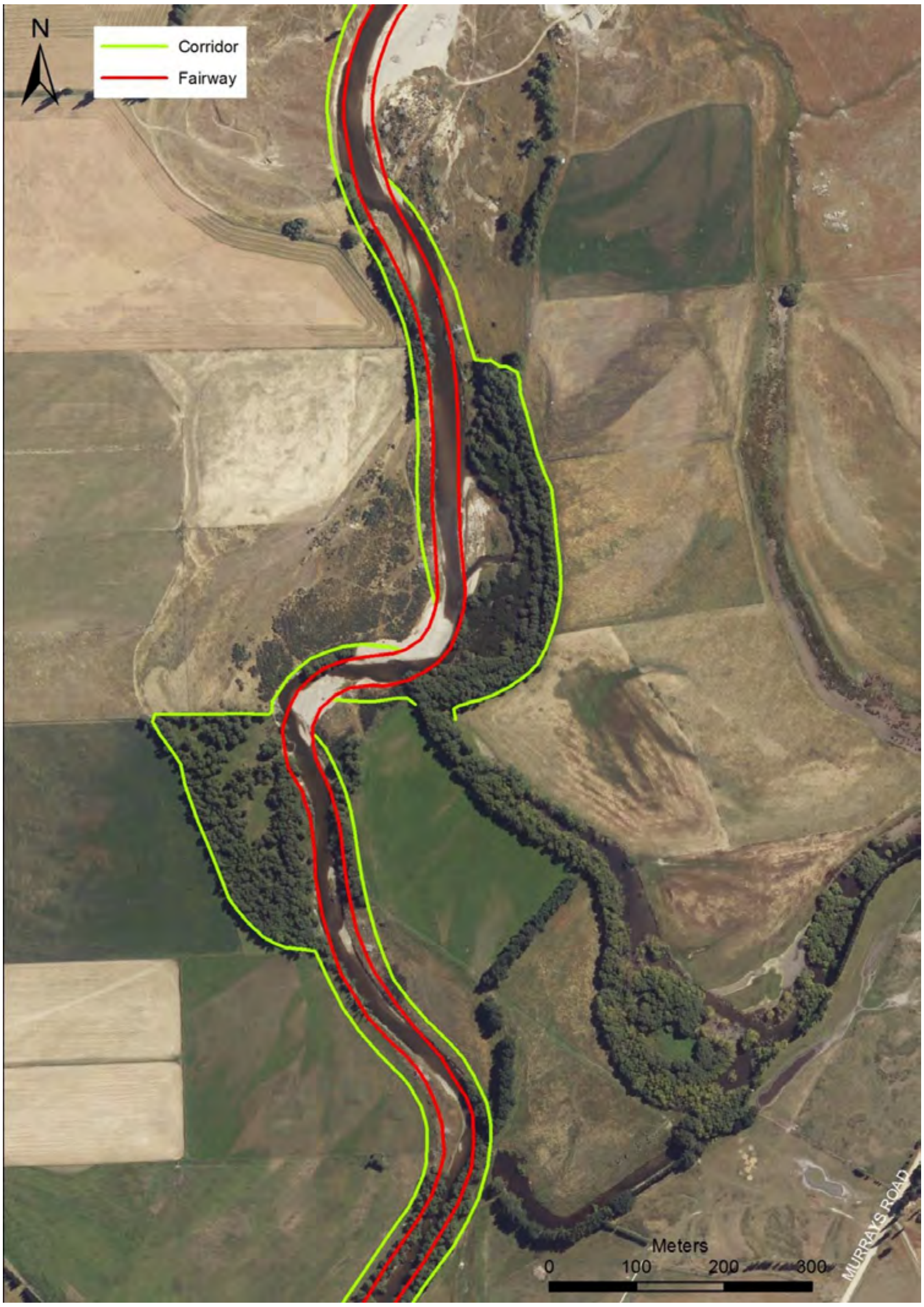

Figure 56. **Taieri River fairway and corridor Map 3 (aerial photography collected 2013)**

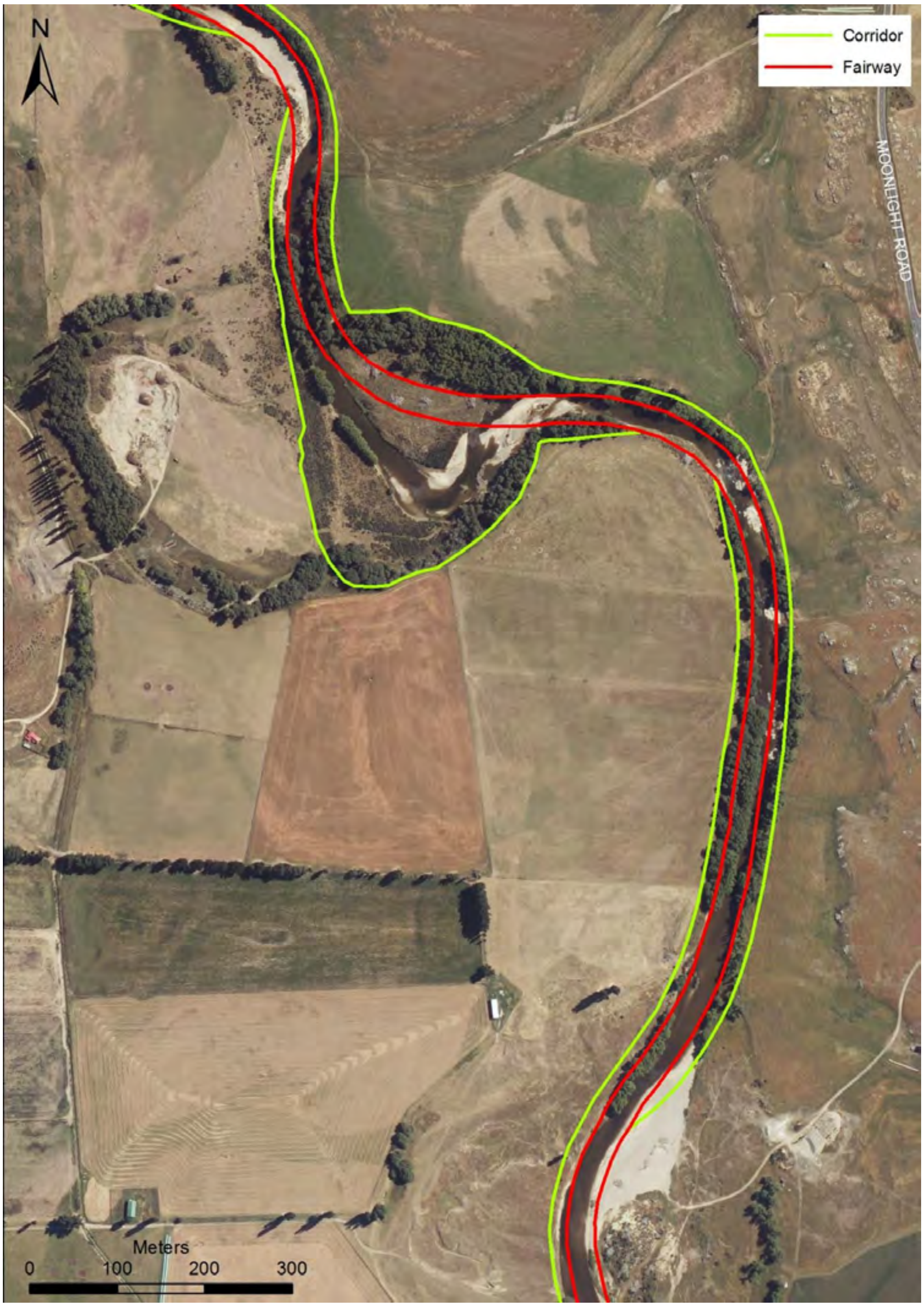

Figure 57. **Taieri River fairway and corridor Map 4 (aerial photography collected 2013)**

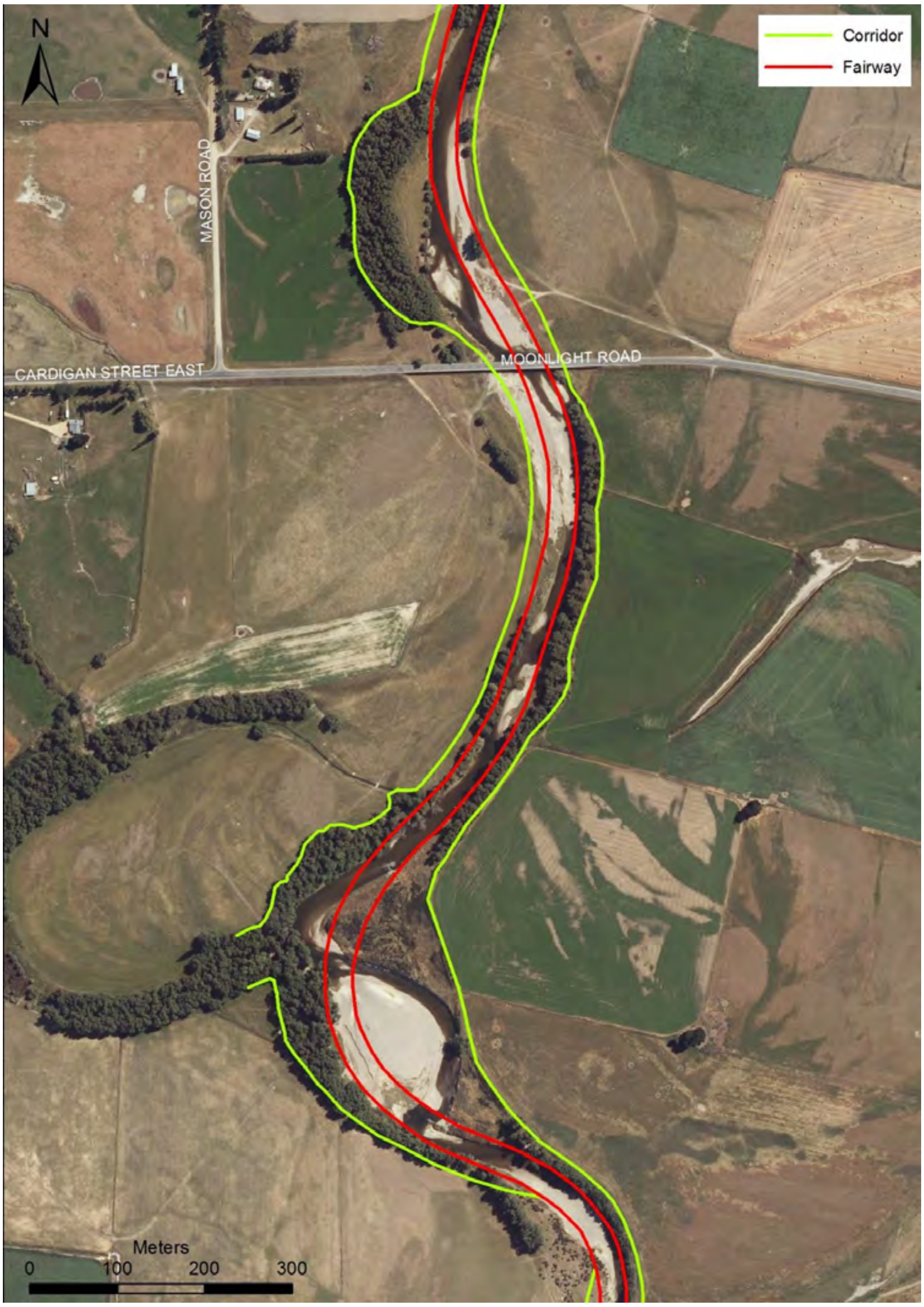

Figure 58. Taieri River fairway and corridor Map 5 (aerial photography collected 2013)

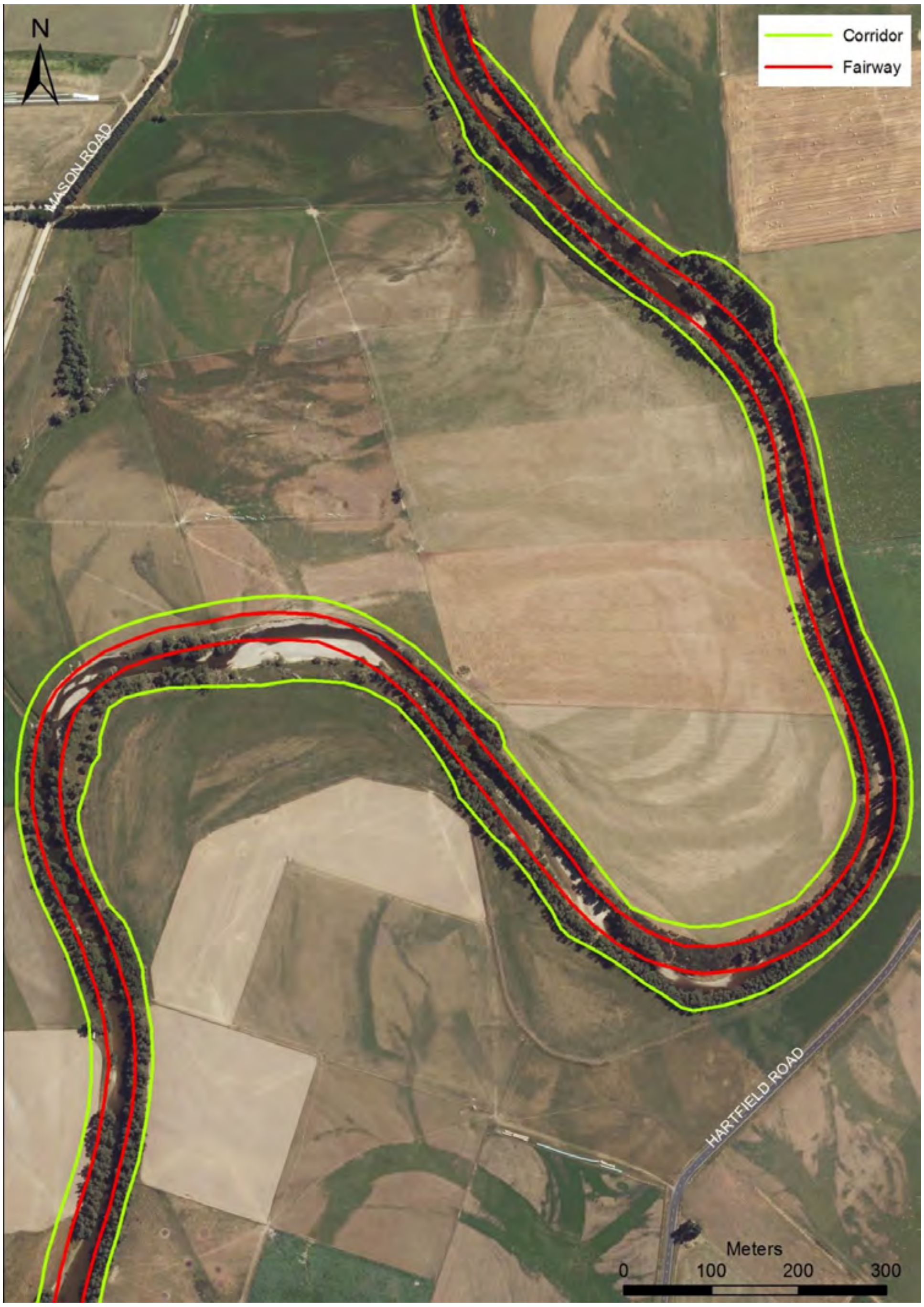

Figure 59. **Taieri River fairway and corridor Map 6 (aerial photography collected 2013)**

Figure 60. **Taieri River fairway and corridor Map 7 (aerial photography collected 2013)**

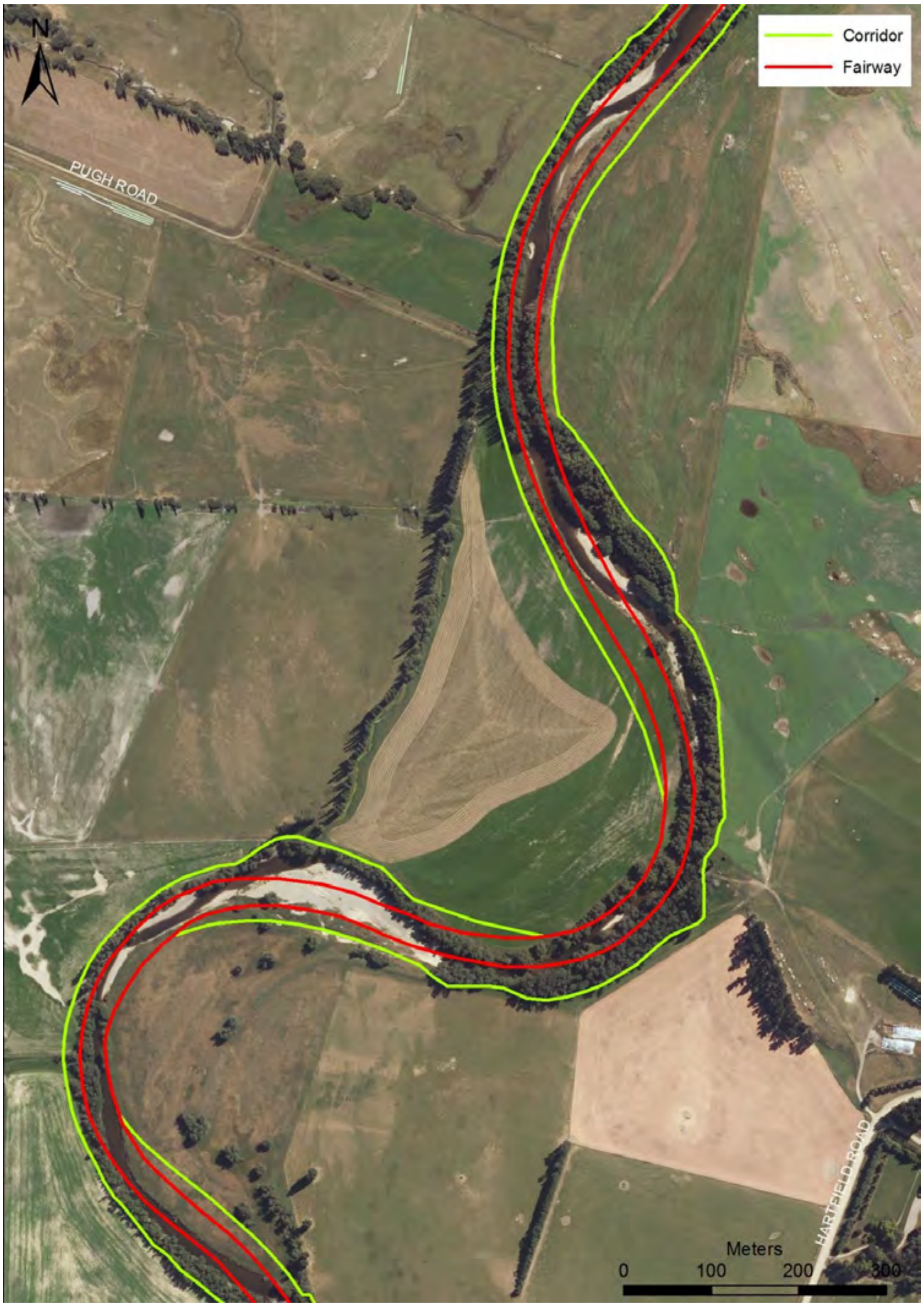

Figure 61. Taieri River fairway and corridor Map 8 (aerial photography collected 2013)

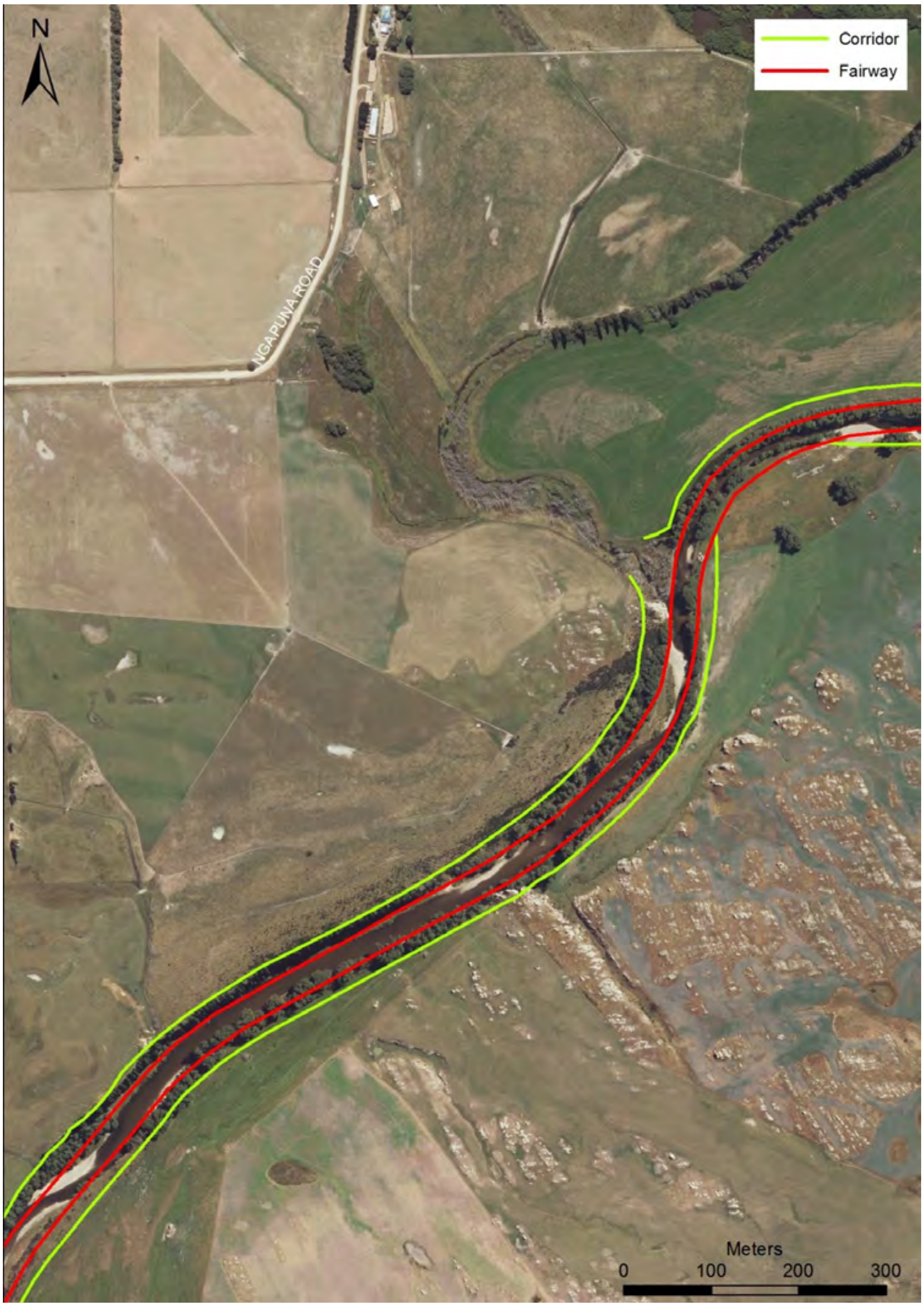

Figure 62. Taieri River fairway and corridor Map 9 (aerial photography collected 2013)

Figure 63. **Taieri River fairway and corridor Map 10 (aerial photography collected 2013)**

Figure 64. Taieri River fairway and corridor Map 11 (aerial photography collected 2013)

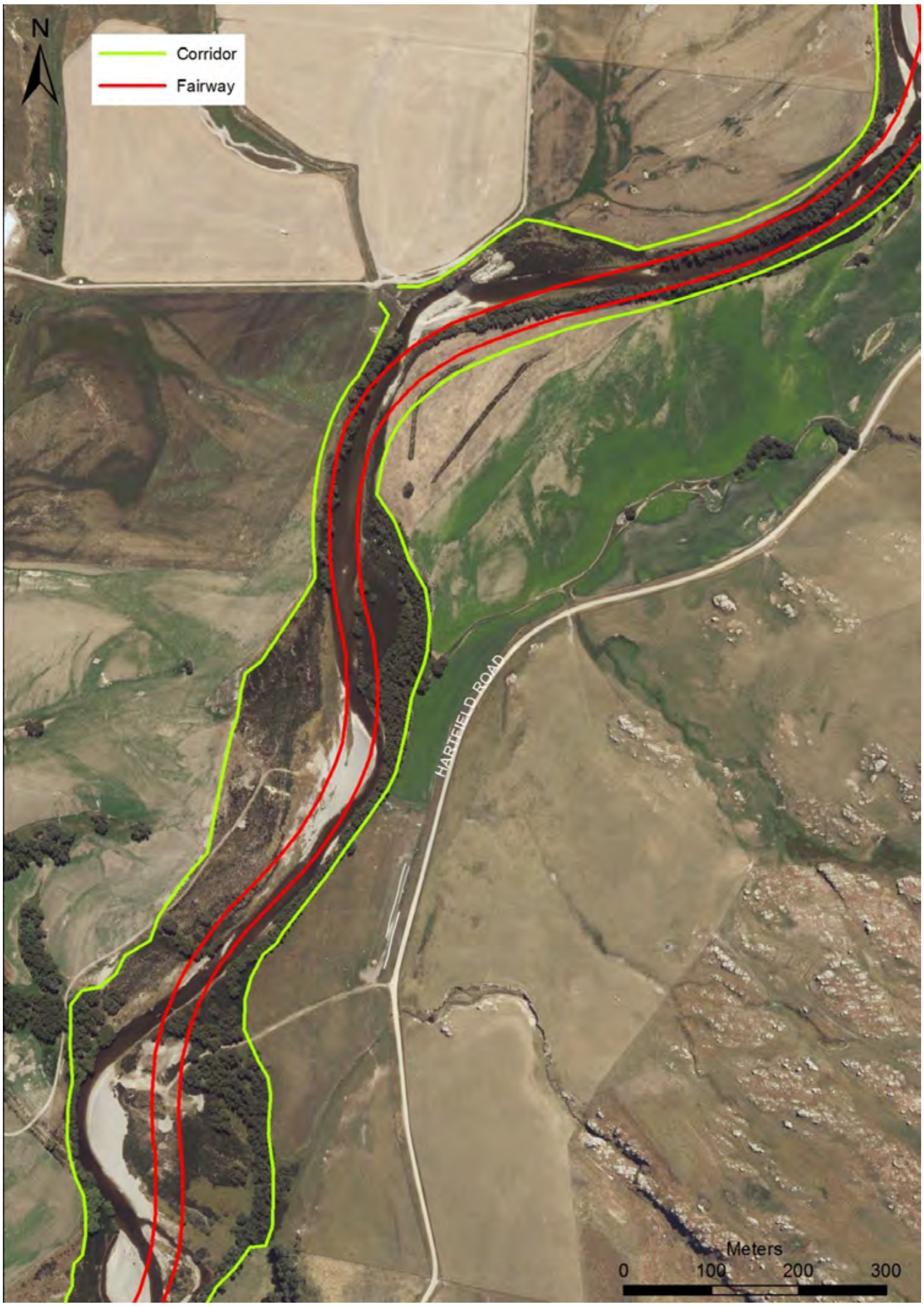

Figure 65. Taieri River fairway and corridor Map 12 (aerial photography collected 2013)

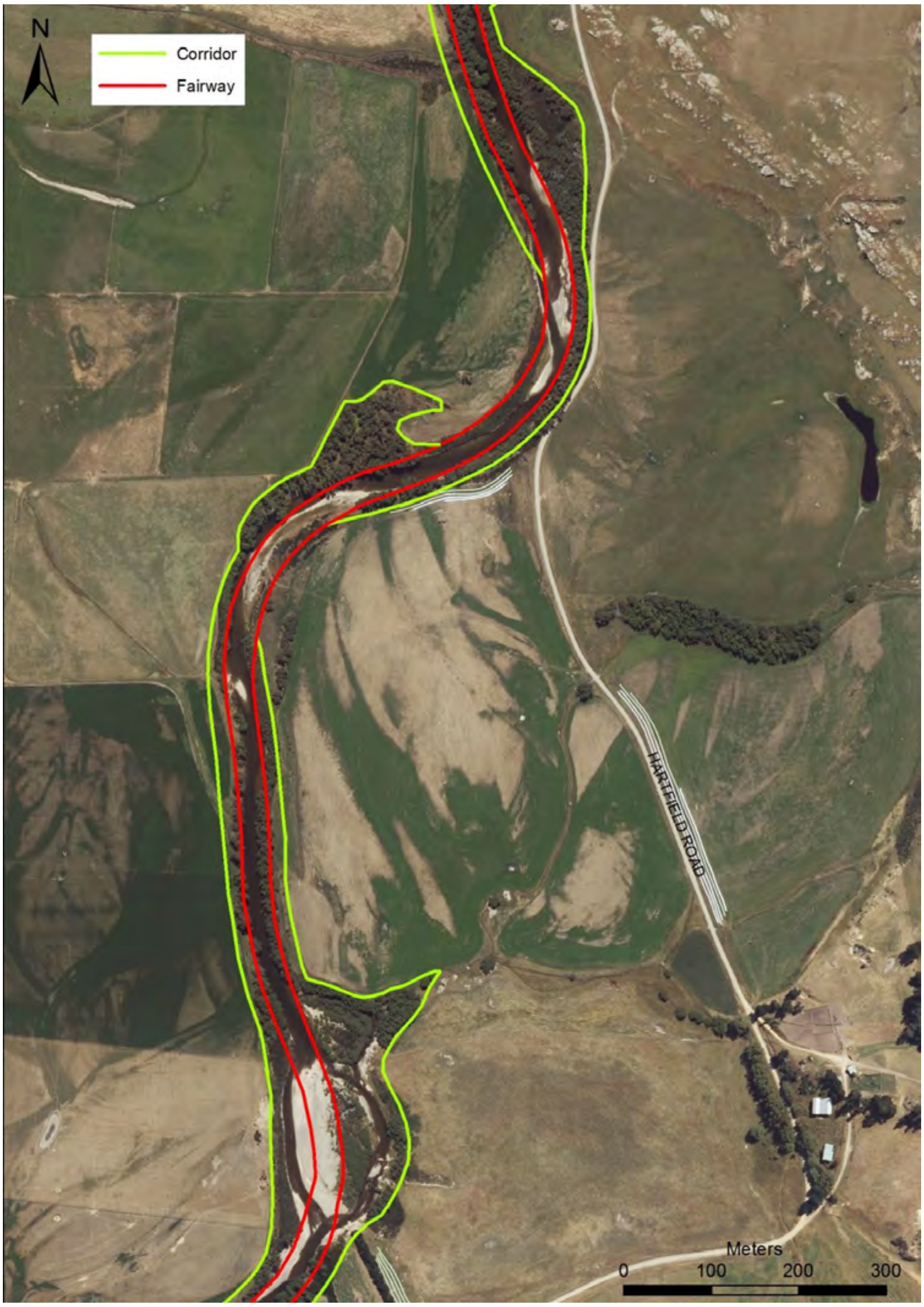

Figure 66. Taieri River fairway and corridor Map 13 (aerial photography collected 2013)

Figure 67. **Taieri River fairway and corridor Map 14 (aerial photography collected 2013)**

Figure 68. **Taieri River fairway and corridor Map 15 (aerial photography collected 2013)**

Appendix 6. Community consultation - public submissions

The community consultation undertaken from March to May 2016 included an opportunity for the public to submit on their concerns, as well as a chance to state what they valued about the Taieri River and what they would like the strategy to achieve. A diverse range of views and concerns were put forward: some people were concerned that that has been insufficient or too much gravel extraction occurring, while others were more concerned with maintenance of the riparian margins e.g. willow planting and removal, habitat for native and exotic fish, and a lack of understanding of the permitted activity rules. An ongoing topic raised at the public meetings was with regard to the difficulty and cost associated with obtaining a resource consent to extract gravel/ The community also discussed the importance of being able to protect their own land. Feedback received through the consultation process highlighted a lack of clear and consistent communication between ORC and the community, as well as wanting to take a holistic approach to management of the Taieri River, including areas outside of the strategy study area. The placement of irrigation infrastructures on the banks of the Taieri River in an appropriate manner, as well as ensuring ongoing access, were points that were also raised through the feedback process.

