



# **Otago Regional Council**

## **Infrastructure Strategy 2024 – 2054**



### **Flood Protection, Land Drainage and River Management Infrastructure**

Prepared by Engineering, Operations Directorate

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**Cover Image**

Contractors working on the training line where the mouth of the Puerua River meets the mouth of the Koau branch of the Clutha River / Mata-Au (2023).

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