Appendix 7. Reference list

Canterbury Regional Council, 2015: *Canterbury Regional River Gravel Extraction Code of Practice July 2015*, Christchurch, New Zealand.

Fuller, I. C.,Basher, L. S., Hicks, D. M. 2014: *Towards understanding river sediment dynamics as a basis for improved catchment, channel, and coastal management: the case of the Motueke catchment, Nelson, New Zealand*, International Journal of River Basin Management**,** 12, 3, P. 1-18.

Marden, M., Rowan, D., Phillips, C. 2005: *Stabilising characteristics of New Zealand indigenous riparian colonising plants*, Plant and Soil, 278, P. 95-105.

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Pomahaka River morphology and riparian management strategy

Version 1.0 – May 2016

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Overview

The Pomahaka River morphology and riparian management strategy has been prepared by the Otago Regional Council (ORC), with input from the local community, to help protect the recreational, cultural and ecological values of the Pomahaka riverbed, and to enable long-term sustainable use of the land that borders the river. The strategy, as summarised in the two diagrams overleaf, is intended to help achieve this by guiding work programs, decision-making, and activities for the community, stakeholders, and ORC. It is therefore recommended that people who live, work, or play within the Pomahaka River catchment consider, and give effect to, the principals, objectives, and actions listed in this strategy.

The strategy is not a statutory document; rather it is intended to present the aspirations of the community and the various stakeholder agencies. However, the statutory processes that do influence river management activities[1] are more likely to be used effectively and efficiently if there is a general consensus on what is valued about the river, and commonly understood objectives.

The strategy is intended to be a living document, which will evolve in response to new information, changes in the environment, the needs of the community, and the work of the ORC and other stakeholders. The strategy will be reviewed regularly, and this process will involve landowners with property alongside the river, other stakeholders, and ORC,[2] and will help to set priorities and work programmes for all of these groups. The strategy document will also record progress made towards achieving the stated objectives. It is intended that version 2 of the strategy will include further guidance and plans for undertaking planting on riparian margins, for river management purposes, and for habitat enhancement.

[1] Including the Local Government Act (in regards to funding considerations), and the Resource Management Act (in regards to environmental effects)

[2] In particular, staff with responsibilities for river and waterway management and natural hazards

Pomahaka River morphology and riparian management strategy - overview

Purpose

- To provide guidance to landowners, stakeholders, and the community for good decision-making and appropriate activities within the riverbed and on the riparian margins of the Pomahaka River.

Vision

- The long-term sustainable use and enjoyment of the Pomahaka River and its riparian margins.

Functions

Appropriate guidance and active engagement to empower good decision-making and to ensure that activities are undertaken in a sustainable and appropriate manner.

Understand natural river processes and morphological characteristics, and the potential effects of those on the river and its margins.

The wise use of resources to:

- Manage the risk to property and assets
- Enable sustainable gravel extraction
- Protect and enhance community values
- Improve community resilience.

A shared vision of the river's values and features to be utilised, preserved and enhanced.

Pomahaka River morphology and riparian management strategy - overview

Objectives & associated activities (these are further refined in Section 8 - implementation)

Objective 1. To recognise and characterise natural river processes.	Objective 2. To equip the community to live with the effects of changes in river morphology.	Objective 3. To enable sustainable gravel extraction.	Objective 4. To promote activities that enhance the natural character and enjoyment of the river.
• Collect information about flood and erosion processes • Report on changes in channel morphology • Provide information to the community • Identify the location of river corridors, within which the river will naturally meander.	• Promote land-use practices and the placement of assets that reduce the risk associated with changes in riverbed morphology • Consider all available options to manage the effects of bank erosion, including structural and non-structural options • Enable works that will, where necessary, improve the conveyance of floodwater and 'train' the river within its natural corridor, without compromising the features that are of high value to the community and iwi.	• Identify areas where gravel accumulation can naturally occur • Identify areas where permanent removal of gravel may have a detrimental effect on assets, riverbed morphology or community values • Identify minimum bed levels/profiles, below which extraction will not occur.	• Provide maps showing the location and characteristics of features that are of high value to the community • Encourage the establishment of riparian plantings that are practical and appealing • Provide access and habitat for fishing and white-baiting activities • Support pest and weed control activities • Discourage dumping, and arrange the regular collection of rubbish.

Contents

1. Introduction

Changes in the morphology (physical form) of riverbeds occur as a result of natural processes that are often uncontrollable, and also from human intervention. The Pomahaka riverbed is an integral part of the wider Pomahaka River catchment (Figure 1). The Pomahaka riverbed is part of a dynamic river system, and has experienced changes in morphology in recent decades. These changes will have occurred in response to naturally occurring flood events, as well as gravel extraction activities and historic river management decisions. Changes to riverbed morphology have included degradation[3] and sedimentation within the main channel and significant bank erosion in places (Figure 2). In some cases these changes have negatively affected the values placed upon the river by the community and stakeholders (landowners, iwi, Fish & Game New Zealand, Department of Conservation (DoC), Clutha District Council (CDC), and residents).

Land alongside the river channel is often referred to as the ‘riparian margin’. More intensive use of the land that borders the river has occurred in recent decades, with valuable farmland replacing what was previously rough vegetation. As a result, changes in the position and form of the riverbed can cause issues for landowners and other river users. The Pomahaka River is valued as a recreational, commercial, and cultural resource e.g. picnicing, swimming, fishing, and farming (Gregory, 2014).

The Otago Regional Council (ORC) has proposed the Pomahaka River morphology and riparian management strategy (‘the strategy’) to help provide guidance (for all users of the river) for good decision-making and appropriate activities on the riverbed and riparian margins of the Pomahaka River. The strategy has a vision of long-term sustainable use and enjoyment of the Pomahaka riverbed and its riparian margins. It is also important when undertaking activities within the riverbed and on the riparian margins of the Pomahaka River that people recognise, and allow for, the traditional, spiritual, and cultural values of local iwi.

The strategy’s key objectives are to:

- Recognise and characterise the natural river and catchment processes that occur in the Pomahaka River
- Equip the community to understand, and live with, the effects of changes in river morphology
- Enable sustainable gravel extraction
- Promote activities that enhance the natural character and enjoyment of the river.

The strategy is also intended to guide the nature and extent of land-use, so that the negative effects of morphological changes in the riverbed do not increase and, where possible, are progressively reduced. It provides a framework for decision-making, so that activities undertaken by people occur in such a way that the results are:

[3] The term ‘degradation’ in this case refers to the wearing down of the channel by the erosive action of water.

- A visually appealing river system
- A habitat that supports existing wildlife, fish, and preferred plant species
- Limited effects on assets as a result of flood events
- Resilient infrastructure (roads, bridges, water supply)
- Continued use of the river for recreational activities.

Many of the actions listed in this strategy are voluntary and will rely on interactions between the key stakeholders and the community to be successful. It is therefore recommended that people who live, work, or play in the Pomahaka River catchment consider, and give effect to, the principles, objectives, and actions listed in the strategy.

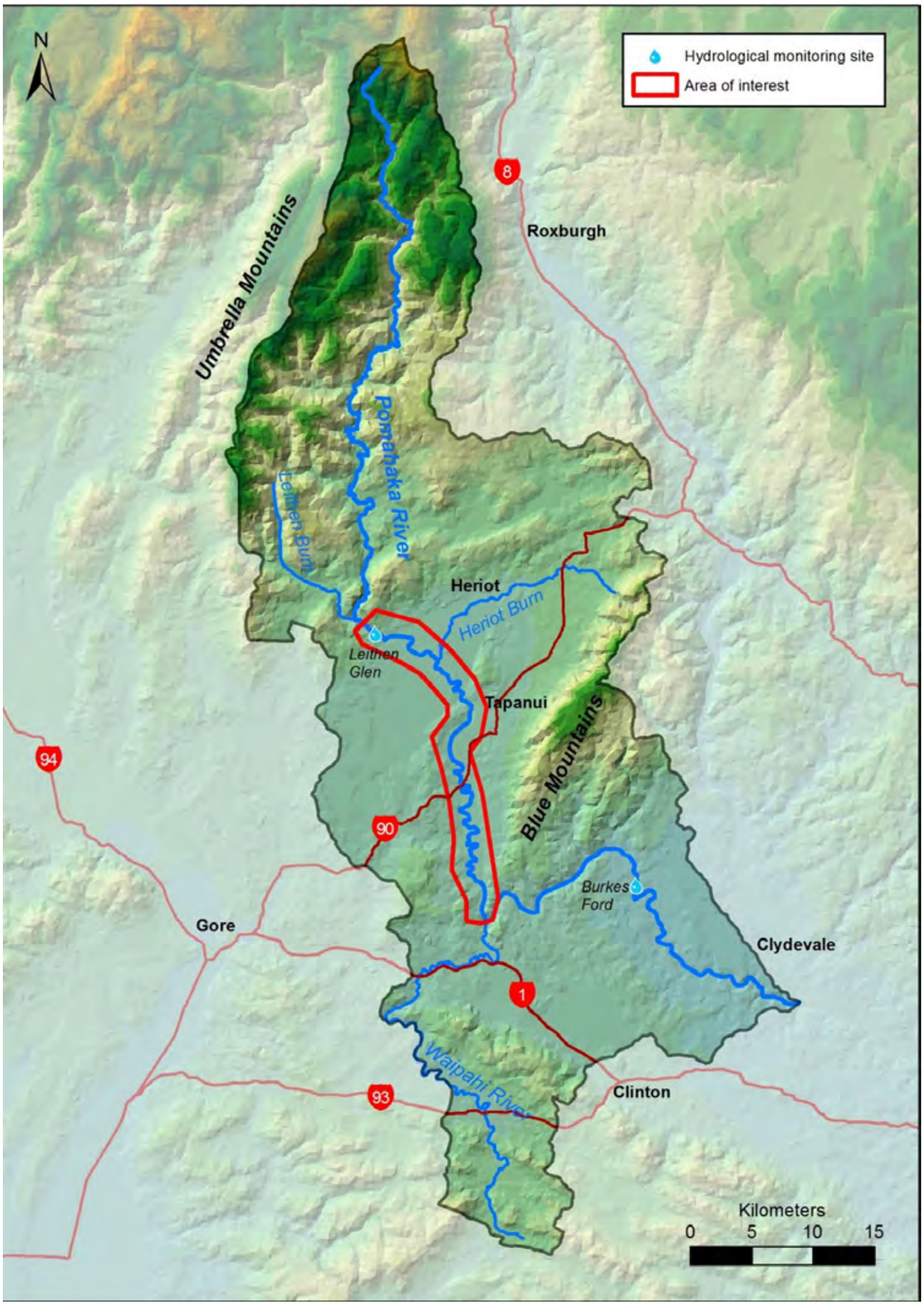

Figure 1. **Pomahaka River catchment boundary, showing main tributaries and the area of interest**

Figure 2. Examples of changes in channel morphology. Top: bank erosion downstream of the Greenvale Road bridge (November 2015); bottom: bank erosion at Camperdown Bend (August 2015)

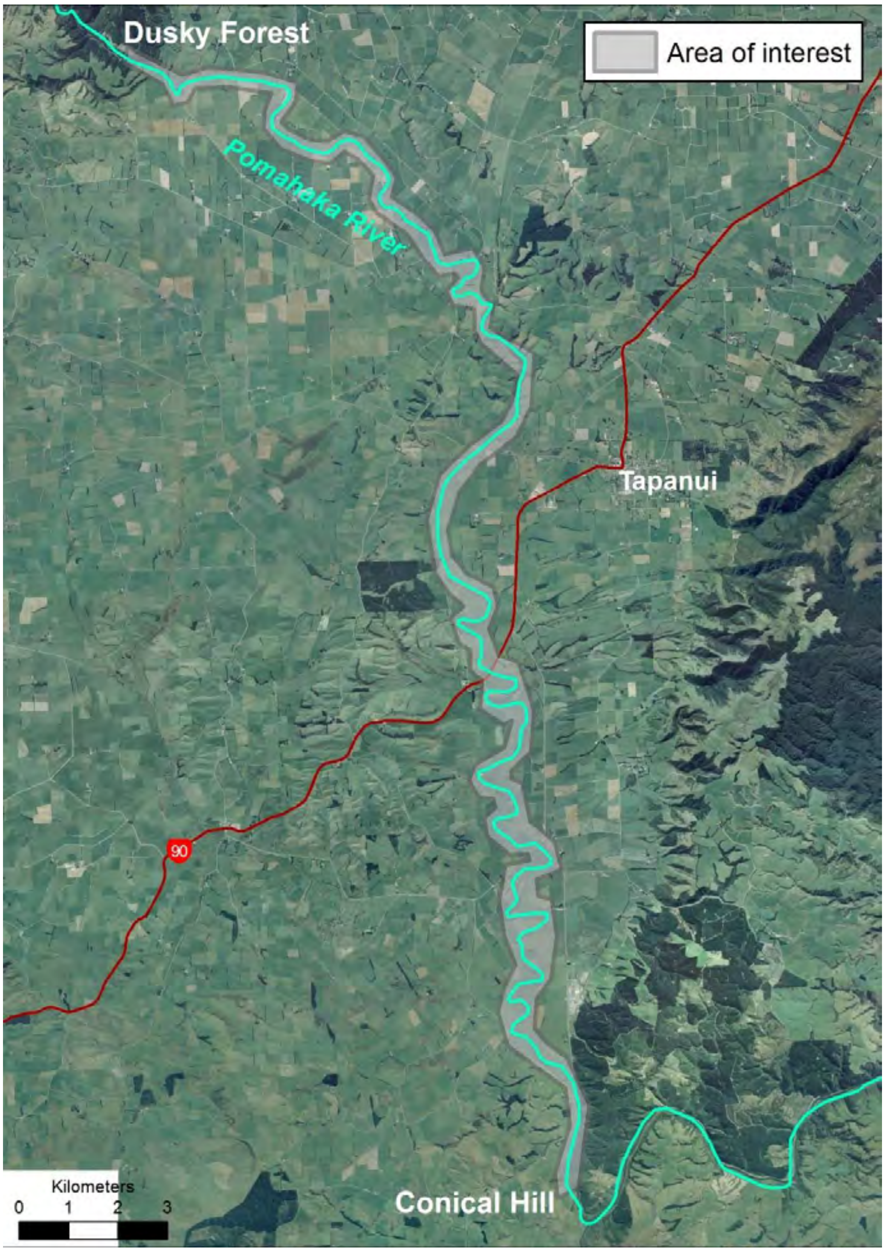

Figure 3. Map showing the reach of the Pomahaka River, to which this strategy applies

2. Scope

2.1. Study reach

The geographical scope of the strategy is the reach of the Pomahaka River between Dusky Forest and Conical Hill (Figure 3). Activities that occur in the upper catchment of the Pomahaka River and in other tributary streams may have an effect on the study reach. The upper reaches and tributary streams were not investigated in this report, as most concerns previously raised by the community were located in the study reach. The focus was therefore on this location. Other areas in the Pomahaka River catchment may also experience problems and issues associated with river processes; however these are not examined here.

2.2. Risk

The strategy has a focus on the risks and effects associated with changes in riverbed morphology (including channel degradation and bank erosion, sedimentation, and flooding) in the study reach of the Pomahaka River. However, it is acknowledged that heavy rainfall events may lead to a range of other risks, including widespread flooding and surface runoff.

There are several other environmental issues and hazards in the Pomahaka River catchment. These include natural hazards such as seismic activity, as well as water quality and quantity issues. While numerous other issues do exist, this strategy is primarily concerned with the negative effects of changes in river form on the values associated with the Pomahaka River. Guidance and regulations relating to other issues can be obtained from the ORC.[4]

2.3. Strategy development

The strategy is intended to be a living document, which will evolve in response to new information and changes in river morphology,[5] the needs of the community, and the work of the ORC and other stakeholders. It will be reviewed regularly as part of council's annual and long term planning process, or in response to large flood events. The review process will involve landowners with property alongside the river, other stakeholders, and ORC staff with responsibilities for river and waterway management and natural hazards. The review is proposed to monitor the effectiveness of the strategy, the workability of its stated objectives, and to note progress towards achieving those objectives. It will also help ORC to set priorities when considering funding and undertaking river-maintenance work in the rivers concerned.

[4] For example, The Otago Natural Hazards Database, the Water Info website and the Regional Plan: Water; all available from www.orc.govt.nz

[5] Including additional understanding gathered during future flood events

Before the review process, ORC will arrange and facilitate a workshop with the local community and invited stakeholder groups. This will consist of two parts:

- An opportunity for participants to present to the group any issues they face as to changes in channel morphology or riparian management; work they have undertaken or would like to see undertaken; or to discuss, question or suggest changes to the strategy itself.

- A facilitated process to coordinate activity and work towards achieving the principals and objectives outlined in the strategy.

3. Environmental setting

The natural and social settings of the Pomahaka River catchment are described in this section, with particular focus on the special characteristics that give rise to the risks associated with changes in riverbed morphology.

3.1. Geological setting

The reach of the Pomahaka River, to which this strategy applies, is located on the two floodplains between Dusky Forest and Conical Hill. Sediment has been eroded from the hill catchments upstream of the study area and has been subsequently deposited by fluvial processes to create the wide, flat floodplain within which the river sits. The geology of the two floodplains is described as gravel and sandy gravel consisting of late Quaternary (2.5 million years before present) age river and alluvial fan deposits (Figure 4, Figure 5) (Turnbull & Allibone, 2003). The surrounding hills are made up of semischist and metasandstone of the Caples terrane from the Permian period (299 to 252 million years before present) (Turnbull & Allibone, 2003). The Tapanui floodplain also contains Tertiary (25 million years before present) sediments and volcanic outcrops (Turnbull & Allibone, 2003).

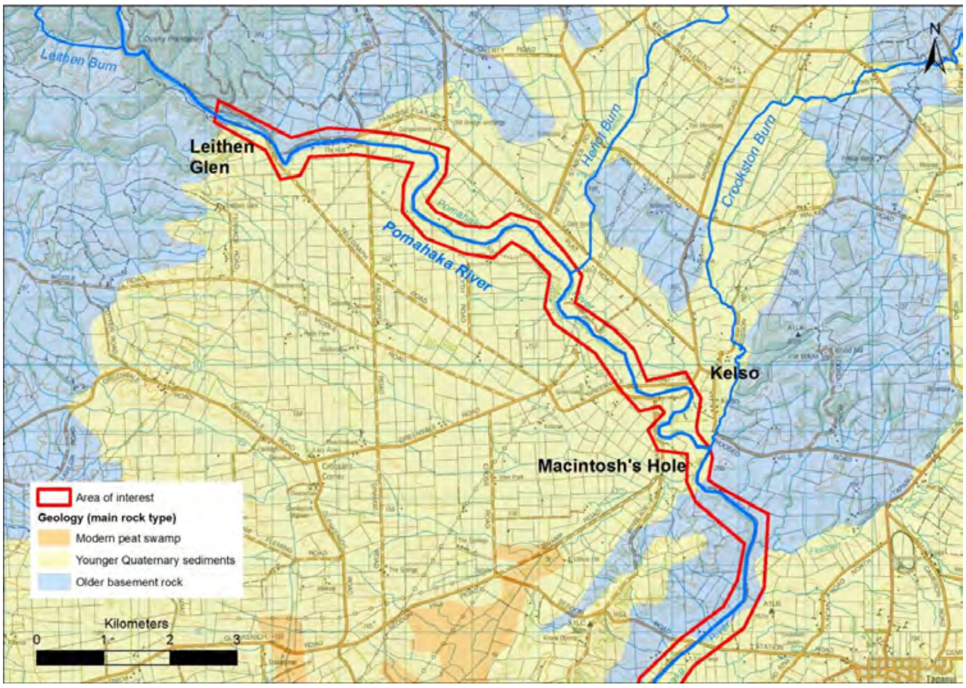

Figure 4. Geological map showing the reach of the Pomahaka River between Dusky Forest and Kelso Gorge

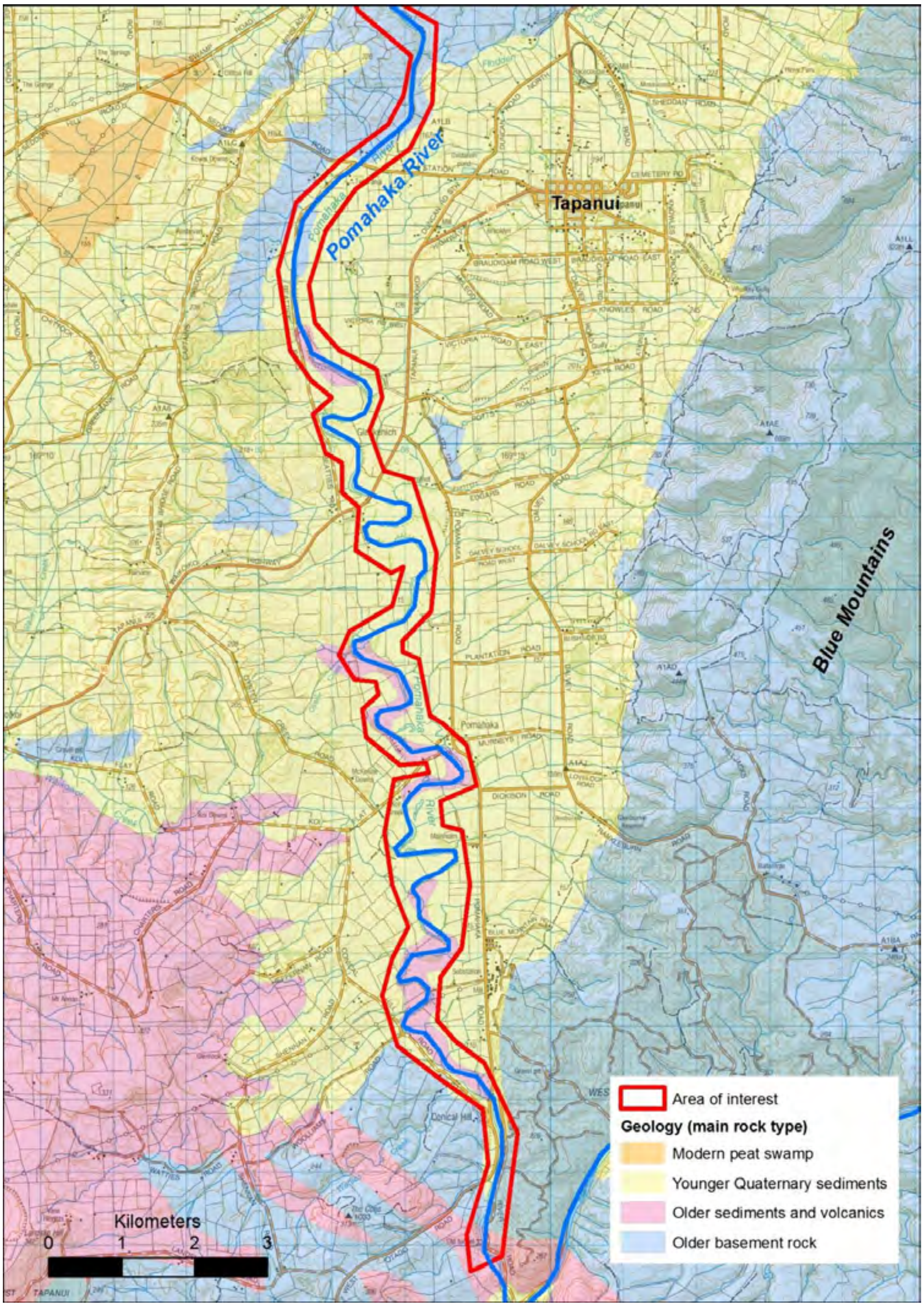

Figure 5. Geological map showing the reach of the Pomahaka between Kelso Gorge and Conical Hill

3.2. Geographical setting

The Pomahaka River catchment is located in southwest Otago and has a total catchment area of 2060 km^2 (ORC, 2007), with several tributaries including the Waipahi River, Heriot Burn, Flodden Creek, and the Leithen Burn. The Pomahaka River catchment contains a diverse range of topography from high altitude mountainous terrain in the upper catchment to rolling hill country and wide floodplains in the lower catchment. The upper reaches of the Pomahaka River originate in the Umbrella Range (west of Roxburgh township) (Figure 1). The Pomahaka River flows south from the Umbrella Range until it emerges from the steeper upper catchment (downstream of Dusky Gorge) at Leithen Glen and heads east onto a wide floodplain. The river then enters the gorge downstream of Kelso (Figure 3) and flows south (past the township of Tapanui), entering another gorge at Conical Hill before heading east along the base of the Blue Mountains, where it then joins the Clutha River/Mata-Au about 6 km southeast of Clydevale.

In the study reach, the Pomahaka River is joined by four main tributaries: the Heriot Burn, Crookston Burn, Flodden Creek, and Waikoikoi Creek. Land-use in the study area is mainly high intensity dairy farming, with smaller farms and higher stocking rates than in the upper catchment (ORC, 2010).

Figure 6. Upper Pomahaka River catchment (November 2015)

3.3. Meteorological setting

The Pomahaka River catchment is located on the east coast of the South Island, within the Clutha District. Flood events in the Pomahaka River catchment are generally caused by heavy rain over a day or longer, due to persistent southeasterly conditions that can be coupled with snow melt in the spring and early summer (ORC, 2007).

The nearest long-term automatic rain gauges are located at Moa Flat, Piano Flat, and Waikaia. Annual average and peak 24 hour rainfall intensities for these sites are listed in Table 1.

Table 1. Annual average and maximum observed 24 hour rainfall intensities for rain gauges in the upper Pomahaka River catchment

Hydrological monitoring site (rain) (date record commences)	Annual average rainfall (mm)	Peak 24 hour rainfall (mm)	Date of peak 24 hr rainfall
Pomahaka at Moa Flat (1988-2015)	838	86	22-23 February 2012
Waikaia River at Piano Flat (1977-2016)	959	103	16-17 January 1980
Wendon Valley at Waikaia (1988-2016)	873	101	20-21 January 2005

3.4. Hydrological setting

Information on river flow is available from two long-term monitoring sites. The Leithen Glen and Burkes Ford recorders have been operating since 1992 and 1961 respectively. The ten largest flows on record for these sites are shown in Figure 7 and Figure 8. The Pomahaka River can rise rapidly during flood events, with a rate of rise greater than 150 m^3 per hour observed. Average velocities observed at these sites range from 2 to 3 m/sec, with velocities likely to be higher in the steeper, more confined sections of the Pomahaka River.

Table 2. Summary of hydrological information for sites within the Pomahaka River catchments

Hydrological monitoring site (river flow) (date record commences)	Maximum observed flow (m^3/sec) (date occurred)	Annual flood (2.3 year return period) (m^3/sec)	Median flow (m^3/sec)
Pomahaka at Leithen Glen (1992-2016)	476 (23 Feb 2012)	166	8.3
Pomahaka at Burkes Ford (1961-2016)	1157 (17 Jan 1980)	292	17.6

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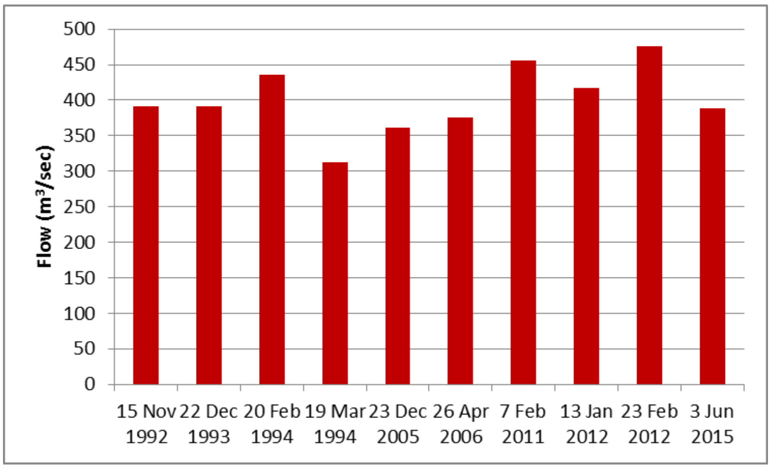

Figure 7. Ten highest flows in the Pomahaka River at the Leithen Glen recorder, since records began in June 1992

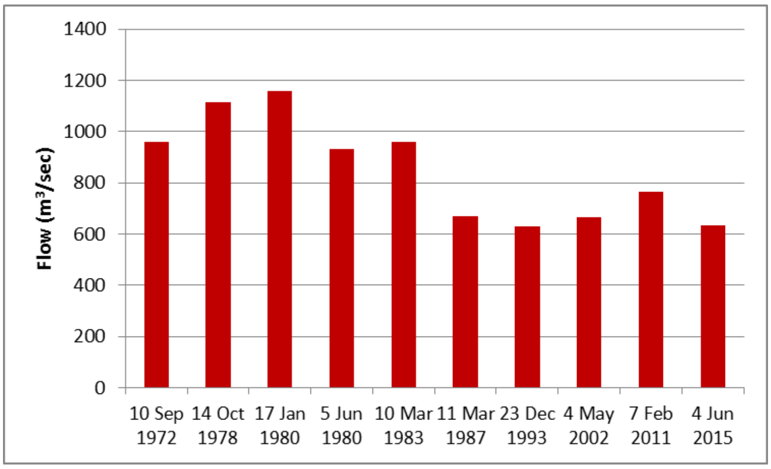

Figure 8. Ten higest flows in the Pomahaka River at the Burkes Ford recorder, since records began in August 1961

3.5. Flooding

Changes in the morphology of the Pomahaka River channel are, in part, driven by the hydrological characteristics of the river, including the magnitude and frequency of flood flows. Between 2010 and 2015 there were four flood events in the study area that ranked in the top ten largest flood events at the Leithen Glen flow recorder (Figure 7). The Pomahaka River has experienced large flood events in the past, with the January 1980 event being the largest on record at the Burkes Ford flow recorder (Figure 8) as well as recent events such as June 2015 (Figure 10). The January 1980 event caused significant damage to the township of Kelso where the gorge downstream of the town caused the water to back up and pond in the area for two days (ORC, 1999) (Figure 9). The township of Kelso was located in the lower reaches of the floodplain (upstream of the Kelso Gorge) but was relocated in the early 1980s due to the effects of numerous floods (ORC, 1999). The mapped flood hazard area for the Pomahaka River, Heriot Burn, and Crookston Burn can be seen in Figure 11. Flooding in the Kelso floodplain reach can be severe due to the Kelso Gorge restricting the escape of floodwaters. Figure 12 shows the mapped flood hazard area for the Pomahaka River and Waikoikoi Creek for the Tapanui floodplain.

Figure 9. **Pomahaka River in flood (17 January 1980), looking downstream above the town of Kelso (location shown in Figure 11)**

Figure 10. **Pomahaka River in flood (4 July 2015), looking upstream from above the Greenvale Road bridge (location shown in Figure 11)**

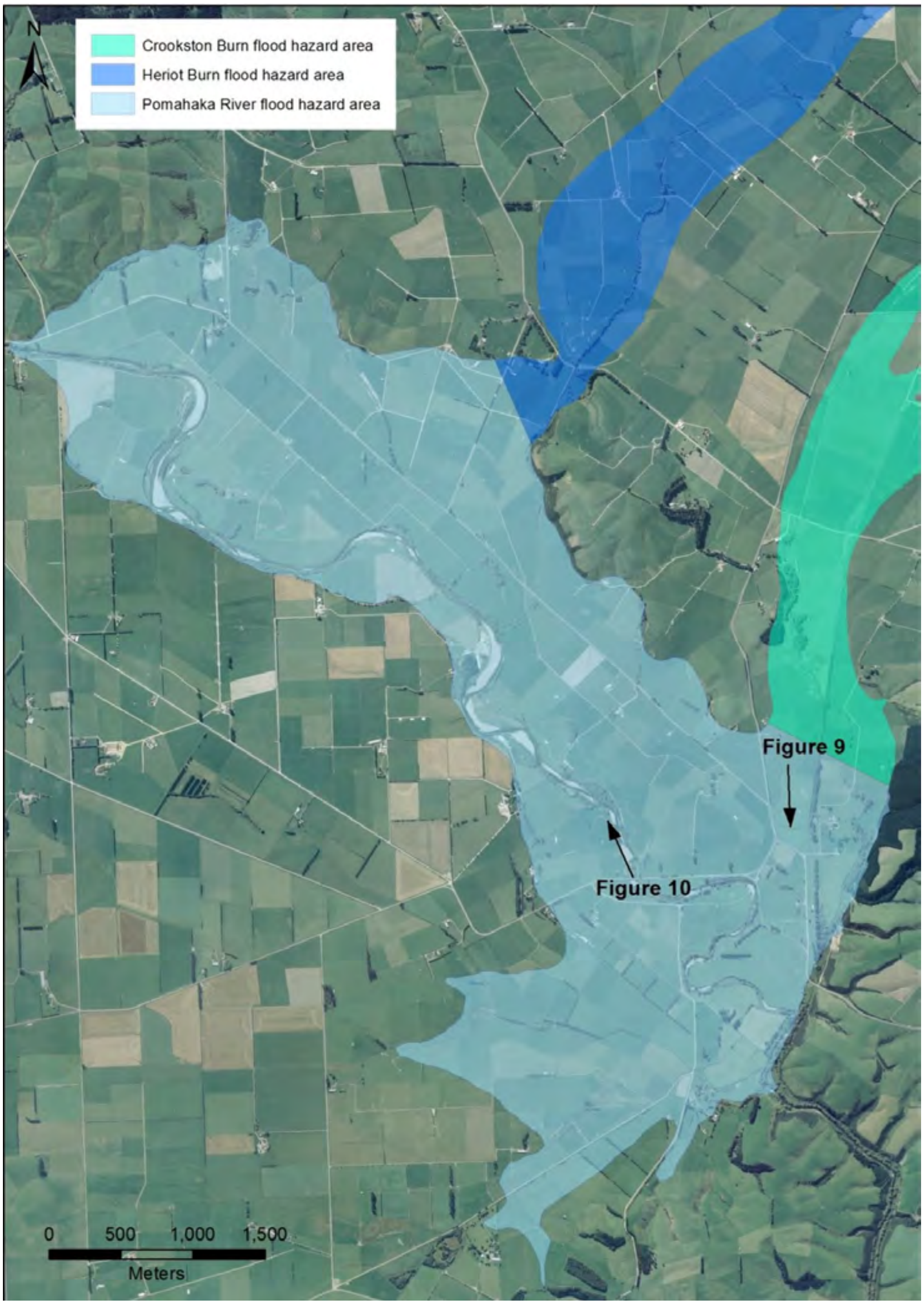

Figure 11. Pomahaka River flood hazard area extent (Kelso floodplain) (ORC, 1999)

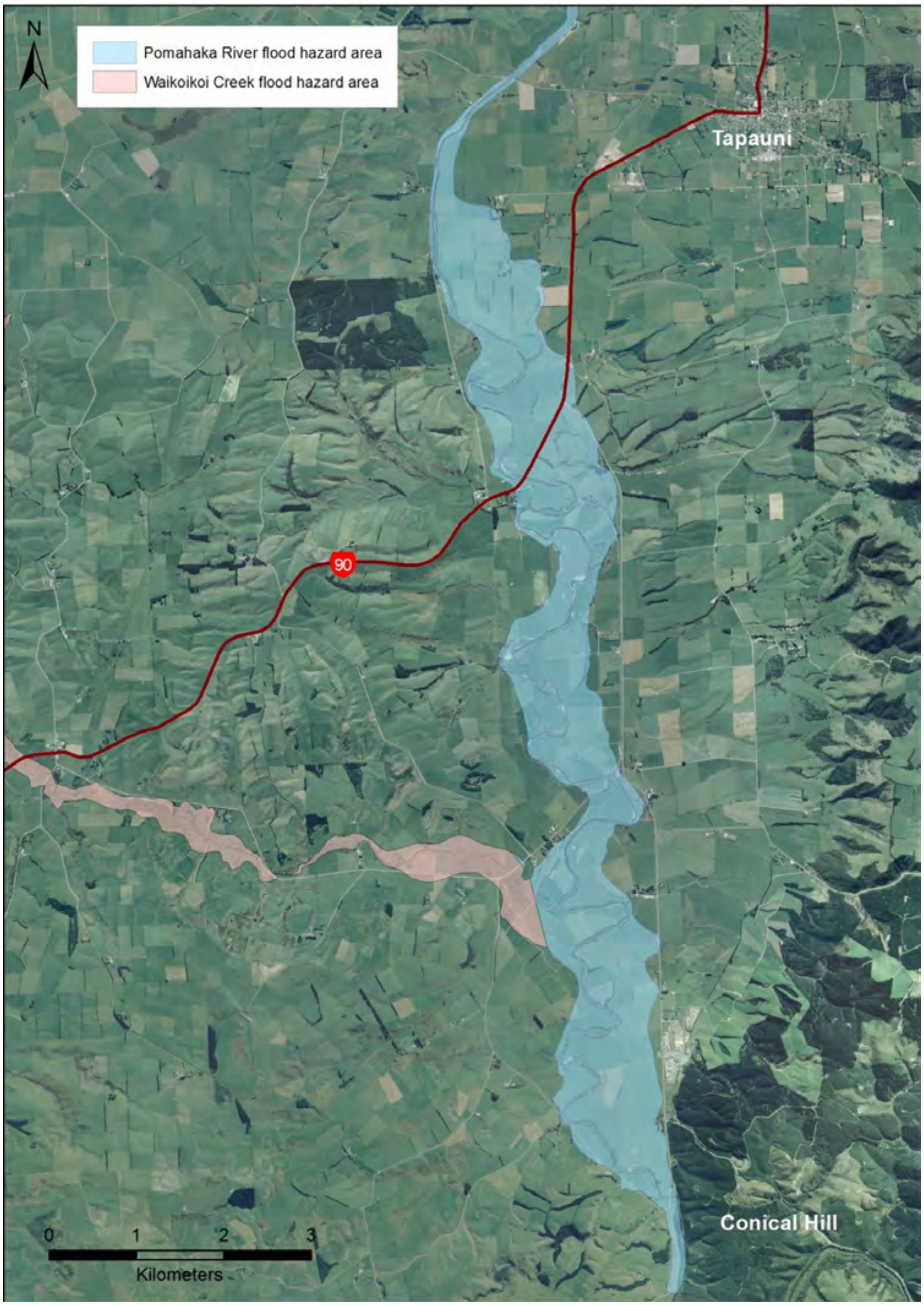

Figure 12. **Pomahaka River flood extent (Tapanui floodplain) (ORC, 1999)**

3.6. Riverbed morphology

The active channel of the Pomahaka River is a dynamic system where flood events and sediment transport regularly cause changes in riverbed morphology. Changes in the longitudinal profile of the riverbed occur due to aggradation and degradation along the channel, and as a result of lateral bank erosion. Significant changes often occur as a result of extreme flood events, but small scale, incremental changes can also occur over longer timeframes. Human activities, such as gravel extraction and physical works, can also result in significant morphological change, particularly near these works, but they can also occur across the wider river system.

ORC undertakes work to describe these changes in morphology using visual inspections, aerial and ground photography, and cross-section analysis. Reports summarising these investigations were published in 2004, 2010, and 2016 (ORC, 2004, 2010, 2016).

Observations of the Pomahaka River in 2015 by ORC staff helped to reinforce the findings of previous investigations, in particular:

- The riverbed changes between stable reaches with riparian planting and limited bank erosion, and areas where there is limited bank vegetation and ongoing bank erosion
- Some parts of the riverbed have experienced an increase in MBL while other parts have experienced a decrease in recent times (2010 to 2015)
- There are several locations where bank erosion is ongoing that are located outside the ORC cross-section network.

A comparison between aerial photography collected in 1944/1946, 1954, and 2006 further highlights the dynamic nature of the Pomahaka River (Figure 13). In some places the active river channel has changed positions and eroded into farmland, while in other places the channel movement has allowed land to become farmable. More back waters were present in the Pomahaka River in 1944/1946 compared to 2006, as well as larger areas of gravel accumulation (Figure 14, Figure 15).

A comparison of cross-sections dating back to 1988 also highlights the dynamic nature of the riverbed, and shows how the channel moved laterally in some locations and more confined and deeper in other locations (Figure 16, Figure 17).

Figure 13. Pomahaka River - top 1944/46, bottom 2006

Figure 14. **Comparison of the Pomahaka River between 1944/1946 and 2006 between Camperdown Bend and the Greenvale Road bridge (aerial photograph collected in 2006)**

Figure 15. **Comparison of the Pomahaka River between 1954 and 2006 below the SH90 bridge (aerial photography collected in 2006)**

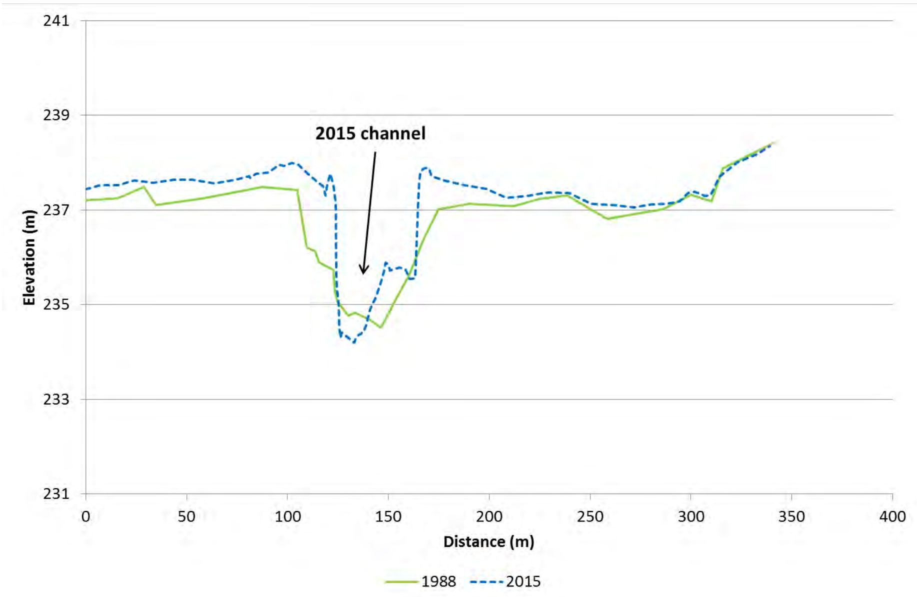

Figure 16. Pomahaka River cross-section P51A (looking downstream)

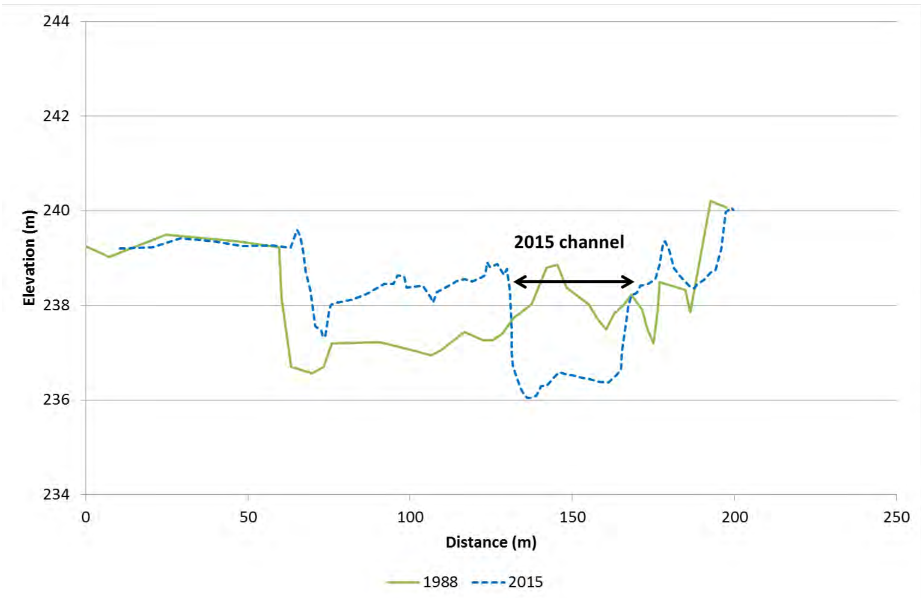

Figure 17. Pomahaka River cross-section P52A (looking downstream)

3.7. Riparian margins

The riparian margin is the area beside waterways that forms the interface between water and land. As noted in the introduction, more intensive use of the land that borders the Pomahaka River has occurred in recent decades. In some parts of the catchment, farmland has encroached onto what was previously a more natural area of rough vegetation (Figure 13). This has resulted in a narrowing (or in some cases, complete removal) of the riparian margin that separates the active river fairway from land that is used for farming, or which accommodates community infrastructure. Previous ORC reports have identified that channel widening by bank collapse and erosion are processes that continue to occur in the Pomahaka River (ORC, 2010). The loss of primary agricultural land and physical property adjacent to eroding stream banks is very costly and the need for their protection against erosion has long been recognised.

Historically, the permanent removal of gravel from the river system has been used as a tool in an attempt to address bank erosion issues. The strategy identifies that gravel extraction, and other river management tools (such as the movement of gravel within the channel and spraying), should still be considered for river management purposes, where that is appropriate. However, a number of authors have identified that the most effective means of controlling river bank erosion is to establish a vegetative cover of strongly rooting plants (Slui 1991, Marden et al. 2005, ORC 2005, Phillips & Daly 2008). In general terms, vegetation roots increase bank stability by protecting soils against entrainment from flood flows, and root mass and density provide soil shear strength, thereby protecting against gravity collapse of undercut banks.

Other indirect benefits of riparian plantings include trapping nutrients and fine sediment, shade, shelter and filtering qualities for the aquatic eco-system, as well as aesthetic and recreational value. If well managed, riparian margins can help to improve water quality, provide food and habitat for freshwater life, and improve diversity (ORC, 2005).

4. Values

Information on the values that the community and stakeholders have for the Pomahaka River was collected through community meetings and collecting feedback (Appendix 4). The Pomahaka River fulfils a number of important roles within the community at a local, district, and regional scale. These roles include (but are not limited to):

- A source of water for irrigation, stock, and people
- A source of gravel for roading and construction purposes
- For recreational purposes, including swimming, kayaking, walking, fishing, hunting, boating, picnicing and camping (e.g. Leithen Glen, Macintosh's Hole picnic area)
- A habitat for native and introduced species
- For customary uses by local iwi, ranging from the use of water for ceremonial purposes, to maintaining the quality and quantity of water to sustain mahika kai populations and habitat.
- Historical sites such as the Kelso flood monument.

The below sections discuss the ecological, community, and Māori cultural values that are held for the Pomahaka River. Limited information was provided/collected on the spatial location of the values discussed and presented by the community and stakeholders. The lack of geographical information on the values discussed in this strategy therefore means all values should be considered whenever activities are planned for the beds and banks of the Pomahaka River at any location.

4.1. Ecological values

Fish

The Pomahaka River provides an important habitat for a range of native and exotic freshwater species. There are ten species of fish (four introduced and six native species) and one species of freshwater crayfish present within the catchment. The introduced species include brown trout (*Salmo trutta*), chinook salmon *(Oncorhynchus tshawytscha)*, rainbow trout *(Oncorhynchus mykiss)*, and perch (*Perca fluviatilis)*. Freshwater mussels (*Hyridella menziesi*) were once abundant in the Pomahaka River but are now uncommon.

Native species include non-migratory galaxiids, common bully (*Gobiomorphus cotidianus*), upland bully (*G. breviceps*), lamprey (*Geotria australis*), longfin eel (*Anguilla dieffenbachii*), shortfin eel (*A. australis*), and crayfish (*Paranephrops sp*.). Longfin eels, lamprey, and galaxiids are threatened species.

Brown trout are the most common species within the catchment.

The Pomahaka River supports a regionally important brown trout fishery. The national angler survey for previous years (Table 3) shows that there has been a decline in the use of the Pomahaka River for angling activities. This may be due to factors such as low flows, riparian management, and poor water quality in tributary streams.

Table 3. Angler effort in the Pomahaka River catchment (angler days +/- standard error) based on the national angler survey (Unwin, 2009)

River	Angler usage (angler days +/- SE)		
	1994/1995	2001/2002	2007/2008
Pomahaka	6780 +/- 1210	6000 +/- 1440	3630 +/- 970

Birds

The wider Pomahaka River environment provides habitat for a range of exotic and native bird species that nest or feed in the riverbed and its margins, including mallard, grey duck, paradise shelduck, New Zealand shoveler, pukeko and Canada geese. The threatened mohua is found in relatively high numbers in the Blue Mountains. In addition the Blue Mountains have very good numbers of other native forest birds such as falcon, bellbird, kereru, grey warbler, rifleman, fantail and shining cuckoo.

4.2. Community

To help identify aspects of the wider river environment that is important to the local community, ORC consulted with a wide range of stakeholders in 2016. These included landowners, local iwi, Fish & Game New Zealand, Department of Conservation (DoC), and CDC.

The values that the community and other stakeholder groups identified with the Pomahaka River environment and its form and function are summarised in the box below. Other values that the local community raised included using the river for canoeing as well as having good swimming holes throughout the catchment.

That the ***function*** of the river continues to support social, cultural, spiritual, recreational, and farming activities – as well as continuing to provide for the taking of gravel as a resource.
That the ***form*** of the river includes riparian management, including planting (both native vegetation and willows) where appropriate.

- The river should support recreational activities such as swimming, fishing, and picnicing
- Regionally important brown trout fishery
- Important habitat for native fish (longfin eel, lamprey, galaxiids)
- The habitat of existing wildlife must be maintained and enhanced
- Access must be able to continue
- That the river channel is able to shift laterally within an identified riparian margin, but:
    - farmland beyond that margin is not eroded, and
    - main flood flows are kept in the channel
- Infrastructure (eg, roads, bridges and water takes) is resilient and able to be quickly reinstated following flood events.

4.3. Māori cultural values

The Pomahaka River is significant to local iwi for mahika kai and other cultural values and is a Statutory Acknowledgement area under the Ngai Tahu Claims Settlement Act 1998 (Schedule 52), providing for the special association of Ngati Mamoe and Ngai Tahu kainga (settlements) in the Catlins and Tautuku areas, with the river. Water has an important place in ceremonial occasions and is particularly recognised where the cultural components of tapu and noa are at work. Water symbolises the spiritual link between the present and the past, as the never ending source of life for generations who have gone before and those to follow.

Ngai Tahu's priority is to maintain the properties of water that are necessary to ensure the sustainability of customary uses. Customary uses range from the use of water for ceremonial purposes to the maintenance of the quality and quantity of water to sustain mahika kai populations and habitats.

4.4. Gravel extraction

The removal of gravel from the riverbed of the Pomahaka River has occurred for many decades, with extracted material generally used for farm laneways, roading, and construction. Gravel extraction typically occurs from locations where sediment accumulates e.g. where there is a decrease in the gradient of the river, leading to a reduction in the velocity of flood flows, or in an attempt to mitigate issues such as bank erosion. In either case, extraction from the bed of the river will tend to increase the conveyance of water during flood events by widening the channel and reducing the MBL at that location. It can also lead to a decrease in the sinuosity of the river channel, as bends are straightened in an attempt to reduce the effects of bank erosion.

Gravel extraction rates have previously exceeded the natural replenishment rates of the Pomahaka River (ORC, 2004). High rates of gravel extraction may have led to bed degradation and bank erosion in some areas of the Pomahaka River (ORC, 2004, 2006). In 2004 the ORC instigated a gravel management plan, which restricted the amount of gravel that was allowed to be removed from the Pomahaka River. In 2006 the ORC reviewed and modified the management plan to allow minor and selective gravel extraction to occur where it can be shown to be a necessary component of erosion risk management in the Pomahaka River. Gravel that is removed from the Pomahaka River system in excess of the natural replenishment rate can lead to issues at downstream locations, such as undermining of river protection works and other assets (e.g. water intakes, bridges, and roads) as well as increased bank erosion and bed degradation.

Gravel extraction within the study reach has been occurring over several decades. Significant commercial extraction occurred during the 1980s and 1990s. Between 1984 and 2004 about 264,000 m^3 of gravel was extracted at an average annual extraction rate of 12,700 m^3 (ORC, 2010). Between 2010 and 2015, 12,206 m^3 of gravel was removed from the Pomahaka River system (based on returns from consented gravel extraction). Currently a total of 2,500 m^3 per year of gravel is consented to be removed from the Pomahaka River, from one extraction location (about 1.5 km upstream of the Greenvale Road bridge) to a given management profile.

Ongoing channel degradation can allow increased water velocities (particularly during flood events) to scour the river bed, deepening the channel, which can result in continued bed degradation. As the channel deepens, flood flows become confined within the channel and continue to scour the bed. This ongoing degradation decouples the channel from the floodplain and alters the floodplain catchment interactions (Fuller *et al.*, 2014). Deeper channels contain larger floods and concentrate flows, leading to more incised channels, potentially generating higher sediment transport rates (due to bank erosion and further removal of material from the riverbed). This process gives the appearance of more prominent gravel bars within the active channel due to the deeper channel. As the channel deepens and gravel bars become more prominent, pressure is often exerted by adjacent landowners to remove the obvious (but in fact non-existent) excess gravel accumulation, which in turn exacerbates the degradation trend (Fuller *et al.*, 2014).

The sediment replenishment rates from the upper catchment of the Pomahaka River are insufficient to maintain the profile of the surveyed reaches. The Pomahaka River is currently experiencing a short-term trend of stability (no large scale aggradation or degradation), however it is still experiencing longterm degradation and ongoing bank erosion.

The permanent removal of gravel can also result in the undermining of river protection works and other assets (e.g. water intakes, bridges and roads), as well as degrading ecological values. Gravel extraction can have a negative effect on the local ecology, with the severity of effects dependent on the extraction methods used and the environment from which the gravel is being extracted. Gravel extraction activities can lead to a reduction in habitat heterogeneity/diversity, an increase in fine sediment, as well as bed compaction that can have a negative impact on the native and exotic animals residing in and on the banks of the Pomahaka River. The potential beneficial and adverse effects of significant gravel extraction are summarised in Table 4.

Table 4. Potential beneficial and adverse effects of gravel extraction (Canterbury Regional Council, 2015)

Potential beneficial effects	***Potential adverse effects***
Channel capacity increased, flood levels lowered	Disturbance of fish and bird habitat
Concentration of flow against riverbanks, resultant lateral erosion, and localised bed scour is minimised	Accidental discharge of fuels and lubricants from machinery
Stable channel alignment and optimum bed level is maintained	Disturbance of the natural meander patter and channel stability
Open gravel beaches can provide a good habitat for indigenous birds	Overall degradation of the riverbed
A renewable gravel resource for local construction may be utilised	Increased bank erosion
	Sediment is discharged, increasing turbidity and smothering habitat
	Temporary reduction in recreational access
	Mauri (life force) of the riverbed affected
	Disturbance of fish spawning sites
	Dust generation
	Reduced river bed heterogeneity

ORC will investigate the possibilities, benefits, and legality of a consent held by the ORC to allow for the management of gravel extraction and river management activities in the Pomahaka River (Leithen Glen to Conical Hill). ORC will aim to use the consent to enable landholders to achieve river management objectives i.e. to help mitigate bank erosion/scouring or excessive gravel accumulation.

5. Legislative context

The manner and degree to which the issues in the Pomahaka River can be managed by the community, stakeholders and local councils is influenced by the obligation, powers and restrictions set out in various statues. No legislation confers the exclusive power or the right to manage the Pomahaka River to ORC or CDC. Whether through works or services, individuals are empowered to initiate their own measures provided they operate within the law. They are also allowed to develop and promote proposals for bank protection works, to apply for and hold the necessary resource consents, and to privately fund works and services should they wish to.

The law provides for a range of methods that both councils and the community can use to manage the Pomahaka River. These methods do not only relate to physical works, but also to planning, information, emergency preparedness and response. They can only be implemented after taking environmental effects into account (under the Resource Management Act (RMA)) and funding consideration (under the Local Government Act (LGA)). The latter includes consideration of the distribution of benefits between the community as a whole, any identifiable part of the community, and individuals.

The Otago Regional Policy Statement (RPS) provides a high-level policy framework for the sustainable integrated management of Otago's resources, as well as giving effect to the requirements of the RMA. This includes the management of the values of water bodies, natural resource systems and the form and function of Otago's rivers, whilst still enabling communities to provide for their needs.

This strategy is concerned with the form and function of the Pomahaka River. Any activities in or on the bed and banks of the Pomahaka River need to be focused on maintaining or enhancing that form and function. The strategy is not a statutory document; rather it is intended to present the aspirations of the community and the various stakeholder agencies. However, the statutory processes that do influence river management activities are more likely to be used effectively and efficiently if there is a general consensus on what is valued about the river, and commonly understood objectives. The strategy sets out the values identified by the community, and the outcomes they seek from managing river form and function, and will be used to inform resource consent decision-making.

6. Principles

The strategy provides a framework to guide activities and decision-making, based on an agreed set of principles. It is intended to help protect the recreational, cultural and ecological values of the Pomahaka River, and to enable long-term sustainable use of the riverbed and its riparian margins.

ORC has developed the framework, in consultation with the local community and other stakeholders. The principles and associated strategic elements are outlined below, and these are intended to protect or enhance the important values and features of the river identified by the community and other stakeholders.

Principle 1: Ensure sustainable river management

Ensure that:

- There is clear and consistent communication between the ORC and other parties
- There is recognition that certain river and catchment processes, such as flooding, bank and channel erosion and sedimentation, will occur naturally, and an understanding of the potential effects of those processes
- Any practices undertaken limit exposure to negative natural-river and catchment processes
- There is an awareness and acknowledgement of the benefits and the risks (including the risk associated with 'super-design' events) that exist for activities such as farming that occur in areas prone to natural-river and catchment processes
- Any negative effects of natural-river processes do not increase beyond their current levels, and are actively reduced where there is opportunity to do so
- Activities are managed in a way that result in:

- Limited effects on assets during flood events
- Essential community infrastructure that is resilient (roads, bridges, water supply)
- Acceptable level of effects to farming caused by river processes
- Sustainable use of river resources
- There is recognition of the kaitiaki responsibilities of the local iwi.

Principle 2: Plan ahead

Ensure that:

- There is clear and consistent communication between the ORC and other parties
- There is an adaptive approach to river management that will allow for the dynamic nature of the Pomahaka River
- Resources are used wisely to ensure that the location and form of community assets and essential infrastructure will result in a more resilient community
- The impacts of climate change and natural climate variability are considered so that future generations do not have to cope with the results of poor decisions made today
- The risk associated with natural-river processes are reduced over time by taking a broad-scale, adaptive approach over the longer term.

Principle 3: Maintain and enhance the natural environment

Ensure that:

- There is clear and consistent communication between the ORC and other parties
- Activities are managed in a way that results in:
- A habitat that supports existing wildlife, fish, and suitable plant species
- A more visually appealing river system
- The ability of the local community and visitors to access and enjoy the river is maintained and/or enhanced
- Traditional and cultural use is enabled, maintained and enhanced.

7. River form and habitat enhancement

7.1. River corridor design and management

ORC has undertaken work to identify the location and width of the active fairway (or riverbed), as well as appropriate buffer zones, which together form a corridor within which the river would naturally lie. The widths of fairway and buffer zones were completed by assessing the appropriate meander form in relation to the nature and width of the river channel. The design channel has been drawn up using a consistent meander length or wavelength oscillation, while taking into account the existing channel location, channel areas and natural controls and restraints. This work has been undertaken in the Pomahaka River between Dusky Forest and Conical Hill (Williams, 2016, 2016). An example is shown in Figure 18, and a full set of river corridor maps is provided in Appendix 3.

The river fairway and corridor mapping provides guidance for multi-purpose river management, and for the design and implementation of management measures, protection works and in-channel design. When physical works or activities are being considered within the fairway or on the riparian margin, these should be undertaken with reference to the mapped fairway and buffer zones. Guidance for managing the river within this corridor, and across the wider floodplain, is summarised in Figure 19.

ORC will work towards maintaining the Pomahaka River to the mapped corridor lines in the study reach where reasonable and practicable. The fairway management will be achieved through river-management processes such as sediment movement (i.e. cross-blading, bank reinstatement, targeted vegetation spraying and, in extreme cases, channel realignment). Keeping the fairways to the mapped lines will be undertaken as a pre-emptive process with the aim of limiting the degree of movement/deviation from these areas in flood events. This work will take into account the community values (as discussed in Section 4). Maintenance work undertaken in the Pomahaka River (as discussed above) will be provided for through the budget set in the ORC Annual Plan.

In some locations, the mapped corridor crosses land that does not currently form part of the active channel of the Pomahaka River, e.g. Figure 18. This is due to the fact that the mapped corridors show an ‘envelope’ within which the river would migrate under natural conditions. In many instances, they do not reflect the current position of the Pomahaka River. In these situations the ORC will not actively move the fairway into these mapped areas; however, if the channel switches its location into these areas (e.g. in response to a large flood event), ORC may decide not to undertake work to reverse the new alignment if the channel still lies within the mapped corridor.

Figure 18. **Pomahaka River mapped fairway deviating from the current channel alignment (aerial photography collected in 2006)**

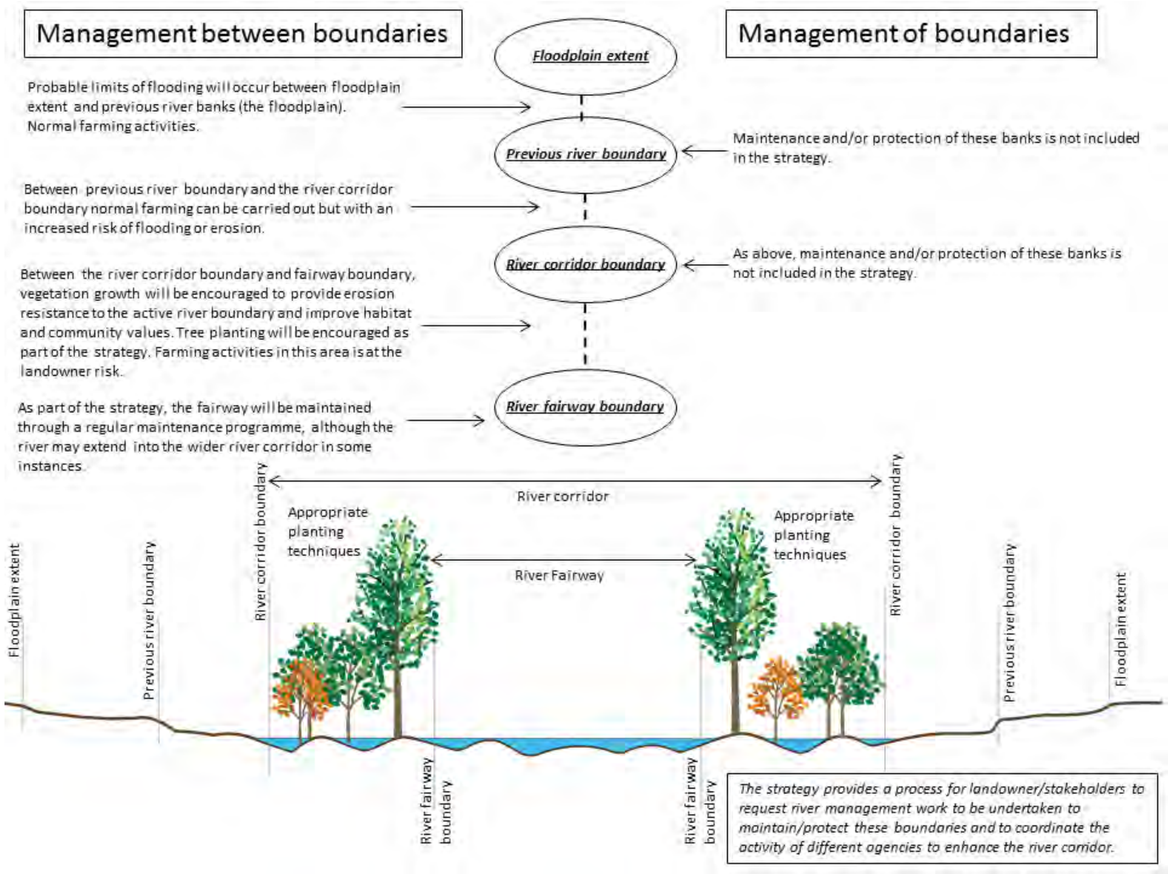

Figure 19. **Policy diagram for management of river boundaries and appropriate land-use on floodplain areas of the Pomahaka River**

7.2. Riparian plantings

As identified in Section 3.7, careful management of riparian margins is key to achieving positive river management outcomes. In addition, one of the key values identified by the community and stakeholders was that they would like to see additional planting and management of riparian plantings included in the strategy as a means of improving the amenity and habitat values of the Pomahaka River, and to help to reduce the effects of erosion (Section 4). The principles identified in Section 6 reflect the importance of sustainable river management and enhancing the natural environment.

Research (Slui, 1991; Phillips & Daly, 2008) shows that to achieve bank protection, the Pomahaka River riparian margins should be planted in vegetation that assists with bank stabilisation. Planting these buffer areas would provide the banks of the rivers with greater stability and assist with limiting bank erosion, as well as providing vegetative cover to slow flood flows and limit the amount of sediment deposited out of the main channel, while also providing habitat for aquatic life. The wider the area of buffer zone planting, the more effective this will be.

Willow species (particularly moutere and kemuti willow) are more suitable for planting close to the river margin due to their rapid growth, ease of propagation and usefulness for vegetative groynes or bank-lining layering. Other vegetation can also be used, including poplars and alders on the relatively higher/drier land. Native vegetation can be used further back from the active river margin and can be useful, especially when part of other/wider riparian planting.

Development of the buffer areas can be undertaken as a staged approach, with planting of the active river margin occurring in areas where there is bank exposure, as well as at possible river breakout locations. Planting of the back area can be undertaken where direct river attack (i.e. bank erosion) is less likely to occur and the native species will have time to become established. Buffer development is about establishing a wide and dense vegetated margin that can absorb river attack and provide habitat for aquatic life.

Planting of the banks of the Pomahaka River is generally seen as a beneficial process in most locations. There are several methods to plant the banks of the two rivers, with the best method being dependent on the environment where the planting is to take place (see Appendix 2).

7.3. Implementation

The objectives of the strategy are listed at the start of this document (in the overview section). The mechanisms that can be used to achieve or implement these objectives are shown in the following tables. These have been derived using the principles outlined in Section 6. The tables below highlight the actions that should be undertaken to maintain and enhance the values associated with the Pomahaka River, as well as the key parties responsible for undertaking the listed actions.

In some cases, ORC has already undertaken work to help achieve objectives, and this work is described within this document (for example, mapping of natural-river corridors and identifying target profiles). It is noted that many of the key actions below are voluntary, and will rely on interactions between the key stakeholders and the community to be successful. It is also noted that many of the activities will be ongoing, and progress will depend on funding, not only through the ORC Annual Plan process, but also from other agencies and the wider community.

ORC has prepared the strategy, with input from the local community, to help protect the recreational, cultural, and ecological values of the Pomahaka riverbed, and to enable long-term sustainable use of the land that borders the river. The objectives and actions listed below are intended to help achieve this by guiding work programmes, decision-making activities for the community, stakeholders, and ORC. It is therefore recommended that people who live, work, or play within the Pomahaka River catchment consider and give effect to the principles, objectives and actions listed in this strategy.

Due to the dynamic nature of the Pomahaka River, parts of this strategy are likely to change as the rivers themselves change; this strategy must therefore be treated as a 'live' document (Section 2.3). This means that some sections and maps in the strategy may change in response to changes in the Pomahaka River (e.g. areas of gravel accumulation may shift).

Objective 1 Recognise and characterise natural-river processes

Activity	How this can be done	Intended outcome	Who will lead it	Timing	Comment
1.1. Collect information about flood and erosion processes					
	Map, describe and report on changes in channel morphology	Improved understanding of natural river processes	ORC	Ongoing	Previous reports describing changes in channel morphology are available
	Identify locations where erosion is occurring	Avoid high-value assets in erosion-prone areas	ORC	Ongoing	
	Make information publicly available, including through the Natural Hazards Database	Improved decision-making around placement of assets and land-use activities	ORC	Ongoing	Information is currently available through the Natural Hazards Database
1.2. Identify the location of river corridors, within which the river will naturally meander					
	Determine the natural meander form of the river, considering the existing channel location, and natural controls and restraints	Improved decision-making around placement of assets and land-use activities	ORC	Complete	Maps included in Appendix 3

Objective 2 Equip the community to live with the effects of changes in river morphology

Activity	How this can be done	Intended outcome	Who will lead it	Timing	Comment
2.1. Asset management and land-use practices (e.g. fences, vegetation clearance, and irrigation structure placement) are undertaken in such a way that reduces the risk associated with natural river processes					
	Land-use practices and other activities have greater regard to natural river processes	A reduction in risk over time	Landowners	Ongoing	ORC to provide guidance and information through field-days and other community programmes
	Consider implementation of land-use controls through the District Plan in areas with greater erosion risk	No net increase in risk over time	CDC	Long-term (5-10 years)	Incorporate into future revisions of CDC District Plan
	Identify mechanisms to modify/protect roading assets that consider natural river processes	Roading infrastructure is resilient	CDC	Ongoing	ORC to provide information as necessary
2.2. Consider all available options to manage the effects of bank erosion, including structural and non-structural options					
	Less intensive use of riparian margins	A reduction in risk over time	Landowners	Ongoing	
	Planting of native and exotic species on riparian margins	Increased stability of riparian margins and riverbanks, improve habitat and community values	Landowners	Ongoing	ORC to provide support, as determined through the ORC Annual Plan process
	Produce guidelines for undertaking planting appropriate for river control and provision of habitat	Increased stability of riparian margins and riverbanks	ORC	Complete	Guidance included as Appendix 2
	Produce maps showing priority planting locations	Community requirements and natural river processes are considered before planting is undertaken	ORC	Ongoing	

	Proactive river management programme	Bank erosion and other river management issues addressed early	ORC	Ongoing	Maintenance work undertaken as provided for through the budget set in the ORC Annual Plan
	Provide information on the Regional Plan: Water permitted activity rules	The community is enabled to complete activities that manage the effects of bank erosion and other river management issues	ORC	Ongoing	Information on permitted activities to be provided to the community at any opportunity
2.3. Enable works that improve the conveyance of floodwater and 'train' the river within its natural corridor, without compromising features that are of high value to the community					
	Physical works by ORC to address existing river management issues	The Pomahaka River is contained, as far as possible, within the natural river fairway/corridor, and convey small to-medium floods without overtopping	ORC	Ongoing	Locations and detail of work to be undertaken between October 2016 and 2019 included in Appendix 1
	Physical works by landowners and other agencies to address river management issues	The Pomahaka River is contained, as far as possible, within the natural river fairway/corridor, and convey small to-medium floods without overtopping	Landowners	Ongoing	ORC to provide guidance on suitable river-management methods (including resource consent requirements) through field days and other community programmes
	Provide information discussing the importance of community/stakeholder values	Works are undertaken in a manner that does not compromise features that are of high value to the community	ORC and the community	Complete	Values discussed in Section 4, these may be modified or adjusted as part of future reviews of this strategy

Objective 3 Enable sustainable gravel extraction

Activity	How this can be done	Intended outcome	Who will lead it	Timing	Comment
3.1. Enable sustainable gravel extraction for river management benefits					
	ORC will investigate the possibilities, benefits and legal ramifications of holding a consent to extract gravel	Gravel extraction is completed in a sustainable manner	ORC	Feb 2017 (to inform the 2017/18 draft Annual Plan)	
3.2. Identify areas where gravel extraction may affect community values					
	Provide information discussing the importance of community/stakeholder values	Extraction is undertaken in a manner that does not compromise features of the location that are of high value to the community	ORC and the community	Completed	Values discussed in Section 4. These may be modified or adjusted as part of future reviews of this strategy

Objective 4 Promote activities that enhance the natural character and enjoyment of the river

Activity	How this can be done	Intended outcome	Who will lead it	Timing	Comment
4.1. Identify the location and characteristics of features that are of high value to the community					
	Community values obtained through consultation and clearly identified within the strategy	Consideration of community values when making decisions	ORC	Completed	Values discussed in Section 4. These may be modified or adjusted as part of future reviews of this strategy
4.2. Establish riparian plantings that serve a purpose, and are appealing					
	Produce guidelines for undertaking planting appropriate for river control and provision of habitat	Increased stability of riparian margins and riverbanks. Improved aquatic and terrestrial habitat	ORC	Completed. See also 2.2 above	Guidance included as Appendix 2
4.3. Provide access for fishing activities and habitat for fish					
	Planting work that facilitates fishing activities and enhances fish habitat	The Pomahaka River supports a regionally important sports fishery, and important populations of native fish (including threatened and endangered species)	Fish & Game, DoC	Ongoing	
	Consent conditions ensure that gravel extraction and physical works are undertaken in a way that does not damage habitat	The Pomahaka River supports a regionally important sports fishery, and important populations of native fish (including threatened and endangered species)	ORC, extractors and landholders	Ongoing	See Objective 3 also

	Encourage the creation of additional public access points	River-access opportunities are increased	ORC, CDC, landowners	Ongoing	Covered in CDC District Plan (Rule FIN.8)
4.4. Adequate pest and weed control activities					
	Landowners (including LINZ) and other stakeholders work collaboratively to manage pest species	The Pomahaka River fairway and riparian margin are relatively free of pest species	Landowners, stakeholders, ORC	Ongoing	
4.5. Discourage dumping, and arrange the regular collection of rubbish					
	Collection of rubbish through regular/routine work at key locations (Leithen Glen). Signs warning of penalties for rubbish dumping to be erected if issues persist.	Improved visual amenity and enjoyment of recreational areas	CDC	Ongoing	
4.6. Protect and enhance the natural character of the Pomahaka River					
	Promote and encourage local restoration initiatives such as bank planting and wetland restoration	Riparian margins are planted/restored, look visually appealing, and provide aquatic and terrestrial habitat	Community& support from other agencies	Ongoing	

Appendix 1. ORC river maintenance work within the Clutha Special Rating District

Five locations within the mapped river corridor have been identified as requiring work to maintain the fairway within its natural position (as mapped in Appendix 3) and/or to ensure the adequate conveyance of floodwater. These locations are shown on Figure 20 and Figure 21. These priority locations have been determined using the latest information available (November 2015) about specific locations that are experiencing river management issues. ORC intends commencing work at these locations during the 2016/2017 financial year, and funding has been provided through the long term plan process to complete work at these locations within the next three years (i.e. by 2018/2019). Ongoing maintenance may also be required at some of these locations into the future.

This list and the need to undertake work at particular locations may change into the future, in response to flood events and to other river management issues that the community may identify through the process outlined in Section 2.3.

The river management work (outlined below) that is scheduled to take place in the Pomahaka River will need to consider the following:

- The principles outlined in Section 6
- The location and width of the natural river corridor and active fairway as described in Section 7, and other natural river processes as described in the strategy
- The objectives and associated activities listed in Section 7.3. In particular objective 2 (equip the community to live with the effects of changes in river morphology) and activity 2.3 (enable works that improve the conveyance of floodwater and 'train' the river within its natural corridor, without compromising features that are of high value to the community)
- The ecological, community and Māori values discussed in Section 4.

The increased program of work in the Pomahaka River by ORC will result in increased costs for the Clutha Special Rating District (SRD). Revenue from rates within the SRD is projected to increase from $265,000 in 2016/17 to $310,000 in 2019/20, in order to fund additional in-stream work required to meet community river management expectations.

The anticipated budget for river management operations (physical works) in the Clutha SRD until 2019/20 is shown in Table 5 below. This shows that $230,000 is budgeted for this work during the 2016/17 year, up from $167,000 in 2014/15. This budget is not solely for the Pomahaka River and includes other rivers in the Clutha District.

The dynamic nature of the Pomahaka River and the inability to predict the timing or consequences of future flood events in the Clutha District means there is a risk that this additional funding for river management work may still be insufficient. As noted above, all ratepayers within the Clutha District contribute towards the Clutha SRD.

Table 5. ORC river management budget for the Clutha District

Year	ORC river management (operation) budget
2014/15	$167,000
2015/16	$218,000
2016/17	$230,000
2017/18	$229,000
2018/19	$235,000
2019/2020	$241,000

Planned river maintenance work – Pomahaka River

A. Work at this location will involve moving gravel to maintain the active channel fairway, and planting to limit bank erosion (Figure 20).

B. Work at this location will involve moving gravel to maintain the active channel fairway, and planting to limit bank erosion (Figure 20).

C. Work at this location will involve moving gravel to maintain the active channel fairway, with the potential to create a new secondary channel (Figure 20).

D. Work at this location would involve channel reshaping to maintain the active channel fairway and planting to limit ongoing bank erosion. Due to the scale of work required at this location it will likely be an ongoing process over several years (Figure 20).

E. Work at this location would involve channel reshaping and moving the channel to maintain the active fairway and planting to limit ongoing bank erosion. Due to the scale of work required at this location it will likely be an ongoing process over several years Figure 21).

Camperdown Bend is an area that has experienced river management issues in the past and is likely to experience issues into the future. The ORC does not currently have a plan to deal with this location due to budget constraints and the size of the issue, however ORC is aware of the location and will continue to monitor it into the future.

Figure 20. **Priority locations for operations work - 1**

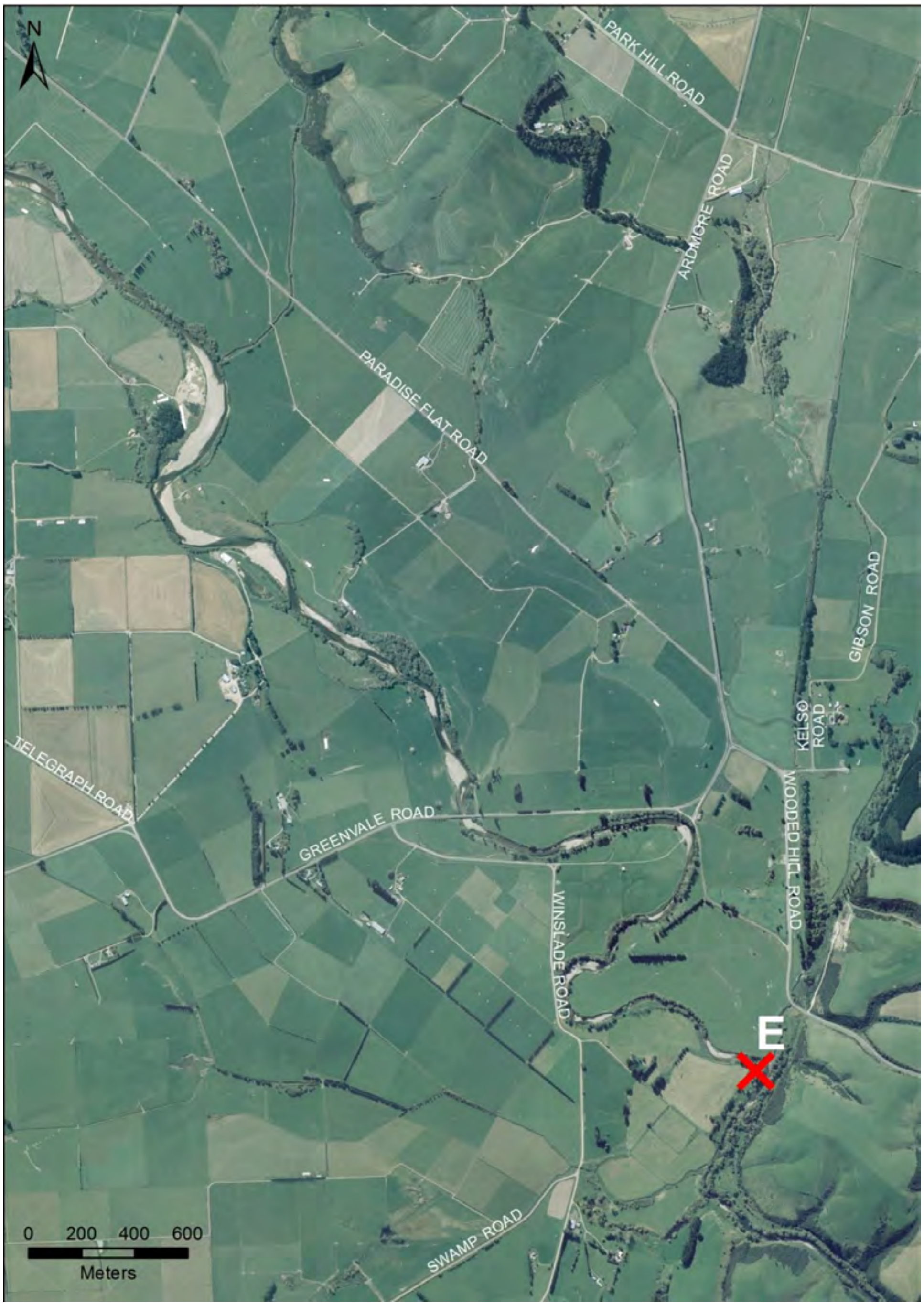

Figure 21. Priority locations for operations work - 2

Appendix 2. Planting guide

Benefits of riparian planting[6]

The benefits of well-planned and well-managed riparian planting areas on farms are considerable, and include:

- Increasing the quality and health of waterways
- Increasing the ability to filter nutrients before they reach waterways – Nitrogen, Phosphorus, and bacteria/viruses e.g. *E.Coli*
- Reducing sediment runoff
- Reducing soil erosion of banks in waterways
- Providing shade, which reduces waterway temperatures and shelter for stock
- Minimising stock losses as animals are excluded from riparian strips by fences
- Increasing biodiversity – aquatic life, native plants, birds and insects
- Improving recreational opportunities (e.g. fishing)
- Enhancing and beautifying the river margins.

Both native and exotic species can be suitable for riparian planting. The species to be used will depend upon many factors, including environmental factors (exposure, soils, etc.) but also the width of the riparian strip, the height of plantings that is desired, and personal preference.

Using trees to stabilise stream banks[7]

Exotics

The most effective trees for stream bank erosion control are exotic willows and poplars. These are planted as stakes (less than 1 m high) or poles (1.5 – 3 m in height). Avoid invasive spreading species, such as crack willow, weeping willow, silver poplar and all non-sterile tree and shrub willows. Before planting fast-growing trees, consider their longer-term maintenance needs.

Winter is the best time to plant these species before stakes or poles sprout new growth. Plant about a third of the length below ground. On waterlogged ground, you can force them in by hand. On firm ground, you may be able to sharpen poles at one end and drive them in with a rammer or use a post auger. Stakes can be planted by putting them into a hole made with a length of reinforcing rod or similar. The most important thing is to make sure stakes and poles are firmly planted.

[6] Adapted from KCCP planting guide (2015)

[7] Adapted from ORC (2005)

Guide to planting willow poles

Storage

It is recommended that poles are planted as soon as possible following delivery. Poles can be stored for a few weeks in water, standing up in a water trough or pond/creek. The bottoms of the poles should be kept wet to keep them alive and absorbing water. Poles should be stored away from stock.

Planting

Poles should ideally be planted on the outside of river bends, or sections of river where erosion is occurring. Plant poles in rows with 2 – 3 m spacing between them. Poles need to be planted 300-500 mm deep. Try and plant down to ground water level. Either a crow bar, post-hole borer or tractor forks/digger with a spike can be used to make a hole in the ground that the pole can be dropped into, and then packed firm.

Looking after plantings

Fence planting off from stock to protect plants; plant protectors can also be purchased and can help give protection. It is recommended that poles are watered the day after planting and at least once a week during dry weather until they are established.

To stabilise banks:

- Pair-plant along straight reaches – one tree on one bank, one tree on the opposite bank, five to seven meters apart
- Plant at two to three metre spacing at critical points, such as the outside of the bends where erosion is the greatest
- Avoid planting on the inside of bends – soil builds up rather than erodes here, so trees will trap sediment and force current against the outer bank
- Avoid planting narrow channels where trees might impede floodwaters.

By the time trees are four or five years old, there will be a solid mass of roots along the bank. At 10 to 20 years, trees can be thinned to 10 to 12 metre spacing, but no wider. If you use sleeves on poles to protect the willows and poplars, sheep can be grazed around the trees from the time they are planted.

Natives[8]

There are many advantages of utilising native plants. These include:

- Enhancing natural character and landscape values
- Forming a habitat corridor and potentially ecological linkage in the catchment
- Restoration of rare riparian forest (and other habitats)
- Creating/enhancing habitat for native birds and invertebrates (including pollinators)

[8] Information on native planting and previous Pomahaka River catchment vegetation provided curtesy of DoC

- Restoration or enhancement of threatened plant habitats
- Do not grow as high or require maintenance (e.g. pruning or thinning)
- Self-regenerating and maintaining.

Planting natives for bank stability will enhance the natural biodiversity of your riparian margin and provide habitat for invertebrates and birds. While exotic tree species are proven to stabilise banks, new research shows that native trees, such as ribbonwood, cabbage tree and pittosporum species, are suitable for bank stabilisation. These species are deep rooting, with a good root spread. Planting native species alongside exotics will help to maintain a mostly native planting on your banks.

Tables 6 through 9 list suitable native vegetation to plant in the Pomahaka catchment, including trees, shrubs, tussock, and rare species.

Original Pomahaka catchment vegetation cover

The vegetation that originally occurred at a site is a reflection of a range of site conditions, particularly climate, soils, and flood regime, however historical events may also affect plant distribution.

The upper catchment of the Pomahaka River (i.e. above Leithen Glen but also in the hill country immediately below Kelso) is believed to have been dominated by beech forest. Silver beech was, and remains, the most common species; however red beech and mountain beech were also present.

The alluvial flats between Leithen Glen and Kelso, and between the junction of the Flodden Burn and Conical Hill, would probably have been dominated by podocarp forest, predominantly kahikatea, totara and matai, with pokaka and other species. However the riparian fringe of the river would likely have contained a ribbonwood – kowhai forest. Both of these forest types are now rare, with few examples remaining on the alluvial flats.

Table 6. Suitable native species for the Pomahaka catchment (trees)

Common name	Scientific name	Mix of plants[9]
Black mapou/kohuhu	Pittosporum tenuifolium	major
Lemonwood	Pittosporum eugenoides	major
Lowland ribbonwood	Plagianthus regius	major
Narrow-leaved lacebark	Hoheria angustifolia	major
South island kowhai	Sophora microphylla	major
Cabbage tree	Cordyline australis	major
Broadleaf	Griselinia littoralis	moderate
Marbleleaf	Carpodetus serratus	moderate
Manuka	Leptospermum scoparium	moderate
Chatham Island akeake	Olearia traversii	moderate
hybrid olearia	Olearia x dartonii	moderate
Silver beech	Lophozonia (Nothofagus) menziesii	major
Red beech	Fuscospora (Nothofagus) fusca	moderate
Mountain beech	Fuscospora (Nothofagus) cliffortioides	moderate
Kahikatea	Dacrycarpus dacrydioides	minor
Mountain totara	Podocarpus hallii	minor
Matai	Prumnopitys taxifolia	minor

[9] The major, moderate or minor is intended to direct the numbers/mix of plants used in a riparian/restoration planting. Therefore the bulk of the plants would compose the 'major' species, with some of the 'moderate' species and only a few of the 'minor' species. The species mix may be in the order of 10 of a 'major' species to 5 of a 'moderate' species to 1 of a 'minor' species.

Table 7. Suitable native species for the Pomahaka catchment (shrubs)

Common name	Scientific name	Mix of shrubs
Mingimingi	Coprosma propinqua	major
A coprosma	Coprosma dumosa/tayloriae	moderate
A coprosma	Coprosma rigida	moderate
Koromiko	Hebe salicifolia	major
Cottonwood	Ozothamnus vauvilliersii	moderate
Weeping mapu	Myrsine divaricata	minor

Table 8. Suitable native species for the Pomahaka catchment (tussock and tussock-like plants)

Common name	Scientific name	Mix of tussock and tussock like plants
Ballerina sedge	Carex secta	major
Toetoe	Austrodieria (Cortadieria) richardii	major
Lowland flax	Phormium tenax	major
Red tussock	Chionochloa rubra ssp. cuprea	moderate

Table 9. Suitable native species for the Pomahaka catchment (rare species)

Common name	Scientific name	Status
Pomahaka tree daisy	Olearia fimbriata	Nationally vulnerable
Hector's tree daisy	Olearia hectorii	Nationally endangered
Linear-leaved tree daisy	Olearia lineata	At risk: declining
Fragrant tree daisy	Olearia fragrantissima	At risk: declining
Bloodwood	Coprosma wallii	At risk: declining
Teucridium	Teucridium parvifolium	At risk: declining

General planting tips

- The wider the riparian strip that is created and planted, a wider range of benefits will be achieved.
- Riparian strips can be of variable width dependent upon site factors such as access for machinery, height above the river (and flood levels), topography, and soils. An example being that wet areas or depressions behind a river bank or levee should be included, as sediments and nutrients may leak into the river.
- Habitat strips/wildlife corridors need to be wider than 5 m (ideally at least 8 m) in order to incorporate the equivalent of three rows of plantings.
- Plantings can be either in rows or randomly scattered to give a more natural appearance. The scattering of plants and natural appearance is more important for restoration plantings and Habitat strips/wildlife corridors.
- Closer plant spacing will provide greater mutual shelter, and so achieve faster growth, however will require more plants and therefore greater cost. They may also require some thinning later. This balance needs to be considered.
- When planting natives for bank stabilisation, plant at 1.5 – 3 metres spacing.
- Additional advice on your site may be available from ORC, DoC, local nurseries, websites and publications.

Appendix 3. River corridor: Maps

The river fairway and corridor mapping provides guidance for multi-purpose river management, and for the design and implementation of management measures, protection works and in-channel design. When physical works or activities are being considered within the fairway or on the riparian margin, these should be undertaken with reference to the mapped fairway and buffer zones. The method used to define the river corridor is explained in Section 7.1.

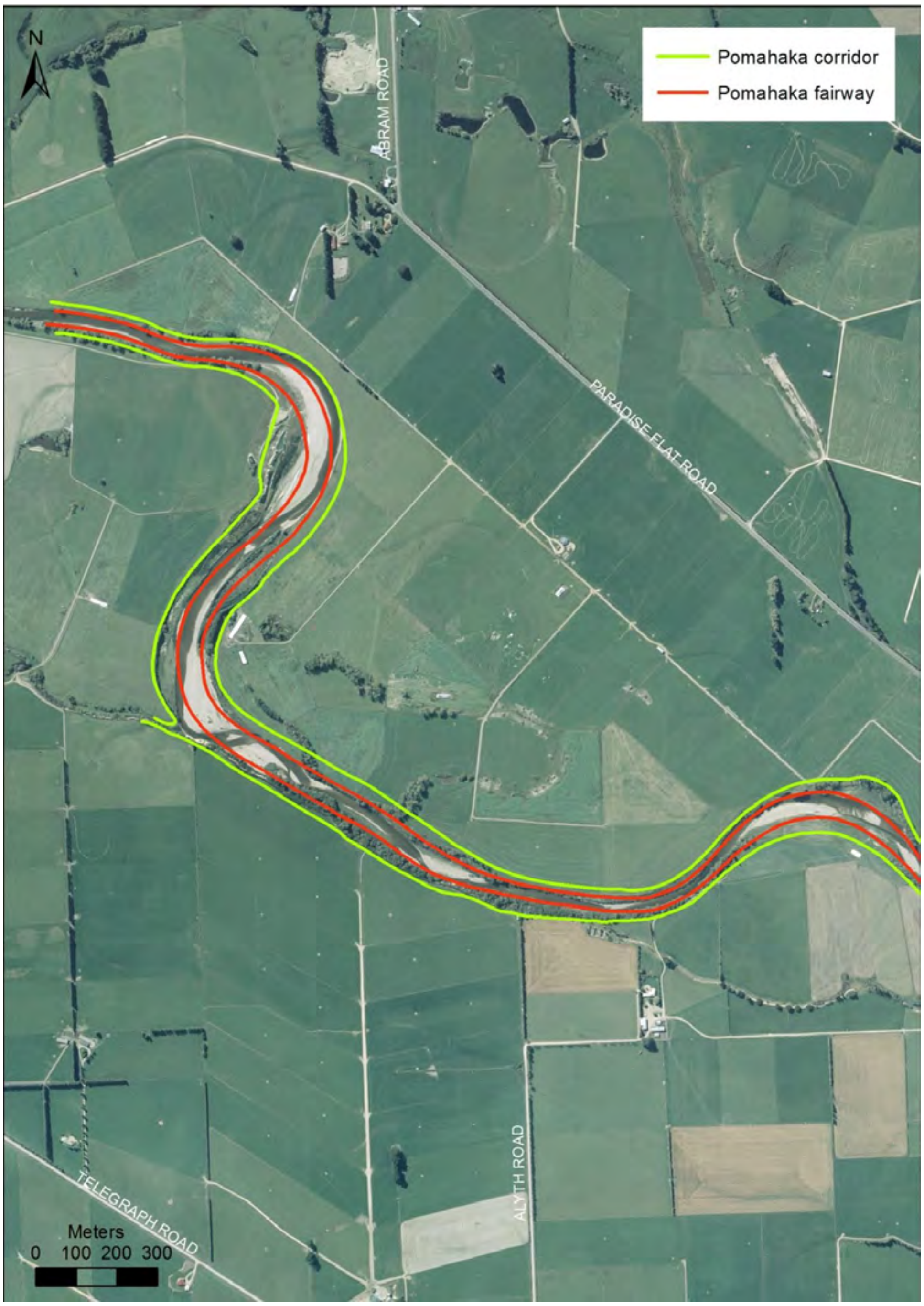

Figure 22. **Pomahaka River fairway and corridor Map 1 (aerial photography collected in 2006)**

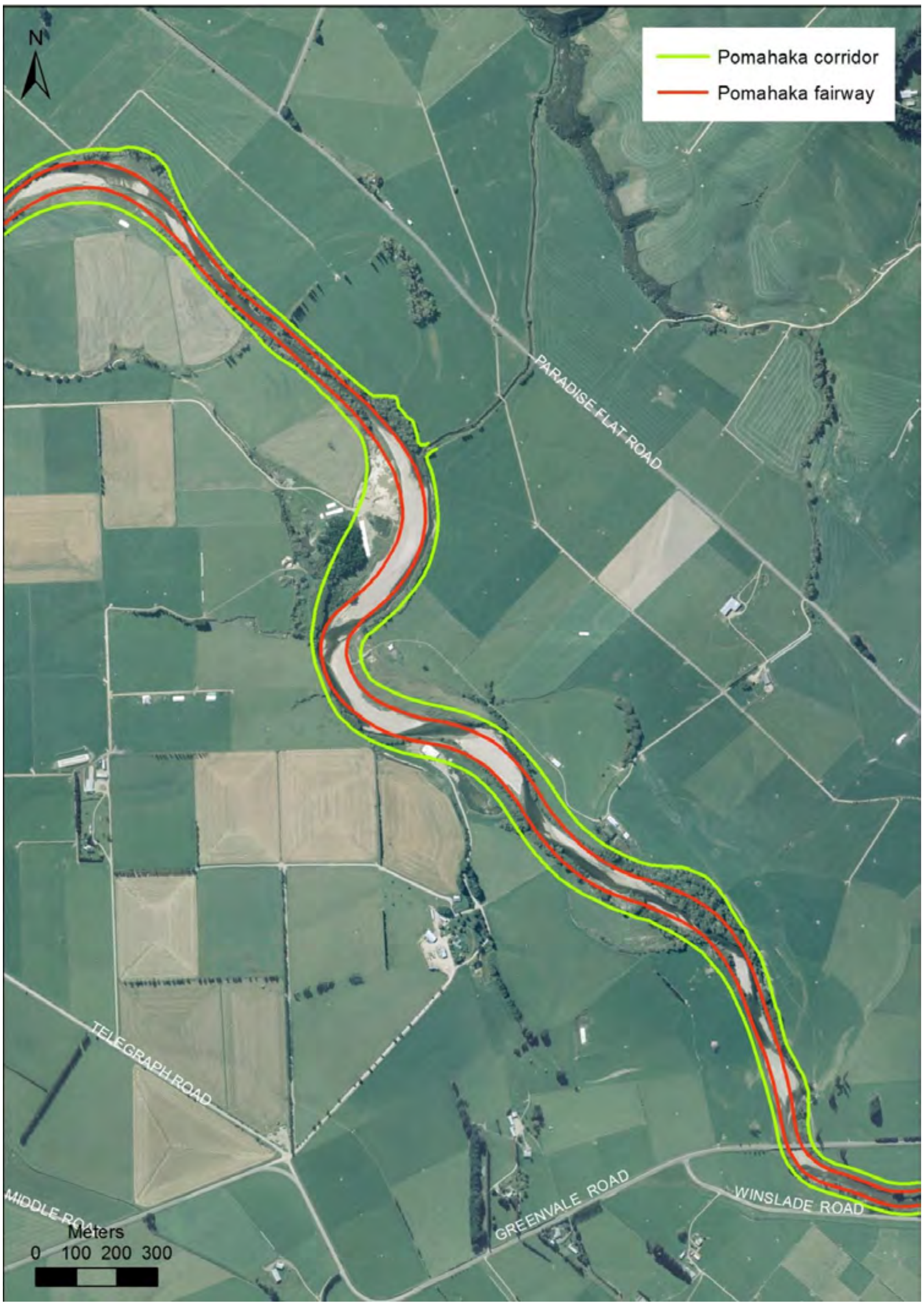

Figure 23. Pomahaka River fairway and corridor Map 2 (aerial photography collected in 2006)

Figure 24. **Pomahaka River fairway and corridor Map 3 (aerial photography collected in 2006)**

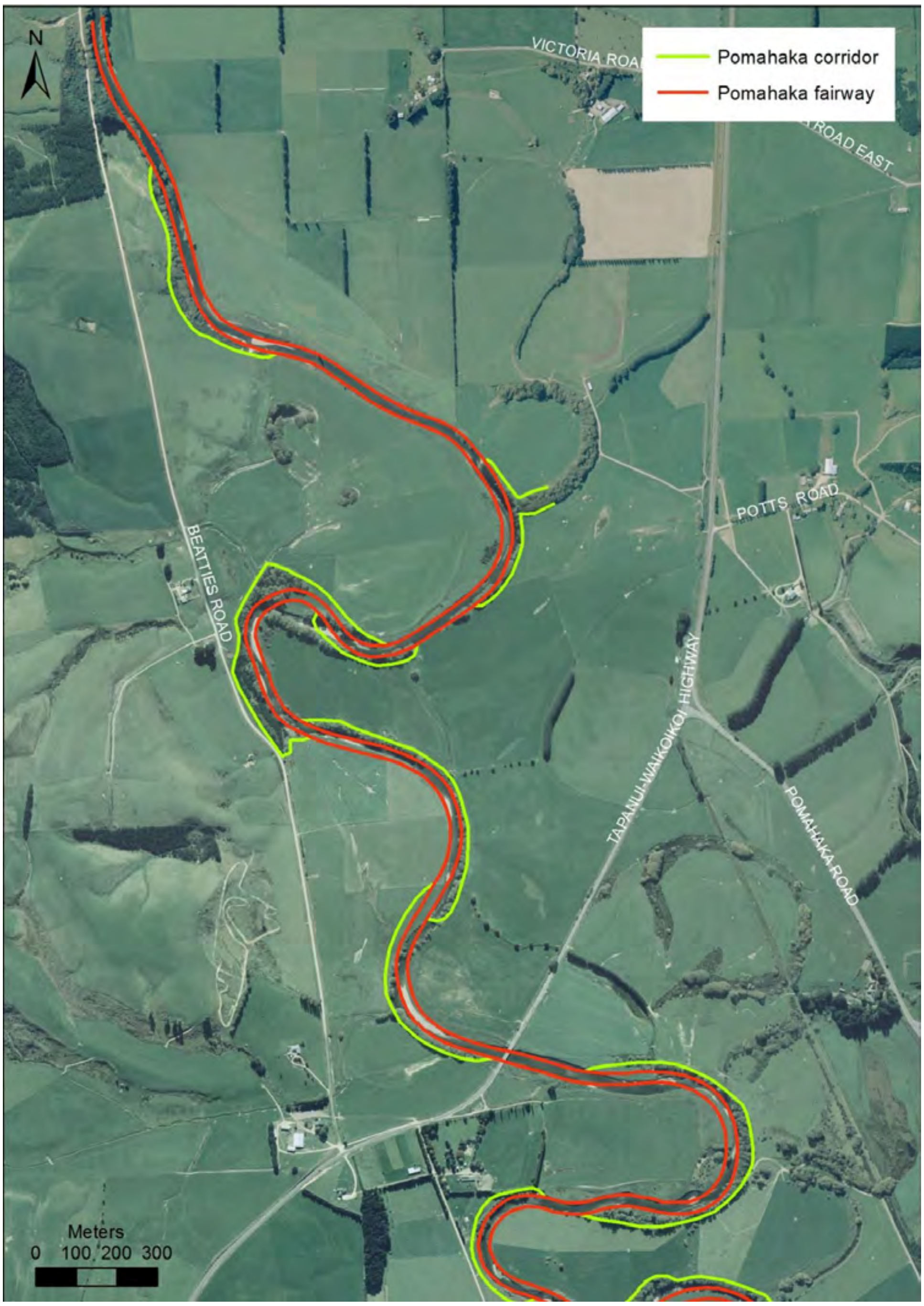

Figure 25. **Pomahaka River fairway and corridor Map 4 (aerial photography collected in 2006)**

Figure 26. Pomahaka River fairway and corridor Map 5 (aerial photography collected in 2006)

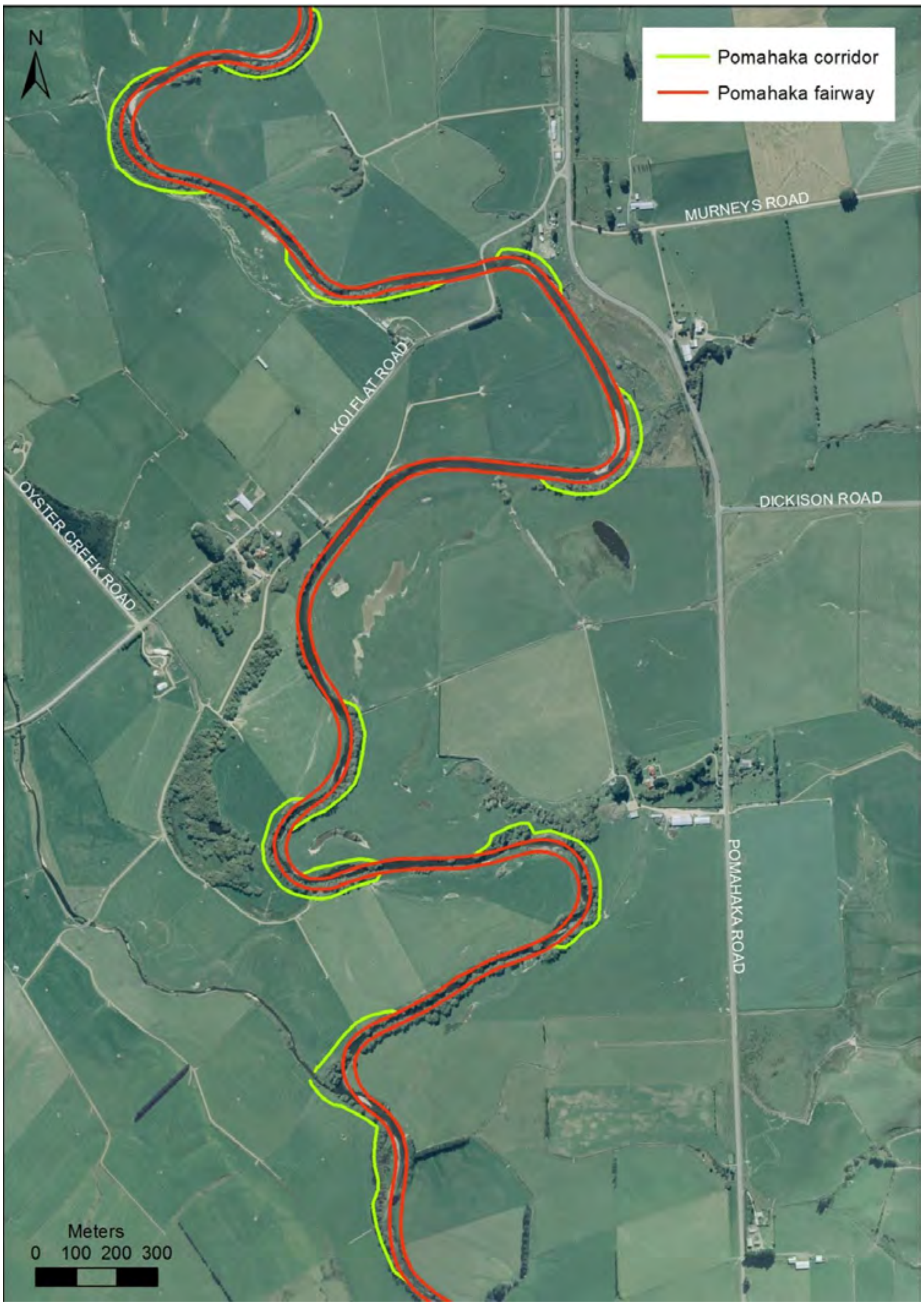

Figure 27. **Pomahaka River fairway and corridor Map 6 (aerial photography collected in 2006)**

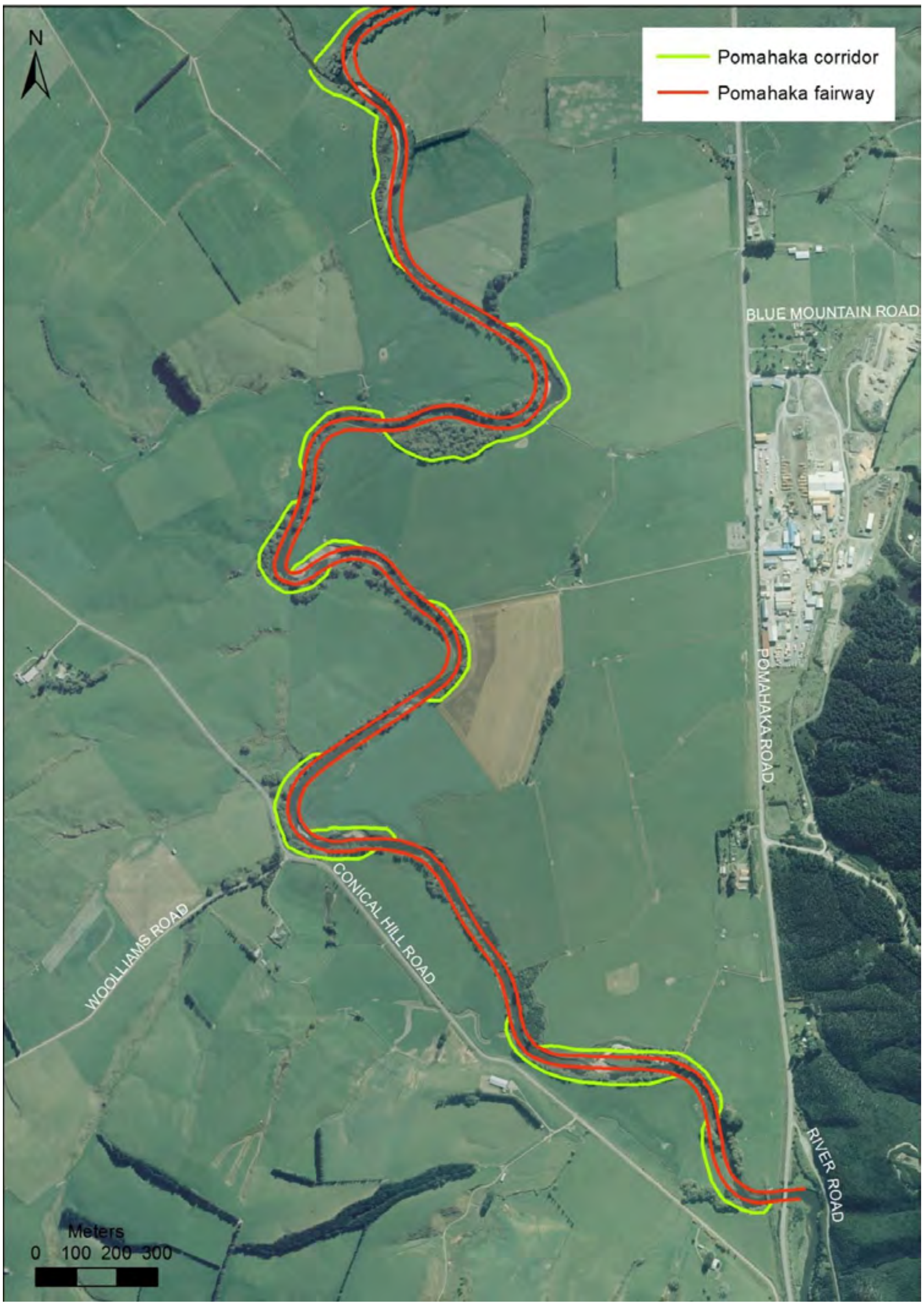

Figure 28. Pomahaka River fairway and corridor Map 7 (aerial photography collected in 2006)

Appendix 4. Community consultations - public submissions

The community consultation undertaken from March to April 2016 included an opportunity for the public to submit on their concerns, as well as a chance to state what they valued about the river and what they would like the strategy to achieve. A range of views and concerns were put forward: some people were concerned about riparian vegetation maintenance, gravel build up and bank erosion, while other parties were concerned about habitat enhancement, ongoing public access and clarity around the Regional Plan, Water permitted activity rules. An ongoing topic raised at the public meetings was with regard to the difficulty and cost associated with obtaining resource consent to extract gravel. The community also discussed the importance of being able to protect their own land. Limited submissions were received by the ORC on the proposed strategy, with all submitters supporting the values gathered by the ORC and the direction and process that the ORC is taking with the strategy.

Appendix 5. Reference list

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Otago Regional Council, 2010: *Pomahaka River – Update on river management outcomes*, Report No. 2010/2364, Dunedin, New Zealand.

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Phillips, C., Daly, C. 2008: *Willows or natives for stream bank control: a survey of usage in New Zealand regional councils*, Landcare ICM Report 2008-2009/01.

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Extracts from Soil Conservation and Rivers Control Act 1941

126 General powers of Catchment Boards

(1) It shall be a function of every Catchment Board to minimise and prevent damage within its district by floods and erosion.

(2) Each Board shall have all such powers, rights, and privileges as may reasonably be necessary or expedient to enable it to carry out its functions, and in particular each Board shall have power to construct, reconstruct, alter, repair, and maintain all such works and do and execute all such other acts and deeds including the breaching of any stopbank as may in the opinion of the Board be necessary or expedient for—

(a) controlling or regulating the flow of water towards and into watercourses:

(b) controlling or regulating the flow of water in and from watercourses:

(c) preventing or lessening any likelihood of the overflow or breaking of the banks of any watercourse:

(d) preventing or lessening any damage which may be occasioned by any such overflow or breaking of the banks:

(e) preventing or lessening erosion or the likelihood of erosion:

(f) promoting soil conservation.

(2A) [Repealed]

(3) Except as expressly provided in this Act, nothing hereinafter contained shall be held to derogate from or prejudice the generality of the provisions of this section and the powers, rights, and privileges conferred by this section.

Section 126(1): replaced, on 1 October 1991, by section 362 of the Resource Management Act 1991 (1991 No 69).

Section 126(2): amended, on 26 October 1967, by section 9 of the Soil Conservation and Rivers Control Amendment Act 1967 (1967 No 32).

Section 126(2)(f): inserted, on 7 December 1945, by section 79(2) of the Statutes Amendment Act 1945 (1945 No 40).

Section 126(2A): repealed, on 1 October 1991, by section 362 of the Resource Management Act 1991 (1991 No 69).

131 Public Works Act 1981 to apply to construction of works

Every Board in carrying out or executing any works it is empowered to undertake pursuant to this or any other Act shall have and may exercise all the powers and authorities given to local authorities by the Public Works Act 1981.

Section 131 heading: amended, on 1 February 1982, pursuant to section 248(1) of the Public Works Act 1981 (1981 No 35).

Section 131: amended, on 1 February 1982, pursuant to section 248(1) of the Public Works Act 1981 (1981 No 35).

132 Powers of Boards to enter for survey and investigation

(1) The provisions of sections 110, 111, and 112 of the Public Works Act 1981 shall apply in respect of works which a Board is authorised to undertake and to the carrying out of any of a Board's functions as if references in those sections to the Minister of Works and Development were references to the Board.

(2) For the purposes of taking levels or making surveys or inspections, any person authorised under section 110 or section 111 of the Public Works Act 1981 (as applied by subsection (1) of this section) may examine any dam, weir, sluice, flood gate, or stopbank, or any other work erected in or upon any watercourse, and open or raise any flood gate or sluice, and make any soundings, or bore the bed or channel of any part of any watercourse.

Section 132: replaced, on 16 December 1983, by section 14 of the Soil Conservation and Rivers Control Amendment Act 1983 (1983 No 152).

133 Maintenance and improvement of watercourses and defences against water, etc

(1)

Subject to the provisions of this section, every Board may for the purposes of this Act, by itself, its engineers, officers, agents, and workmen,—

(a)

cleanse, repair, or otherwise maintain in a due state of efficiency any watercourse or outfall for water, either within or outside its district, or any bank, dam, groyne, or other defence against water:

(b)

deepen, widen, straighten, divert, or otherwise improve any watercourse or outfall for water, either within or outside its district, or remove any groynes, stopbanks, dams, weirs, trees, plants, or debris, or any other obstructions whatsoever to watercourses or outfalls for water or to the free flow of flood waters in existing flood channels, or raise, widen, or otherwise improve any defence against water:

(c)

in such manner and of such materials as it thinks necessary or proper, make any new watercourse or new outfall for water and cause the same to communicate with the sea or any arm thereof, or with any other watercourse or a lake, either within or outside its district, or erect any new defence against water, or carry out any other work it thinks necessary or desirable for the purpose of controlling or preventing damage by flood waters:

(d)

divert, impound, or take away any water from any watercourse.

(2)

Except in the case of urgent work to meet an emergency, where a Catchment Board proposes to exercise any of the powers referred to in the last preceding subsection in any drainage district or river district, or in respect of any watercourse or defence against water which is under the control of any local authority or other public body, the following provisions shall apply:

(a)

the Catchment Board shall give to the Drainage Board, River Board, local authority, or other public body, as the case may be, not less than 1 month’s notice in writing of its intention, and with such notice shall supply full particulars of its proposals:

(b)

if the Catchment Board does not within the period of the notice receive any objection in writing from the Drainage Board, River Board, local authority, or other public body to which the notice was given, it may forthwith carry out its proposals:

(c)

if any such objection is received and agreement cannot be reached between the Catchment Board and the Drainage Board, River Board, local authority, or other public body aforesaid, the Catchment Board shall refer the matter to the Minister, whose decision shall be final.

(3)

No Catchment Board shall be entitled to exercise any of its powers in any reserve or catchment area vested in any local authority or public body for water supply purposes or in respect of any watercourse adjacent to any such reserve or area as aforesaid without the consent of the local authority or public body.

Section 133(2)(c): amended, on 1 April 1988, pursuant to section 52(1) of the Soil Conservation and Rivers Control Amendment Act 1988 (1988 No 48).

Section 133(3) proviso: repealed, on 16 December 1988, by section 2(b) of the Soil Conservation and Rivers Control Amendment Act (No 2) 1988 (1988 No 212).

134 Afforestation, etc

(1)

Every Catchment Board may, wherever it considers it expedient for the carrying out of its functions so to do, either on land acquired by it or, subject to the consent of the owner, on any other land plant or sow and maintain trees, shrubs, plants, or grasses.

(2)

Subject to the provisions of the Wildlife Act 1953, every Board may destroy, or make grants for the destruction of, any deer or other animals which in its opinion are likely to destroy or damage any trees, shrubs, plants, or grasses the existence of which may tend to mitigate soil erosion or to promote soil conservation or the control of floods.

Section 134(2): amended, on 1 April 1954, pursuant to section 73(1) of the Wildlife Act 1953 (1953 No 31).

135 Incidental powers of Boards

Every Board shall, in addition to any other powers given to it by this Act, have and possess the following powers, that is to say, it may—

(a)

take, in manner provided by the Public Works Act 1981, or purchase, or otherwise acquire and hold any land, or any estate or interest therein, within or outside its district, which in its opinion may be necessary or convenient for the carrying out of any of those powers or functions:

(b)

without any previous payment, tender, or deposit, enter upon and use any land within its district for the purpose of taking therefrom any earth, clay, stone, boulders, gravel, sand, and other material:

(c)

at all reasonable times, by itself, its engineers, officers, agents, and workmen, and with or without vehicles, loaded or unloaded, enter into and pass through and over any lands within its district for the purpose of constructing, reconstructing, altering, repairing, and maintaining any works under this or any other Act, and for that purpose may make on those lands temporary roads or approaches to the works, doing thereby no unnecessary or avoidable damage to the lands:

(d)

lay or deposit on any lands within its district any materials whatsoever to be used in connection with any works under this or any other Act, and erect on any such lands any temporary shelter for any workmen or other persons, causing thereby as little damage or inconvenience as may be:

(e)

deposit on any land within its district any spoil from any works constructed under this or any other Act, or removed from any watercourse in the cleansing, repairing, maintaining, or improving of the watercourse:

(f)

break up the soil of any roads, streets, ways, or footpaths and excavate and sink trenches, and do all such other matters and things as it deems expedient, necessary, or proper for making, cleansing, repairing, maintaining, or improving any watercourse or other works to be made, done, or provided by the Board.

Section 135(a): amended, on 1 February 1982, pursuant to section 248(1) of the Public Works Act 1981 (1981 No 35).

136 Notice to authority concerned before interfering with roads, etc

Before interfering with any road, street, or footpath, or any other public work of whatsoever kind under the control of any local authority or other public body, every Board shall give not less than 1 month's notice in writing to the local authority or other public body having control thereof:

provided that this section shall not apply in respect of the carrying out by any Board of urgent work to meet an emergency.

Section 136: amended, on 1 April 1988, by section 32 of the Soil Conservation and Rivers Control Amendment Act 1988 (1988 No 48).

137 Notice in respect of works to be undertaken on private land

(1)

Before constructing any work through or upon private land, every Board shall—

(a)

deposit for public inspection at the office of the Board, and, where that office is outside the district, also at some place within the district, a plan and description of the work, showing how it affects the land; and

(b)

give notice in writing to the occupier of the land, and also to the owner when known, of the Board's intention to construct the work, referring in the notice to the plan and description aforesaid and stating where they are on view, and calling upon him to lodge with the Board within 1 month after the date of the notice his objections (if any) in writing to the proposed work not being objections to the amount or payment of compensation.

(2)

If within that period of 1 month no such objection is lodged the Board may forthwith proceed with the work.

(3)

If any such objection is lodged and agreement cannot be reached between the Board and the objector, the Board, after consultation with the objector, shall appoint an independent assessor and refer the matter to that assessor.

(3A)

After giving the Board and the objector an opportunity to be heard, the assessor shall consider the matter fairly and without bias, make a decision on it, and supply the Board and the objector with a written copy of the decision and the reasons for it.

(3B)

Subject to section 33B, every decision under subsection (3A) shall be final.

(4)

Nothing in this section shall apply in respect of the carrying out by any Board of urgent work to meet an emergency.

(5)

This section shall not apply where the owner and the occupier of the land have entered into an agreement in writing with the Board as to the construction of the work, or where the entry on the land is for the purpose of the maintenance or repair of any existing work on the land and the Board has given to the occupier of the land notice in writing 48 hours before entering on the land.

Section 137(1)(b): amended, on 17 November 1964, by section 7 of the Soil Conservation and Rivers Control Amendment Act 1964 (1964 No 59).

Section 137(3): replaced, on 1 April 1988, by section 33 of the Soil Conservation and Rivers Control Amendment Act 1988 (1988 No 48).

Section 137(3A): inserted, on 1 April 1988, by section 33 of the Soil Conservation and Rivers Control Amendment Act 1988 (1988 No 48).

Section 137(3B): inserted, on 1 April 1988, by section 33 of the Soil Conservation and Rivers Control Amendment Act 1988 (1988 No 48).

Section 137(5): inserted, on 21 October 1959, by section 25 of the Soil Conservation and Rivers Control Amendment Act 1959 (1959 No 48).

138 Boards may apportion cost of works with owners of lands

In any case where any works are to be constructed by a Board, the Board may agree with the owners or occupiers of any lands on or near which the works are to be constructed for the apportionment of the cost of the works in such proportions as are deemed fair and equitable by the parties.

139 Land may be purchased on system of time payment

Any land purchased by a Board may, with the approval of the Minister, be paid for by the Board by instalments extending over a period not exceeding 20 years, and interest at such rate as the Minister approves may be paid by the Board in respect of any portion of the purchase money that may for the time being be unpaid.

140 Leasing powers of Boards

In addition to any leasing powers conferred on a Board by any special Act, every Board is hereby declared to be a leasing authority within the meaning of the Public Bodies Leases Act 1969 and shall have and may exercise the powers conferred on leasing authorities by that Act.

Section 140: amended, on 1 January 1970, pursuant to section 28(1)(a) of the Public Bodies Leases Act 1969 (1969 No 141).

The End

7.2. Environmental Implementation Quarterly Update

Prepared for:	Implementation Committee
Report No.	OPS2206
Activity:	Environmental: Land Environmental: Water
Author:	Andrea Howard, Manager Environmental Implementation
Endorsed by:	Gavin Palmer, General Manager Operations
Date:	28 February 2022

PURPOSE

[1] To provide a quarterly summary of operational implementation activities being undertaken in the areas of freshwater, biosecurity, and biodiversity. This report complements the Annual Plan quarterly reporting. It includes details of projects underway, and improvements being made to processes and systems that support delivery of these activities.

EXECUTIVE SUMMARY

[2] Since the last quarterly report[1], the Environmental Implementation Team Environmental Implementation Team is nearly at full complement with one position yet to be filled.

[3] ORC is leading and delivering four Jobs for Nature projects to a total value of $22.5m:

i. The National Wilding Conifer Control Programme to Boost Regional Economies and Employment: Otago,
ii. Containing Wallabies to Protect Agriculture, Forestry and Native Plants, And Boost Regional Economies: Otago,
iii. Private Land Biodiversity: Maintaining the Gains, and
iv. Te Hakapupu/Pleasant River intervention and restoration project to reduce sediment and nutrient inputs into a waterway.

[4] Otago now has a total of 25 Jobs for Nature funded projects, totalling $53m. The projects are expected to create approximately 456 jobs over the duration of implementation.

[5] Work has started on Council's implementation of catchment action plans (CAPs). This includes identification of six key work areas including plan alignment mapping, the most appropriate approach for community collaboration planning, theme level program logics, spatial database and online representation, adaptive management, monitoring, evaluation, and reporting framework.

[6] The $4.0m, Ministry for the Environment funded, Te Hakapupu/Pleasant River project was announced on 21 December 2021. Over the next four years a series of initiatives will be implemented by ORC, in conjunction with mana whenua and the local communities

[1] *Environmental Implementation Update*, Report BIO2103, Report to 8 December 2021 meeting of the Implementation Committee.

to improve water quality in the Te Hakapupu/Pleasant River catchment and impacts on the coastal marine area.

[7] Staff within the Catchment Team have met with a range of Catchment Groups, industry groups and other key stakeholders to identify and pursue support opportunities. Work is also underway to provide improved spatial data and analysis to individuals and groups to better inform their environmental management plans.

[8] A Cultural Values Assessment for the Wai Whakaata (Lake Hayes) project has been commissioned to inform the refreshed strategy and the restoration project plan is being delivered as expected. Survey works and preliminary geotechnical investigation for the culvert site (SH6 at Hayes Creek) have been completed. A report detailing the proposed lake levels and the target range for the lake has been completed. A resource consent has been obtained for the detailed geotechnical investigation work to be completed and this work is scheduled to be completed by the end of February. The consent application for the culvert construction has begun.

[9] A key stakeholder meeting for the Lake Tuakitoto Water Quality project was held in January 2022 and wider public consultation on potential projects within the management plan is underway.

[10] The Jobs for Nature – Maintaining the Gains project has officially started with the funding agreement being signed in December 2021. The project includes just under $1 million from DOC to deliver maintenance of QEII covenanted land using a work force contracted through Aukaha. The project is expected to create up to 11 jobs.

[11] The Biosecurity Operational Plan for 2021-22 is being implemented as expected, with good progress being made across the 90 KPIs. Two staff surveyed 880 freshwater users on their understanding of freshwater weeds and pests as part of Council's delivery of the national Check, Clean Dry (CCD) Regional Advocacy Programme. The results of the survey, and implications for work programmes will be reported to a future Council meeting.

[12] A sample of Aceria vitalbae (Old Man's Beard mite) was purchased by ORC from Manaaki Whenua/Landcare Research and was released on a site in North Otago on 24 November 2021. This release forms part of Council's emerging biocontrol strategy. Biocontrol reduces the reliance on conventional pest controls such as herbicides which have been found to have minimal effective in containing the spread of Old Man's Beard due to the tenacity of the root stock of the species. Biological control is currently viewed as the best option to reduce Old Man's Beard densities at a landscape scale.

[13] The Community Led Rabbit Management projects continue to be implemented in accordance with the overall project plan. There are numerous examples of collaborative, longer-term management options being implemented by landowners in Otago and, for those who have not engaged in the facilitated process, more formal compliance processes are due to commence in March 2022.

[14] The first tranche of Notices of Direction have been issued under the Biosecurity Act 1993, with more planned over the next six months (and beyond) as the time frame for adhering to compliance notices ends and as a result of a significant increase in property inspections over the past year.

[15] Otago's delivery of the national wilding conifer programme continues with good progress being made against delivery plans in both the Whakatipu and Central Otago areas. Council's oversight of the new Luggate Management Unit is progressing well, with control work due to commence in mid-March 2022.

[16] In terms of wallaby control, operations are progressing across seven Management Units (MU) with four ground-based contractors using a range of surveillance methods to search for wallaby, including ground hunters searching for field sign, ground hunters with dogs, and ground hunters using thermally equipped UAV (drones). One wallaby has been killed in the past quarter, near Richmond (North Otago).

RECOMMENDATION

That the Committee:

1) ***Notes*** *this report.*
2) ***Notes*** the range of implementation activities being undertaken to maintain and improve Otago Regional Council's delivery of environmental implementation activities.

DISCUSSION

1) Environmental Implementation Summary

[17] Figure 1 provides a snapshot of environmental focused initiatives underway across the region. Some are led by the ORC, while others are community driven, with extensive central government investment.

[18] These initiatives include at least 22 individual catchment groups in various stages of development. These groups are being supported by Otago Catchment Community, which has received $225,000 this financial year from the Council.

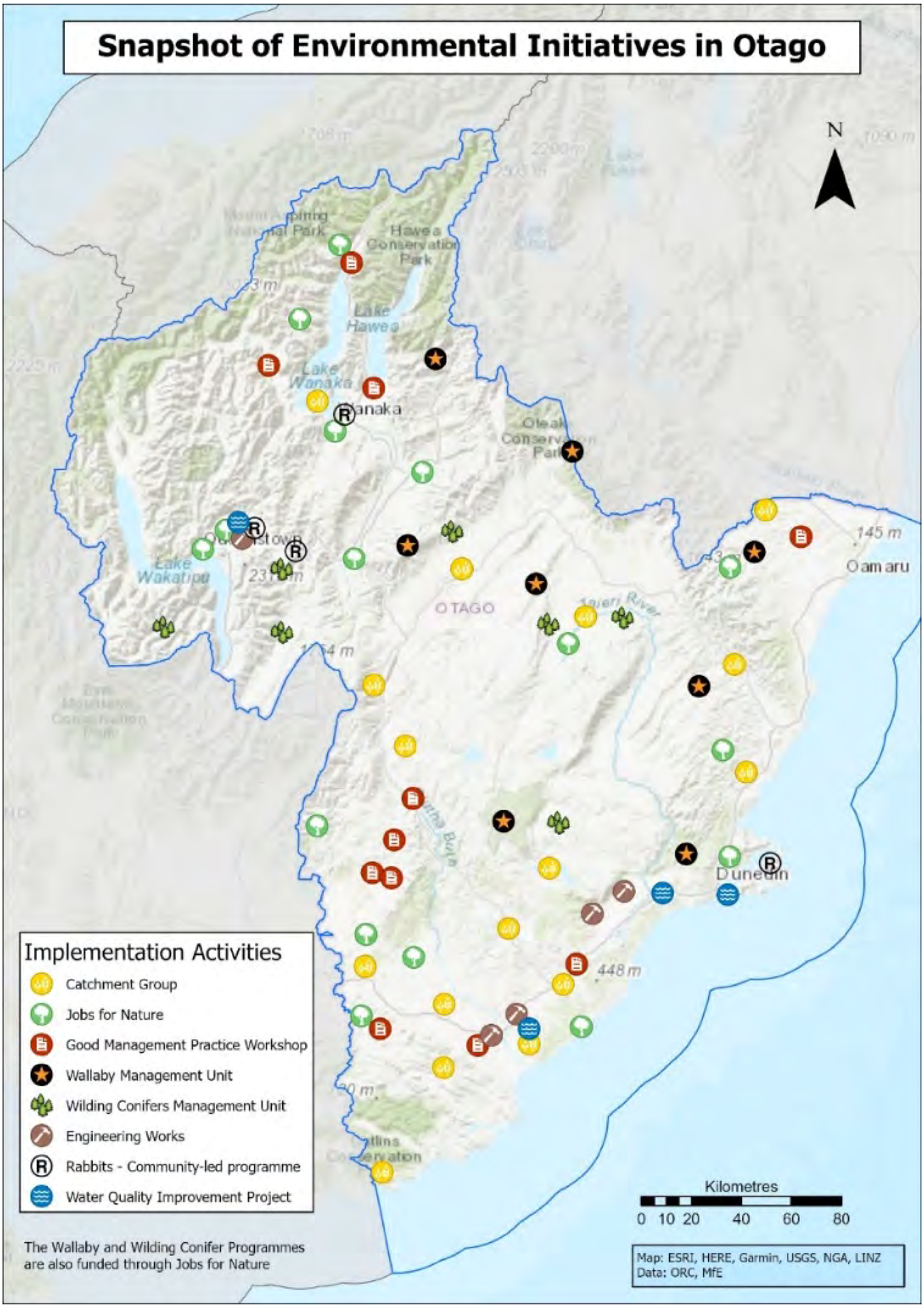


Figure 1: Environmental Implementation Regional Overview

[19] As of February 2022, 25 large projects in Otago have been funded by Jobs for Nature (J4N) (Figure 2). These projects are worth $53m to the region and will be delivered over several years. The projects are focused on ecosystem and freshwater restoration, pest control, recreational enhancement, regulatory implementation, and building capability. These are in addition to the four Climate Resilience ("shovel-ready") flood protection projects being delivered by ORC's Engineering team ($5.4m of central government funding).

Funding Recipient	Project Name	J4N Funding	Estimated FTE	Project Intent
Aspiring Biodiversity Trust	Makarora Catchment Threatened Species Project	$321,000	1.82	Ecosystem Restoration, Pest Control Animals
Department of Conservation	In the Wild Queenstown & Fiordland Workforce Hub	$250,000	9	Capability Development, Pest Control Animals, Pest Control Plants
Friends of Tucker Beach Wildlife Management Reserve Society Incorporated	Tucker Beach Habitat Restoration	$1,000,270	14.3	Capability Development, Ecosystem Restoration, Pest Control Plants
Halo Project	Halo Project - Source to Sea	$1,979,974	27	Ecosystem Restoration, Freshwater Restoration
Hukarere Station Ltd.	Hukarere Station Indigenous Planting	$2,335,340	25	Ecosystem Restoration, Freshwater Restoration
Lake Dunstan Charitable Trust Board	Lake Dunstan Restoration and Community Engagement Project	$953,000	4.51	Pest Control Animals, Pest Control Plants, Recreation Enhancement
Landscape Connections Trust	Halo Project - Source to Sea	$600,000		Freshwater Restoration
Lindis Catchment Group Inc	Lindis Catchment Group	$771,724		Ecosystem Restoration, Freshwater Restoration, Pest Control Plants
Mana Tahuna Charitable Trust	The Rehabilitation of Te Wai Whakaata the Lake Hayes Catchment	$4,450,000	64.1	Capability Development, Ecosystem Restoration, Freshwater Restoration, Pest Control Animals, Pest Control Plants
North Otago Sustainable Land Management Group Inc	North Otago Sustainable Land Management	$361,776		Ecosystem Restoration, Freshwater Restoration, Pest Control Plants
Otago Regional Council	Maintaining the Gains' - Protecting and restoring indigenous biodiversity on Otago's covenanted private land	$961,234	10.57	Capability Development, Pest Control Plants
Otago Regional Council	National Wilding Conifer Control Programme to Boost Regional Economies and Employment: Otago	$13,463,527	45.81	Pest Control Plants
Otago Regional Council	Containing Wallabies to Protect Agriculture, Forestry and Native Plants, And Boost Regional Economies - Otago	$4,170,342	19.23	Pest Control Animals
Otago Regional Council	Te Hakapupu Restoration Project	$4,004,500	$5,290,500	Ecosystem Restoration, Freshwater Restoration, Pest Control Plants
Pomahaka Ware Care Group	Pomahaka Water Care Group	$175,907		Ecosystem Restoration, Freshwater Restoration, Pest Control Plants, Regulatory Implementation
Pomahaka Water Care Group	Pomahaka Water Care Group	$1,400,000	13.5	Ecosystem Restoration, Freshwater Restoration

Pomahaka Water Care Group Incorporated	Pomahaka Corridor Planting Project	$2,312,161		Freshwater Restoration
Royal Forest and Bird Protection Society Dunedin Branch	Tautuku Restoration	$577,274	9	Capability Development, Pest Control Animals
Southern Lake Sanctuary (SLS) Trust	Southern Lakes Sanctuary (SLS)	$3,111,000	38.7	Capability Development, Pest Control Animals
Te Rūnaka o Ōtākou	Te Nukuroa o Matamata	$4,954,167	71.25	Capability Development, Ecosystem Restoration, Freshwater Restoration, Pest Control Animals, Pest Control Plants
The Routeburn-Dart Wildlife Charitable Trust Board	Routeburn Dart Wildlife Trust - Predator Trapping Project	$416,000	8	Capability Development, Pest Control Animals
Tokomairiro	South Otago - Tokomairiro	$83,970		Ecosystem Restoration, Freshwater Restoration, Pest Control Plants
Upper Taieri Wai	Maniototo Tiaki - Preservation Maniototo	$4,550,000	76.92	Capability Development, Ecosystem Restoration, Freshwater Restoration, Historical or Cultural Heritage Restoration, Pest Control Plants, Recreation Enhancement, Regulatory Implementation
Wai Wanaka	WAI Wanaka - Wanaka Future Reset	$3,000,000		Ecosystem Restoration, Freshwater Restoration, Pest Control Animals, Pest Control Plants
Wanaka Catchment Group	Wanaka Catchment Group Wai Ora Initiative	$1,132,269	9.91	Capability Development, Ecosystem Restoration, Freshwater Restoration, Historical or Cultural Heritage Restoration, Recreation Enhancement, Regulatory Implementation
Yellow-eyed Penguin Trust / Te Tautiaki Hoiho (YEPT / the Trust)	Jobs Increasing Hoiho Conservation: the story of a taonga species	$422,000	8	Capability Development, Ecosystem Restoration, Freshwater Restoration, Historical or Cultural Heritage Restoration

Figure 2: Jobs for Nature Projects in Otago by Funder

2) Catchment Action Planning (Integrated Catchment Management)

[20] Work has started on Council's development and implementation of catchment action plans (CAPs). This includes identification of six key work areas:

i. Plan alignment mapping
ii. Community collaboration planning
iii. Theme level program logics
iv. Spatial database and online representation
v. Adaptive management
vi. Monitoring, evaluation, and reporting framework.

[21] An internal staff reference group has been established and met in late January 2022. Members of this group identified which key work area they should be involved in.

[22] The plan alignment mapping exercise will incorporate thinking on how we integrate or account for external planning already underway (or being implemented) in catchments.

[23] Work has started on scoping an approach to community collaboration. This will include consideration of how mana whenua would like to be involved at various levels. The wider community collaboration plan will identify how we will collaborate in the development of the CAPs and why we chose a certain way of collaborating (e.g., establishing an ongoing catchment committees vs series of community meetings).

[24] The theme level program logics are the structural outline of every CAP. This area of work will be generic program logics for themes of mana whenua, community, biodiversity, land, and water, which can be tailored specific to each catchment. The program logics include the values and outcomes for each theme, the actions and targets for each value, and priorities and decision-making criteria for each action. The logic was explained at the Council workshop on 8 December 2021.

[25] Designing the scope for the spatial database has begun with discussion between GIS staff and the Environmental Implementation team. We are also currently designing the initial stages of what will become an ORC integrated reporting database to capture outputs from work areas across ORC, starting with the ECO Fund.

[26] Adaptive management and the monitoring, evaluation and reporting framework will be underway later in 2022 but will be informed by the program logics and the spatial database design.

[27] The CAP work will be described in more detail in a paper to the 8 June 2022 meeting of the Implementation Committee.

3) **Freshwater Implementation**

Jobs for Nature - Te Hakapupu (Pleasant River Catchment) Restoration Project

[28] The $4.0m, Ministry for the Environment funded, Te Hakapupu/Pleasant River project was announced on 21 December 2021. Over the next four years a series of initiatives will be implemented by ORC, in conjunction with mana whenua and the local communities to improve water quality in the Te Hakapupu/Pleasant River catchment (Figures 3a, 3b).

[29] Te Hakapupu is showing signs of excess sedimentation and nutrients, which impacts on ecosystem habitat and health, cultural values, as well as reducing recreation and amenity values. These signs include areas of dense algal mats, anoxic water conditions, and muddy sediment around the estuary. Changing land use in the area over time has contributed to sediment and nutrients entering the waterways. Erosion which is associated with land clearance and weather events has also exacerbated sediment issues in the catchment.

[30] Over the next year, the project will gather baseline data on the catchment to better understand the sediment, fish habitat and water quality issues, as well as creating an overarching sub-catchment plan[2], to guide activities that will improve water quality.

[2] See Appendix 1 for an example of a (sub) catchment plan.

[31] Throughout the course of the project, staff will work actively with the forestry sector to ensure that best practice forestry harvesting is undertaken to reduce sediment loss and with landowners to create and implement Sediment Mitigation Plans.

[32] By June 2025, the project will have implemented on-the-ground mitigation activities in line with the catchment plan. This is expected to include installing 60km of fencing, planting over 100,000 native trees, restoring fish passage in the catchment, and a range of other potential remediation actions – like sediment traps, bank stabilisation, wetland restoration, and riparian buffers in forestry areas.

[33] A dedicated Project Manager commenced work for ORC on 8 February 2022, and work is now underway to design the detailed programme plan, establish governance structures and commence consultation with the local community.

Figure 3a: Te Hakapupu/Pleasant River Catchment – Taking a Mountains to the Sea approach to improving the environment

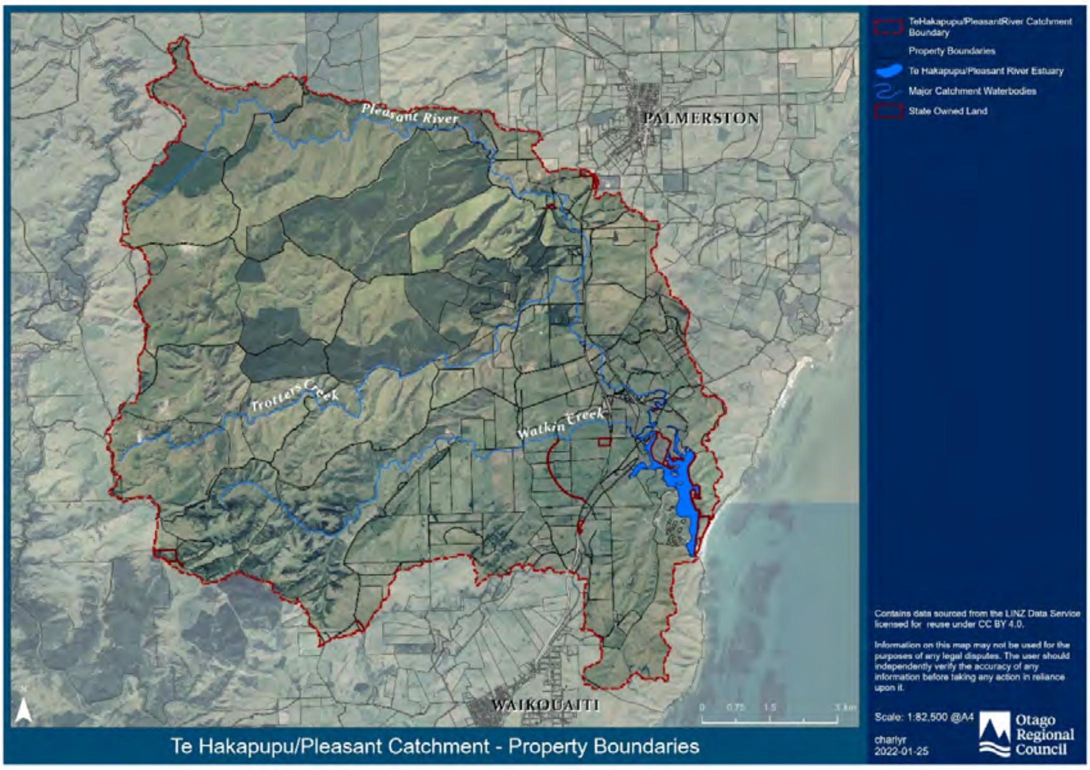


Figure 3b: Te Hakapupu/Pleasant River Catchment – Taking a Mountains to the Sea approach to improving the environment

Delivering Annual Plan Programmes

Support of Catchment Groups

[34] In the last three months, staff have met with the following catchment groups to provide advice and support:

i. NOSLaM
ii. East Otago Catchment Group
iii. Otago Peninsula Catchment Group
iv. Otago South River Care
v. Lindis Catchment Group
vi. Upper Taieri Wai/Tiaki Maniototo
vii. Strath Taieri (group in infancy)
viii. Wai Wānaka
ix. Wānaka Catchment Group
x. Teviot Valley Catchment Group
xi. Ida Valley Catchment Group
xii. Friends of Bullock Creek
xiii. Hāwea Catchment Group

[35] Work is underway to provide Catchment Groups with environmental and spatial data to inform work programmes and evaluate impact. The provision of information will be available directly (by providing a user-friendly guide to publicly available information) and through ORC's Catchment Advisors who will have access to a range of more detailed spatial information including:

i. Environmental Monitoring Locations
ii. Soil Types
iii. Land Use and Ownership
iv. Regional policy areas
v. TLA Planning zones and associated features
vi. Conservation land and covenants
vii. Aerial and LiDAR
viii. ORC assets
ix. Ecology, habitats, threatened species
x. Catchment boundaries
xi. Freshwater and coastal features
xii. Geology

[36] This information will assist individuals and groups to identify issues, priorities and potential mitigation solutions. By mid-year, it is hoped that Catchment Advisors will be able to download a report for part or all of a catchment (or a property or collection of properties) with relevant information to inform discussions and future action with stakeholders.

Lake Hayes Water Quality Strategy

[37] The Wai Whakaata /Lake Hayes Strategy Group is continuing to support the development of a refreshed strategy. The group focuses on:

i. Coordinating actions across member organisations in order to improve water quality.

ii. Identifying significant existing and emerging issues affecting Wai Whakaata /Lake Hayes and responding appropriately.

iii. Considering agreements, policies and strategies and all other proposals to achieve integrated outcomes for Wai Whakaata /Lake Hayes.

iv. Identifying necessary actions by the partner organisations and other relevant organisations.

[38] The group comprises representatives of mana whenua, ORC, Friends of Lake Hayes, Department of Conservation and Queenstown Lakes District Council.

[39] A cultural values assessment for Wai Whakaata /Lake Hayes is underway, being led jointly by Aukaha and Te Ao Marama. The assessment will provide a comprehensive summary of mana whenua values and environmental aspirations and will be used to inform the final refreshed strategy (and other planning and strategic processes concerning the Wai Whakaata catchment). The cultural values assessment is due to be completed mid-year.

Lake Hayes Restoration

[40] This project aims to improve water quality within Lake Hayes and reduce the risk of flooding along the perimeter of the lake. Currently there are flooding impacts to the existing recreational trail which affects public access, negatively impacts on the Crested Grebe habitat, increases runoff of nutrients from flooded land and impacts adversely on native planting, which has been established for local biodiversity restoration along the shores of Lake Hayes.

[41] ORC's Project Manager has prepared a detailed project plan. Survey works and preliminary geotechnical investigation for the culvert site have been completed.

[42] A report detailing the proposed lake levels and the target range for the lake has been completed. This report has been circulated with key stakeholders to ensure that this is agreed upon and we are awaiting comment on this.

[43] A resource consent has been obtained for the detailed geotechnical investigation work to be completed and this work is scheduled to be completed by the end of February.

[44] The consent planner is progressing the consenting side of the culvert construction with the timeline for this to be lodged in mid-April 2022.

[45] Stakeholder engagement is ongoing. The key stakeholders involved in this project are Te Ao Marama, Aukaha, Queenstown-Lakes District Council, Department of Conservation, Waka Kotahi, Friends of Lake Hayes, Fish and Game and Wai Whakaata.

Tomahawk Lagoon Water Quality Project

[46] Staff have developed a Tomahawk Lagoon Management Plan in consultation with the community.

[47] A drop-in session was held to provide opportunity for the community to provide input and feedback in the Outline Management Plan on 29 April 2021. This was an opportunity for the community to provide feedback on which projects within the Plan should be prioritised.

[48] Based on community input and feedback the three projects which were deemed to be the highest priority are: the support and formation of a catchment group, an ecological assessment of the catchment is to be undertaken and a permanent water quality monitoring site to be installed. This plan will come back to Council for final approval. Staff are currently scoping these projects and there is budget available for this in Year 2 (2022/23) of the 2021/31 Long-Term Plan. Regular communication is provided to key stakeholders within the Tomahawk Lagoon community.

[49] The Ecological assessment for the Tomahawk Lagoon catchment and following up the formation of a catchment group for the area is being progressed, conversations are ongoing internally to have a permanent water quality monitoring site set up.

Lake Tuakitoto Water Quality Project

[50] Staff have developed a Draft Lake Tuakitoto Management Plan based on community consultation which was undertaken in 2018. Goals, values, and potential projects were identified through this consultation process.

[51] A key stakeholder meeting was held (online) on the 25 January 2022 with Councillors Wilson, Scott, and Chair Noone in attendance. This was held to obtain feedback on the draft management plan and an opportunity for the key stakeholders to put their votes forward for the priority projects they would like to see progressed.

[52] Online consultation is available until the 23 February 2022 for the community to provide their feedback on the projects they would like to see progressed. Following this the feedback will be collated and a confirmed Management Plan will be presented along with the top priority projects that are being progressed based on the community feedback.

[53] The Robson Lagoon Flow Control Structures Upgrade project is continuing, with construction underway. This is one of the four Climate Resilience ("shovel-ready") projects being delivered by ORC's Engineering team.

Land Management and Freshwater

[54] Over the past three months there has been a focus by the Catchment Advisors on creating relationships with catchment groups, community groups and industry. During this time, we have connected with 39 different community groups/individuals across Otago and have connected with the following groups:

i. Otago Poplar and Willow Trust
ii. Beef and Lamb
iii. Otago Polytechnic (regarding seed propagation and collection)
iv. Department of Conservation
v. Forest and Bird
vi. Predator Free Dunedin
vii. Mid Otago Forestry Association
viii. Environmental Protection Authority
ix. Ministry of Primary Industries (Otago)
x. Central Otago and North Otago Winegrowers Association
xi. Otago Fish and Game
i. Foundation for Arable Research

ii. Deer Industry NZ

[55] Staff have attended the National Freshwater Conference and the Farmed Landscaped Research Centre conferences both in February 2022.

[56] Two staff have commenced further formal upskilling through Massey University and are currently completing the Intermediate Sustainable Nutrient Management Course, with other regular informal upskilling occurring across the team.

[57] The Environmental Implementation Team has just recently purchased four NIWA Stream Health Monitoring and Assessment (SHMAK) kits. These kits are to be used as an engagement tool with mana whenua, community groups, schools and catchment groups so that we can provide scientifically sound tools and resources to monitor the ecological health of Otago's streams. This assists those who use this to learn more about what is located within their waterways and what some localised issues may be.

[58] Work is occurring to develop a multi-year programme of works which captures programmes and projects which have occurred across New Zealand in both the rural and urban context. This work will assist the team to learn what has worked in other regions across New Zealand and look to implement a range of best practice projects and interventions using a prioritisation methodology based on factors relevant to Otago.

[59] The development of both a stormwater education and a septic tank education programme is underway. Once developed the Catchment Advisors will roll this out in areas which are considered to be high priority throughout the region. The aim of these programmes is to encourage behaviour change to improve water quality.

[60] The team have also commenced providing biodiversity advice to landowners in the form of a basic plan, where requested, to provide assistance on the type of species that were historically in the area, so landowners have a starting point for their planting plans and purchase of plants.

[61] Longstanding Catchment Advisor, Bruce Monaghan, retires in March 2022. Bruce has been employed by the ORC since its inception and earlier with the Otago Catchment Board. Bruce has contributed immensely to ORC's regulatory and non-regulatory functions over many years and his knowledge and expertise of rural matters is held in high regard by catchment groups, industry, and landowners. This long period of dedicated service to the Council, and the guidance that he has provided to communities within Otago, is highly valued and greatly appreciated.

4) Biodiversity Implementation

[62] The Partnership Lead – Biodiversity position was filled in late-January. This role:

i. Coordinates the Otago Biodiversity Forum
ii. Leads the revision of the Otago Biodiversity Strategy to align with the National Policy Statement for Indigenous Biodiversity (when released)
iii. Develops partnership projects in line with the Biodiversity Strategy and action plan
iv. Coordinates the ECO Fund
v. Provides biodiversity advice where appropriate.

[63] The Jobs for Nature – Maintaining the Gains project has officially started with the funding agreement being signed in December 2021. The project includes just under $1 million from DOC to deliver maintenance of QEII covenanted land using a work force contracted through Aukaha. The project will create up to 11 jobs.

[64] The Project Delivery Specialist role will project manage this project starting with a meeting with project partners (Aukaha and QEII) on Monday 21 February 2022.

5) **Biosecurity Implementation**

Biosecurity Operational Plan Implementation

[65] The Biosecurity Operational Plan for 2021-22 has 90 KPIs. As at the end of January 2022, 12 KPIs (13.3%) have already met or exceeded their annual targets. These include rookery inspections, rabbit inspections and identification of monitoring sites for various plant pests.

[66] Fifty KPIs (55.6%) are assessed as being on target; hence are expected to be completed, or substantively completed, by the end of the year. These include pest plant inspections for Old Man's Beard, gorse, broom, nassella tussock and bomarea. Twenty-eighty KPIs (31.1%) are assessed as being marginal for completion. Most of these relate to delays and limitations due to Covid lockdowns or restrictions (targets were set at 100% and therefore no tolerance to any loss of work productivity due to factors within or beyond our control).

Check, Clean, Dry

[67] ORC was granted $20,000 by the Ministry of Primary Industries – Biosecurity New Zealand through the Freshwater Biosecurity Partnership Programme to support the Region's Check, Clean Dry (CCD) Regional Advocacy Programme. This programme aims to stop the spread of freshwater weeds and pests through in-person advocacy, associated communications, education and engagement activities carried out at a selection of Otago's freshwater lakes and rivers, with a key interest in Lake Wakatipu, Lake Dunstan and Lake Wanaka.

[68] As part of this funding, Council had two fixed term roles over summer from 15 December 2021 – 7 February 2022, to run the programme to raise awareness about aquatic pests. These roles focussed on educating people on freshwater pests including Didymo, Lagarosiphon and Lake Snow and encourage them to take action to minimise their spread.

[69] Through this programme thousands of freshwater users were engaged, and survey information was collected from 880 people. Survey data is collected nationally, and this information helps us better understand people's knowledge of freshwater pests, identify high risk pathways/vectors and what we can do to keep them better informed. The results of the survey, and implications for work programmes will be reported to a future Council meeting.

Old Man's Beard Gall Mite release

[70] Old Man's Beard is considered the most damaging climbing plant introduced to New Zealand because it smothers the plants and trees it grows on (Figure 4). This makes it a threat to Otago's biodiversity. It spreads easily, and stems on the ground can take root

and produce new pla ... ıich stay in the soil or are spread by ... an produce up to 10 metres of new

Figure 4: Old
(Sou

[71] The plant is capable ... st canopy and prevents the establis ... wind and water borne.

[72] Weeds are one of the hardest to control pest problems in New Zealand with massive adverse effects on productive land, natural habitats, and taonga species. The costs to conventionally manage weeds can be significant, as well as the costs of reduced productivity and biodiversity loss. Biocontrol is increasingly being recognised as an essential part of integrated pest management systems that contributes to sustainable pest control.

[73] Historically, herbicide use has been applied and/or recommended by ORC to landowners and occupiers as a control mechanism. The root stock of this species is tenacious, and these existing methods have mixed success in containing the spread of Old Man's Beard, so Council has explored new control methods.

[74] Biological control involves using living organisms, such as insects, pathogens, or grazing animals, to suppress a weed infestation. Biological control relies on the release of large

[3] Old Man's Beard falls into Council's Progressive Containment biosecurity programme. Under the Regional Pest Management Plan, Rule 6.3.2.1, all occupiers within the Otago region must eliminate old man's beard infestations on the land that they occupy.

numbers of biocontrol agents to allow insect or pathogen populations to establish. These agents continue to control target pests over many years.

[75] A sample of *Aceria vitalbae* (Old Man's Beard mite) was purchased by ORC from Manaaki Whenua/Landcare Research and was released on a site in North Otago on the 24th November 2021 (Figure 5). The site was selected for its climatic conditions and dense infestations of Old Man's Beard down the river system which will provide the best opportunity for establishment and spread. The release of the mite was carried out in consultation with Manaaki Whenua/Landcare Research.

[76] A release effectiveness monitoring plan was created based on advice from Manaaki Wheuna/Landcare Research, with the site being monitored on an annual basis and any progress measured over time. If successful, a redistribution strategy will be developed in consultation with Manaaki Whenua/Landcare Research where the original site could be used to obtain samples to spread throughout other suitable sites in Otago. Further sites are yet to be determined and will be investigated if the pilot release is successful. The Old Man's Beard mite has been released in Manawatu and near Wellington and there are releases in other parts of New Zealand which are proposed to take place shortly.

[77] Biocontrol reduces the reliance on conventional pest controls such as herbicides. Herbicides can be expensive over widespread areas and may have harmful indirect effects on non-target species. It has also been found that herbicide use has not been effective to date in containing the spread of Old Man's Beard due to the tenacity of the root stock of the species. Biological control is currently viewed as the best option to reduce Old Man's Beard densities at a landscape scale.

[78] The gall mites feed on the plant and cause growth abnormalities/galls on the old man's beard shoot tips and leaves. The effect of this is that the leaves will look atrophied and curled. The formation of the galls reduces the growth rate of the plant and can cause the shoots to die off prematurely.

[79] It is expected that the effects of the mite release will be gradual at first as the mite establishes and disperses in the environment. As a result, Old Man's Beard populations would not be expected to decline rapidly due to the mite's actions. Any damage from the mite will take some time to become evident and the mites are not visible to the naked eye (Figure 6).

Figure 5: Photo point 1 showing where Old Man's Bead Gall mite has been released in North Otago. Photo shows the prevalence of Old Man's Beard at this location. (Source: Kirk Robertson – Biosecurity Officer, 2021)

Figure 6: Shows the gall mites under a microscope – these cannot be seen by the naked eye. (Source: Manaaki Whenua/Landcare Research, 2021)

Rabbit Management

Next Generation Solutions

[80] Work to develop and implement more innovative solutions to Otago's rabbit problem continues. A project has commenced to scan how other countries, particularly Australia, are using biological control tools and other successful public/private partnership options to reduce populations. The aim of the work is to identify and progress a series of relevant options for Council to consider.

[81] The Council has continued to liaise with the Ministry for Primary Industries to encourage a more national approach to tackling the complexities of rabbit management. Ministry for Primary Industries are due to present their ideas at the next local government Biomanagers forum in March 2022.

[82] Working with the private sector and scientific advisors, we are also aiming to pilot some carefully managed poison bait station trials that might address concerns around using poison in sensitive areas where protected wildlife or domestic animals are present.

[83] Council has created a detailed list of research questions to support its rabbit management programme that require specialist scientific input. Initial engagement with a crown entity has proven that the delivery of this work would be expensive and would have a lengthy timeframe due to limited resourcing, so other options are being considered.

Rural Inspections – Rabbit Management

[84] From 1 July 2021 until 18 February 2022, 109 rabbit inspections have been undertaken in rural areas (defined as inspections that were not part of a community rabbit programme). Data from the inspection dashboard shows that 61.5% of the properties inspected were compliant to the RPMP rule with a Modified McLeans Scale (MMS)[4] of three or less (Figure 7).

[85] Of the 109 properties inspected, 69 were re-inspections of non-compliant properties from the previous inspection carried out in 2020-21 (Table 1, Figure 7). Of those 69 re-inspected properties, 32 remained non-compliant. Four properties had an MMS rating of 6, five properties an MMS rating of 5, while the remaining 23 properties had an MMS rating of 4.

Inspection Type	Compliant	Non-compliant	Total
Scheduled	11	2	13
Re-Inspection	37	32	69
Complaint	19	8	27
Total	67	42	109

Table 1: Rural Rabbit Inspection by Type and Compliance (1 July 2021 – 18 February 2022)

[4] https://www.orc.govt.nz/managing-our-environment/pest-hub/animals/rabbits

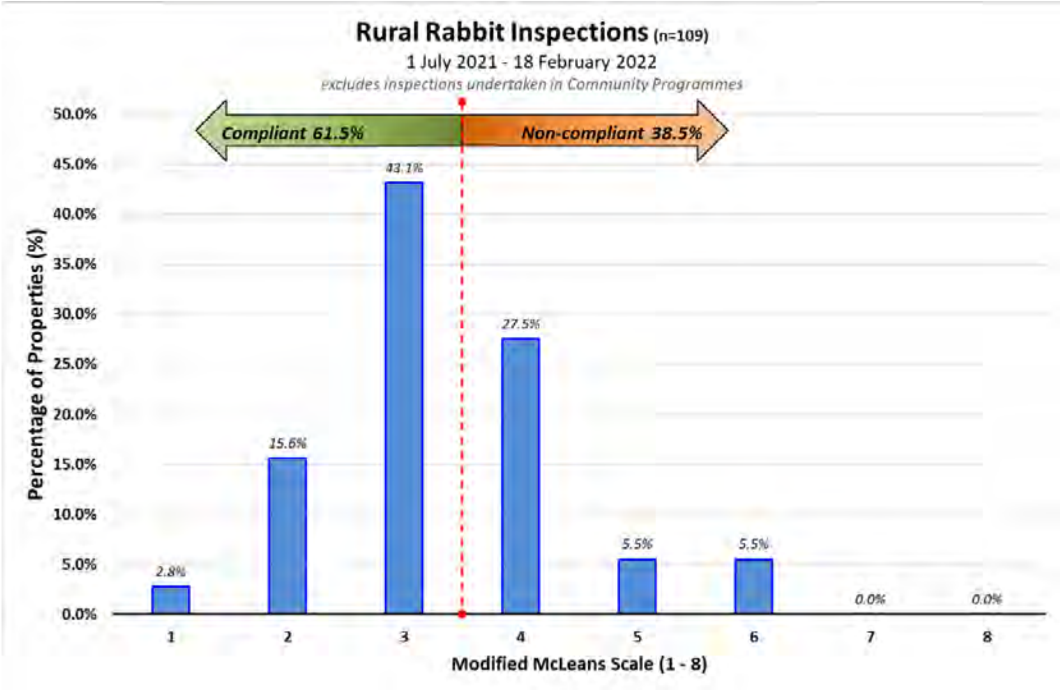


Figure 7: Distribution of Rural Rabbit Inspections by Modified McLeans Scale

[86] In terms of area, rural rabbit inspections have covered just under 14,108 hectares between 1 July 2021 – 18 February 2022. (An additional 10,348 ha were covered by community programmes – see below).

[87] The first Notice of Direction orders for non-complying properties were issued in early March 2022. The number of notices issued should increase considerably over the next few months as properties are reinspected and timeframes to comply are exceeded.

[88] Biosecurity internal compliance procedures have been extensively revised over the past six months to ensure high standards of data collection and the development of enforcement processes that are clear, robust and legally defendable.

[89] The initial compliance focus will be on those properties that remain above 5 on the MMS, with ongoing conversations occurring, and support provided, to those recording just over acceptable levels (e.g., MMS 4) to ensure these levels are reduced. This approach will be adjusted as needed.

[90] *Notices of Direction* (and subsequent Default Work) will be issued to both private and public landowners. As per Council's Biosecurity Compliance Enforcement Policy[5], occupiers will be given a set time to comply and if this isn't achieved, where appropriate, the *Default Work* process will commence.

[5] https://www.orc.govt.nz/media/10235/orc-biosecurity-compliance-enforcement-policy_final.pdf

Community-Led Rabbit Management Programmes

[91] In addition to standard compliance work within our rabbit programme, which has increased significantly in the past year, ORC is facilitating several large-scale community responses to better rabbit management in semi-rural and peri-urban environments. The ORC Biosecurity Operational Plan 2021-2022 has the target to facilitate and lead eight community responses to reduce rabbit populations in areas of high need across Otago.

[92] Table 2/Figure 8 provides an overview of the communities that ORC is currently working with. Each approach is unique, based on the landscape, number of properties, land use activities and preferences of the community. The projects have been run simultaneously where possible but have had to be prioritised due to resourcing.

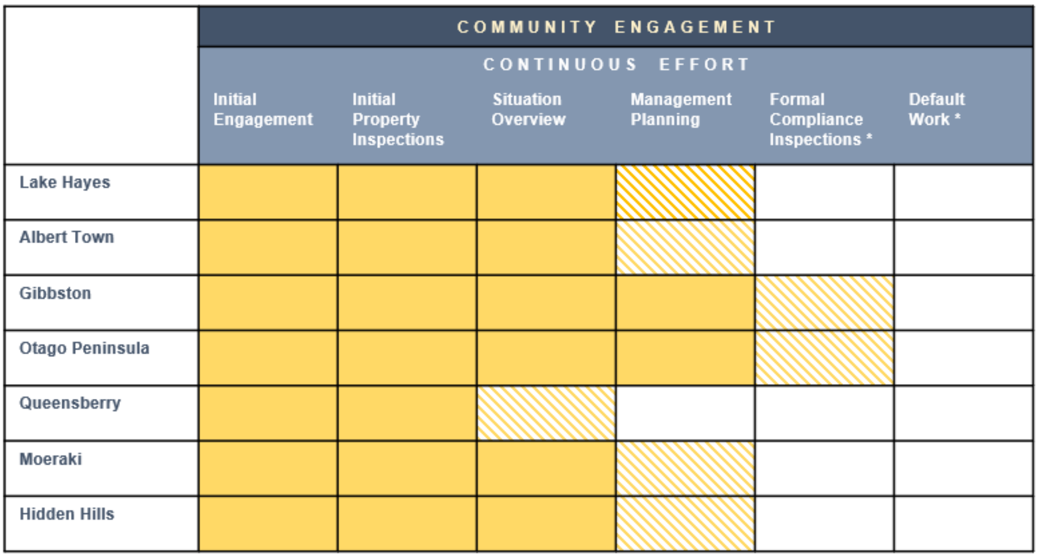


Table 2: Status of Community Led Rabbit Management Programmes as at February 2022

Figure 8: Community Rabbit Management Project Areas

[93] A process for engaging landowners to ensure strategic responses and coordination of control efforts has been developed. The community-led strategic management approach will be facilitated and supported through the following means:

i. Education and awareness - workshops, website, social media, pamphlets and one on one meetings/discussions highlighting:

ii. Rules, roles and responsibilities.

iii. Primary and secondary control techniques; and

iv. Contractor selection.

v. Information gathering to support recommendations and compliance action, including:

   a. Property inspections to identify properties that are at greatest risk of non-compliance, and to produce heat maps showing rabbit hotspots and to identify fences other than barriers that reduce the risk of reinvasion; and
   b. Ongoing monitoring of control efforts.
   c. Support with preparation of Management Plans - including technical advice on control methods.
   d. Compliance inspections and implementation of enforcement procedures. This is critical to increase recognition of ORC’s rules and compliance functions, and to ensure that a few non-compliant properties do not cause wider community efforts to fail.

[94] Table 3 provides a summary of recent progress to implement ORC's community led rabbit management programmes as of February 2022. This approach follows the previously outlined Community Led Rabbit Management process and compliance pathways as outlined in Appendix 1.

COMMUNITY	ACTIONS UNDERWAY – PAST QUARTER
ALBERT TOWN	Staff meeting with DoC/QLDC and LINZ in February to create implementation plan for long-term, sustained control.
LAKE HAYES	Biosecurity staff inspected 230 properties, of which 82 were indicative of non-compliance. Rabbit Management Plans were due 1 February. 56[6] Management Plans requested, 31 (55%) have been received or are imminent. Follow up occurring with those who have not submitted. Notice of Direction compliance inspections will be completed mid-year 2022 for properties not reducing populations.
GIBBSTON	Biosecurity staff inspected over 170 properties, of which 52 were indicative of non-compliance. A total of 49 management plans were requested. Of these, 37 (76%) have been received or are imminent, and there are currently 12 where communications have not been responded to. Notice of Direction compliance inspections will be completed in March 2022 for properties not reducing populations.
HIDDEN HILLS	Advice and connections provided to Residents Association. Community in the process of creating a strategy for implementation.
QUEENSBURY	68 property inspections took place in February. A community meeting will follow to outline the situation and a rabbit management plan will be requested from non-complying properties. This will be supported by our standard rabbit management plan workshops and individual visits, where needed, from Biosecurity staff.
MOERAKI	Biosecurity staff inspected 56 properties, of which 39 were indicative of non-compliance. A total of 39 management plans were requested and plans for 20 (51%) properties have been received or are imminent (some of the plans received cover more than one property). Follow up occurring with those who have not submitted. Notice of Direction compliance inspections will be completed mid-year 2022 for properties not reducing populations.

[6] Note that the number of management plans requested is often lower than the number of properties inspected because there are various groups of properties managed collectively.

OTAGO PENINSULA	Initial property inspections took place in Otago Peninsula in early 2021, prior to the full community programme model being established. A rabbit management plan workshop was held with property owners in early 2021, but little progress was made by owners during the year. Biosecurity staff inspected 37 properties at the end of 2021, and 28 management plans are due at the end of February. A further rabbit management plan workshop was held with landowners in February 2022. Notice of Direction compliance inspections will be completed in March 2022 for properties not reducing populations.

Table 3: Summary of Community-Led Rabbit Management Programme Progress

[95] As resourcing allows, staff will continue to assess other communities that might benefit from some extra assistance. The Millers Flat community is currently considering if they would like support and there has been some interest from rural property owners in the Waianakarua area. Support for the smaller, more rural focused communities is considered 'business as usual' work.

Community-Led Rabbit Management Programmes - Implementation Progress

[96] The community led rabbit management programmes have resulted in a number of landowners developing comprehensive rabbit management plans, implementing long-term, sustainable rabbit control measures (e.g., fencing, gates) and working collaboratively rather than engaging in ad hoc, one-off, poison operations without adequate secondary control plans being established and without a co-ordinated neighbourhood approach.

[97] Two examples of recent collaborative efforts are outlined below:

Case Study A

Three adjacent vacant lots on the shore of Lake Hayes with little fencing and a MMS score of 5.

This vacant land was no doubt housing, and acting as a through-fare for, a local rabbit population. The owners of the lots are unknown to each other and have future development plans.

The Lake Hayes Community-led Rabbit Management Programme alerted the owners to the level of rabbit sign on their properties and so rather than fencing only the southern-most lot, they have made plans to fence all three lots together. On the western boundary, it made more sense to fence along the walking track rather than on the property boundary, and so the property owners have gained permission from DOC to erect the fence on the marginal strip provided that they undertake weed control and planting of native vegetation.

Once the fence is installed, further rabbit control will be undertaken within the property as required. The images below show rabbit sign on the property, a screen shot from the rabbit app showing the inspections undertaken, and the proposed perimeter fence that will circle all three lots and also encompasses DOC marginal strip on the western boundary.

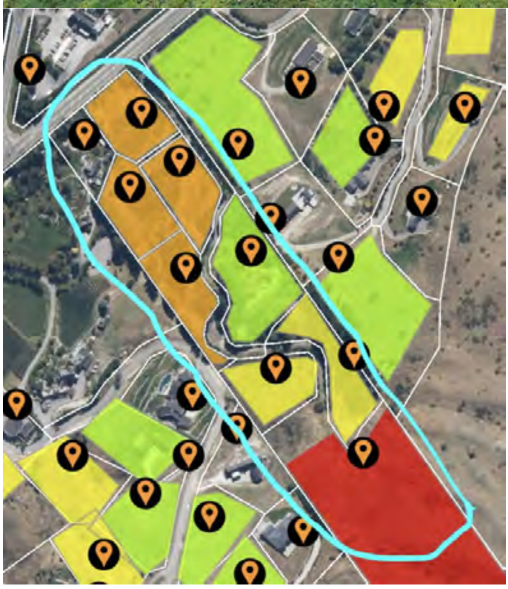
Case Study B

This property encompasses 8 different lots that are all managed as one, with only one dwelling in place.

Different parts of the property received scores from MMS 4 to MMS 7 (the highest score given to any property in Lake Hayes).

Biosecurity Staff met onsite with the property manager to discuss the rabbit issue. A very comprehensive, well-researched rabbit management plan has since been submitted that demonstrates a logical, staged approach to addressing the rabbit problem on the property. This also will help to alleviate rabbit pressure on neighbouring property boundaries.

The images below show rabbit sign on the property, a screen shot from the rabbit app showing the inspections undertaken, and the proposed perimeter fence that will circle all of the residential lots.



Community Programmes – Indicative Compliance

[98] Due to the limitations of the Modified McLeans Scale for small properties (under four hectares), these inspections are an indicative assessment of compliance (Table 4)[7].

Location	Month	Number of Inspections	Indication of…	
			Compliance	Non-Compliance
Gibbston	June/July 2021	173	54.9%	45.1%
Lake Hayes	October 2021	236	65.3%	34.7%
Moeraki	October 2021	89	37.1%	62.9%
Otago Peninsula	November 2021	39	25.7%	74.3%
Queensberry	February 2022	68	48.5%	51.5%

Table 4: Summary of Community Project Inspections

[99] In terms of area, community rabbit inspections have covered a total of 10,348 hectares between 1 July 2021 – 18 February 2022. This is broken down into Gibbston (4,360 ha), Lake Hayes (491 ha), Moeraki (970 ha), Otago Peninsula (4,010 ha) and Queensberry (517 ha).

[100] As noted above, for those properties that are indicative of non-compliance and do not submit a rabbit management plan and show a reduction in numbers, where possible Notices of Direction will be issued as part of the 'pathway b' formal enforcement approach. This will ensure that the good work being undertaken by the majority of owners is not undermined by the inactivity of others. The 'pathway a' or 'pathway b' approaches apply to both private and public landowners.

National Wilding Conifer Programme

[101] Whakatipu Wilding Control – operations are progressing in the Whakatipu basin, with control works approximately 45% through the total budget for 2021/2022 season. So far 11,396 hectares have been controlled by ground and aerial basal bark application (ABBA) methods. The aerial foliar spray application (AFSA) or boom spray programme is due to commence early February, subject to weather conditions, and will target areas of dense infestations around Queenstown Hill, Ben Lomond, Moke Lake, and Skippers.

[102] Central Otago Wilding Control – operations are progressing in the Alexandra, Rough Ridge and Dunstan Management Units, with control works approximately 25% through the total budget for 2021/2022 season. So far 2,921 hectares have been controlled using ground-based methods. Operational planning for the Community Partnership Projects is underway for areas located within the Maungatua and the Kakanui Ranges and control work is due to begin in March 2022, subject to contractor availability.

[103] The Central Otago Wilding Control Group (CWG) have also been focusing on education to increase the profile of the programme and wilding conifer issue in Central Otago, which will assist in gaining landowner support and the 20% contribution towards wilding

[7] A think piece on alternative compliance measures for smaller properties has been recently undertaken and may be considered as part of any future review of the Regional Pest Management Plan.

control on individual properties. CWG have also been working closely with MPI and the Wilding Pine Network to develop advertising and organise a community event in Alexandra, in March. CWG are also looking to engage a part-time Community Engagement person to develop a communications plan and undertake engagement activities around wilding conifer control.

[104] Luggate Control – ORC led operational planning for Luggate MU has been completed, and landowners notified of the proposed wilding pine control priority areas. Landowner responses to date have been positive, and several site visits have been completed to discuss the control work with landowners and assess wilding pines on properties. The current focus is on establishing property-specific control plans and costings, and landowner agreements. Control work is expected to begin mid-March.

[105] An online meeting was held with members of the Wānaka and Hāwea communities in mid-February to discuss wilding conifer management in the area and options for the best model of public/community action to progress better management and control. This area is currently not funded by MPI. The next step will be to undertake a workshop to identify short-, medium- and longer-term actions that could be undertaken by the range of stakeholders.

National Wallaby Programme

[106] Operations are progressing across seven Management Units (MU) with four ground-based contractors using a range of surveillance methods to search for wallaby, including ground hunters searching for field sign, ground hunters with dogs, and ground hunters using thermally equipped UAV (drones). One wallaby has been killed in the past quarter (Table 5; Figure 9).

Total area searched (ha):	61,420	A contractor has recently found sign in two locations within the Hawkdun MU, at sites where wallaby have been killed previously. Efforts are underway to locate the animals.
Total sightings reported:	22	All reports have been followed-up within 3 working days, and a search completed where a report has been deemed credible. No live wallaby or sign has been found following surveillance.
No. wallaby destroyed:	1	One wallaby has been killed. This was shot by a landowner in the North Otago MU in mid-January.

Table 5 Surveillance and control results for the period 1 July 2021 to 31 January 2022

[107] Unmanned Aerial Vehicle (UAV) thermal surveillance (Figure 9) was recently used to search for wallaby in the Hāwea and Dunedin Management Units, in response to sights reported by the public and following up a historic report of sign. While no wallaby or sign was located, UAV technology offers significant advantages over traditional ground-based search methods by enabling surveillance to be undertaken at night when wallabies are most active. UAV thermal surveillance supported by intensive ground

searching with indicator dogs will be used increasingly within the Otago Wallaby programme, as contractors develop the capability and capacity to undertake this work.

Figure 9: Unmanned Aerial Vehicle (UAV) thermal surveillance, Breast Creek, Central Otago

[108] Road signs prompting the public to report wallaby have been installed by contractors for ORC and Environment Canterbury along the State Highway near Lindis Pass and another near Ranfurly. Further signs are to be installed in Coastal Otago and South Canterbury in the coming months. The website ReportWallabies.nz is an online form that records and shares sighting information with managers and staff involved in the wallaby programme.

[109] Research is underway on a number of projects which aim to provide operational staff with new tools and information to support decision making and enhance operational efficiency. These include:

i. Environmental DNA – eDNA refers to all the tiny traces of genetic material that is left behind as living things pass through water or soil. Developing and implementing novel eDNA monitoring to rapidly and accurately measure the presence/absence of wallaby at low densities on a landscape scale is highly desirable. The opportunity to collaborate with the Otago University on a Ministry for Business Innovation and Employment eDNA project is currently being investigated.

ii. Strontium isotope – strontium isotope analysis of wallaby teeth, hair and nail samples collected over the past 12 months is underway by Otago University to try and identify the place of origin of animals. This information will potentially provide information about the range and mobility patterns of the Bennett's Wallaby through Canterbury and Otago. Results are due in February 2022.

iii. Grid-based risk mapping – Manaaki Whenua Landcare Research has been engaged by MPI to develop grid-based risk maps for Bennett's wallaby, as a cost-effective way to measure the likelihood of wallaby presence in an area. This will assist operations in prioritising search effort to areas most likely to be inhabited by invading wallabies. Completion date is December 2022.

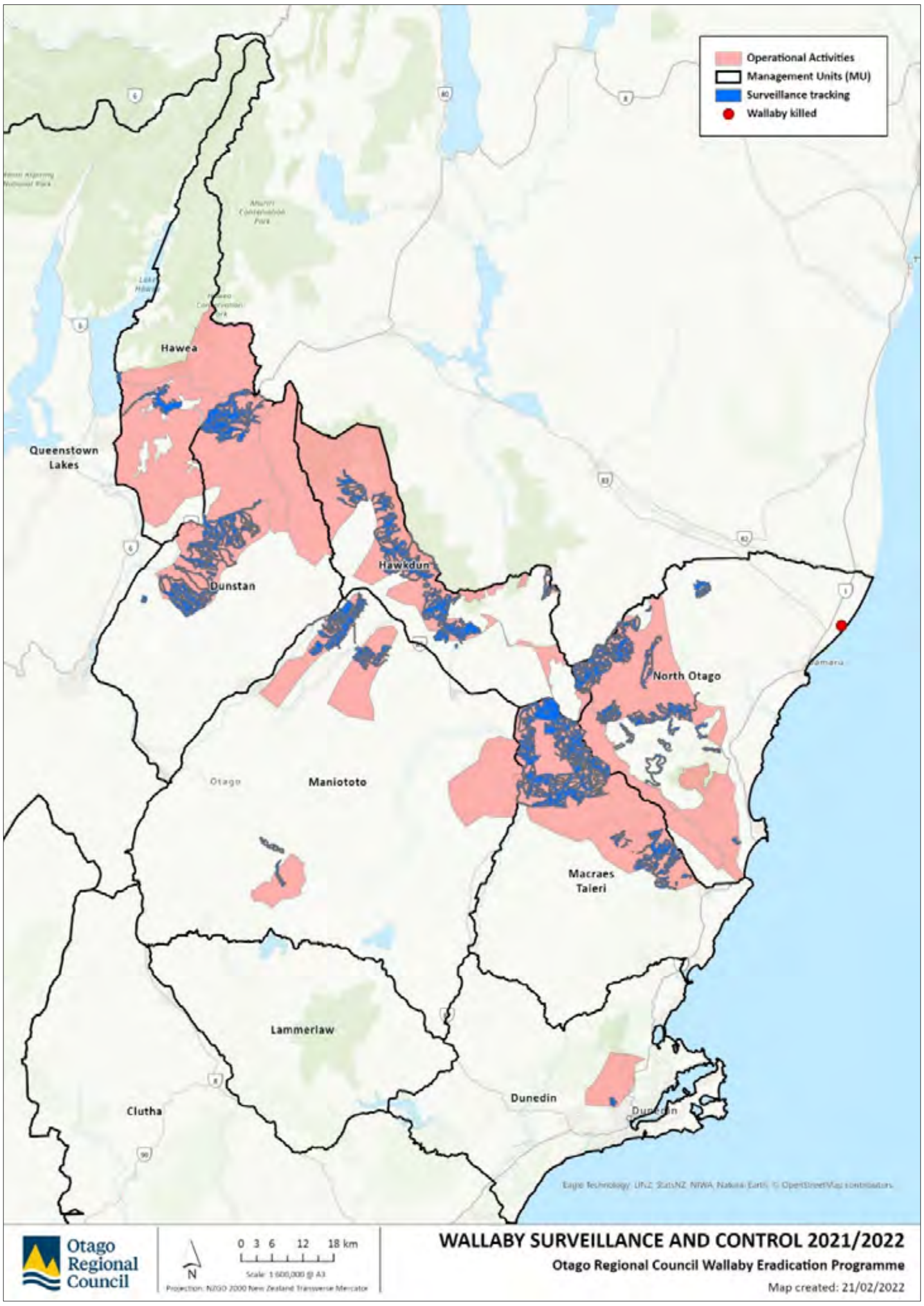


Figure 10: 2021/2022 Wallaby Operational Areas and Surveillance tracking (as at 31 Jan 2022)

[110] A Request for Proposal (RFP) is in progress to establish a new Biosecurity Services Panel to support our environmental programmes and initiatives within Otago for a duration of 3 years (2021–2024). RFP submissions are currently being reviewed, and successful respondents will be notified in February 2022. Services required cover:

i. Aerial and Ground-based wilding tree control
ii. Aerial and Ground-based wallaby surveillance and control
iii. Reactive response pest control services

iv. Assistance with the Rabbit Haemorrhagic Disease (RHD) virus blood monitoring programme
v. Assistance with monitoring rabbit numbers across the region
vi. Provisions to undertake default work in accordance with the 'Power to act on default'
vii. Provisions to assist in surveillance and monitoring of pests identified within the RPMP
viii. Aquatic and marine monitoring services

[111] The Biosecurity Services Panel will allow ORC to have a range of contractors 'on its books' to ensure effective delivery of our national programmes and to support implementation activities, it will also provide more contractual certainty, over a longer period and minimise ongoing procurement administration.

CONSIDERATIONS

Strategic Framework and Policy Considerations

No considerations arising from this paper.

Financial Considerations

No considerations arising from this paper.

Significance and Engagement Considerations

No considerations arising from this paper.

Legislative and Risk Considerations

No considerations arising from this paper.

Climate Change Considerations

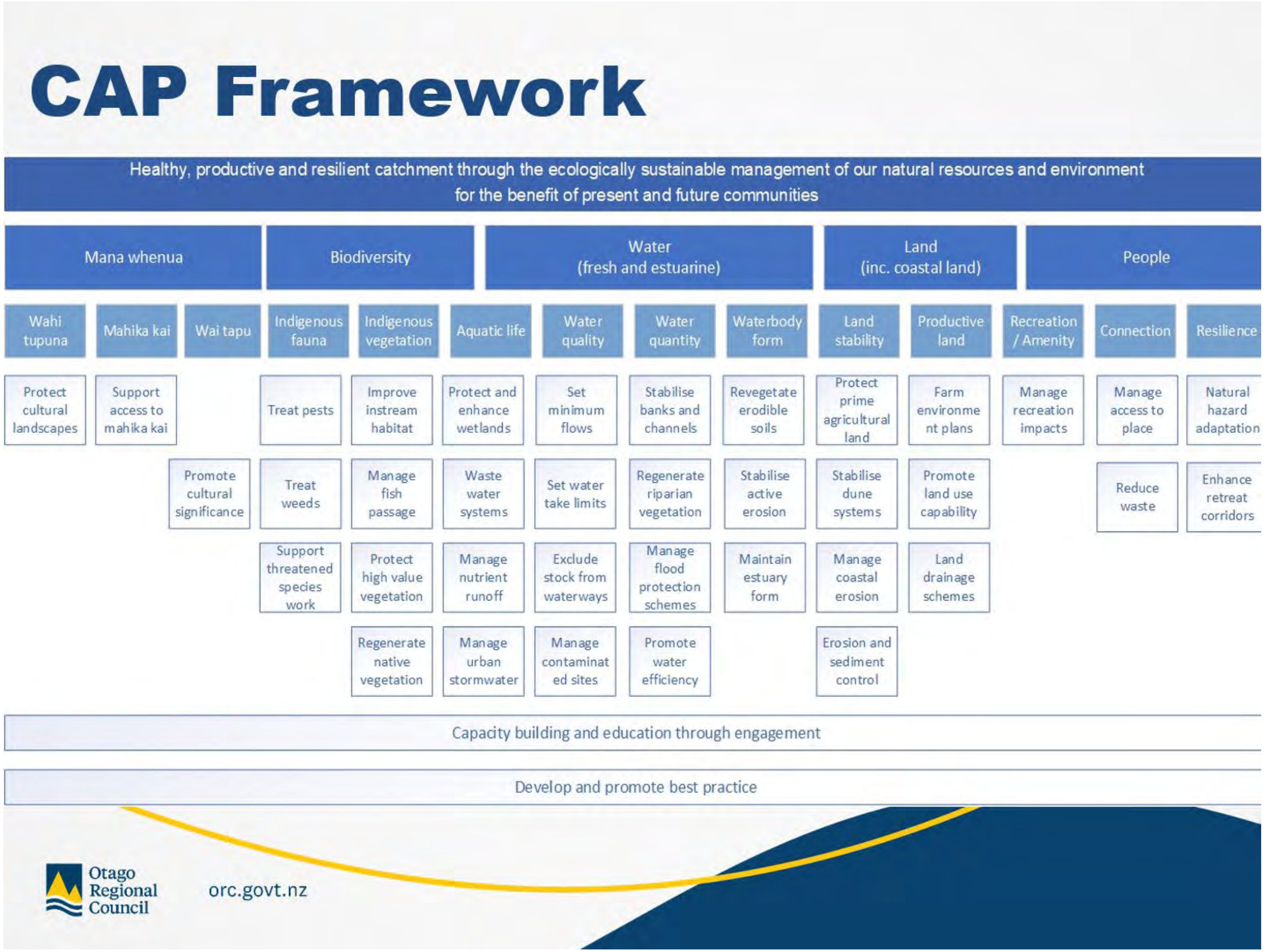
No considerations arising from this paper.

Communications Considerations

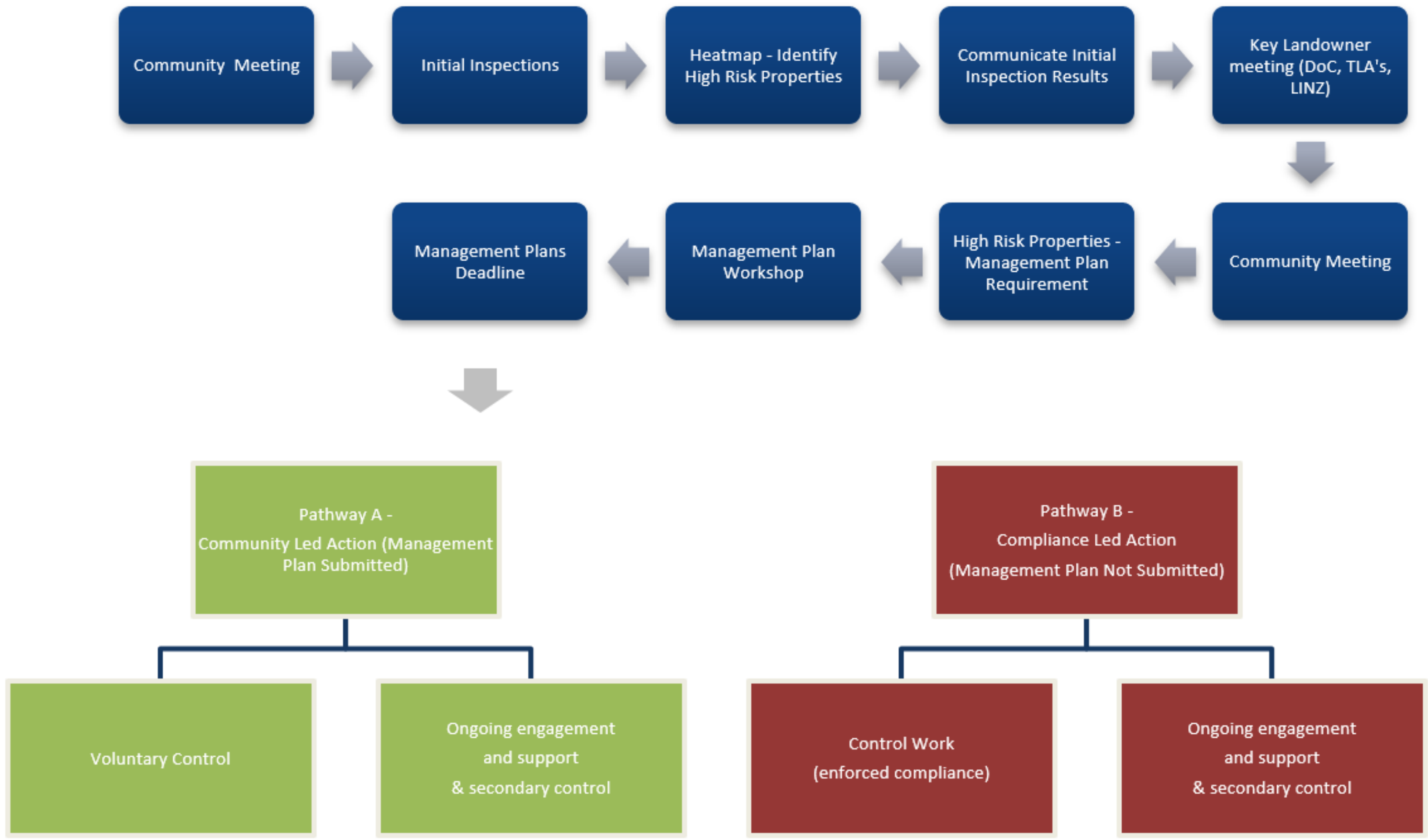
No considerations arising from this paper.

ATTACHMENTS

1. Appendix 1 CAP Example [**7.2.1** - 1 page]
2. Appendix 2 Community Led RMP [**7.2.2** - 1 page]


CAP Framework
Healthy, productive and resilient catchment through the ecologically sustainable management of our natural resources and environment for the benefit of present and future communities
Mana whenua
Biodiversity
Water (fresh and estuarine)
Land (inc. coastal land)
People
Wahi tupuna
Mahika kai
Wai tapu
Indigenous fauna
Indigenous vegetation
Aquatic life
Water quality
Water quantity
Waterbody form
Land stability
Productive land
Recreation / Amenity
Connection
Resilience
Protect cultural landscapes
Support access to mahika kai
Promote cultural significance
Treat pests
Treat weeds
Support threatened species work
Improve instream habitat
Manage fish passage
Protect high value vegetation
Regenerate native vegetation
Protect and enhance wetlands
Waste water systems
Manage nutrient runoff
Manage urban stormwater
Set minimum flows
Set water take limits
Exclude stock from waterways
Manage contaminated sites
Stabilise banks and channels
Regenerate riparian vegetation
Manage flood protection schemes
Promote water efficiency
Revegetate erodible soils
Stabilise active erosion
Maintain estuary form
Protect prime agricultural land
Stabilise dune systems
Manage coastal erosion
Erosion and sediment control
Farm environment plans
Promote land use capability
Land drainage schemes
Manage recreation impacts
Manage access to place
Reduce waste
Natural hazard adaptation
Enhance retreat corridors
Capacity building and education through engagement
Develop and promote best practice
Otago Regional Council
orc.govt.nz

Appendix 1: Community Project Process and Compliance Pathways



The general subject of each matter to be considered while the public is excluded, the reason for passing this resolution in relation to each matter, and the specific grounds under section 48(1) of the Local Government Official Information and Meetings Act 1987 for the passing of this resolution are as follows:

General subject of each matter to be considered	Reason for passing this resolution in relation to each matter	Ground(s) under section 48(1) for the passing of this resolution
3.1 PPT2204 Public Transport Planning for COVID-19 Omicron Variant	Section 7(2)(b)(ii): To protect information where the making available of the information—would be likely unreasonably to prejudice the commercial position of the person who supplied or who is the subject of the information. Section 7(2)(i): To enable any local authority holding the information to carry on, without prejudice or disadvantage, negotiations (including commercial and industrial negotiations).	Section 48(1)(a): Subject to subsection (3), a local authority may by resolution exclude the public from the whole or any part of the proceedings of any meeting only on 1 or more of the following grounds: (a) that the public conduct of the whole or the relevant part of the proceedings of the meeting would be likely to result in the disclosure of information for which good reason for withholding would exist.
3.2 OPS2207 Update on how the 2022 School Year Impacted Dunedin Bus Services	Section 7(2)(b)(ii): To protect information where the making available of the information—would be likely unreasonably to prejudice the commercial position of the person who supplied or who is the subject of the information. Section 7(2)(i): To enable any local authority holding the information to carry on, without prejudice or disadvantage, negotiations (including commercial and industrial negotiations).	Section 48(1)(a): Subject to subsection (3), a local authority may by resolution exclude the public from the whole or any part of the proceedings of any meeting only on 1 or more of the following grounds: (a) that the public conduct of the whole or the relevant part of the proceedings of the meeting would be likely to result in the disclosure of information for which good reason for withholding would exist.
3.3 PPT2203 Update on Dunedin Bus Route 1 Changes	Section 7(2)(b)(ii): To protect information where the making available of the information—would be likely unreasonably to prejudice the commercial position of the person who supplied or who is the subject of the information. Section 7(2)(i): To enable any local	Section 48(1)(a): Subject to subsection (3), a local authority may by resolution exclude the public from the whole or any part of the proceedings of any meeting only on 1 or more of the following grounds: (a) that the public conduct of the

	authority holding the information to carry on, without prejudice or disadvantage, negotiations (including commercial and industrial negotiations).	whole or the relevant part of the proceedings of the meeting would be likely to result in the disclosure of information for which good reason for withholding would exist.

This resolution is made in reliance on section 48(1)(a) of the Local Government Official Information and Meetings Act 1987 and the particular interest or interests protected by section 6 or section 7 of that Act or section 6 or section 7 or section 9 of the Official Information Act 1982, as the case may require, which would be prejudiced by the holding of the whole or the relevant part of the proceedings of the meeting in public.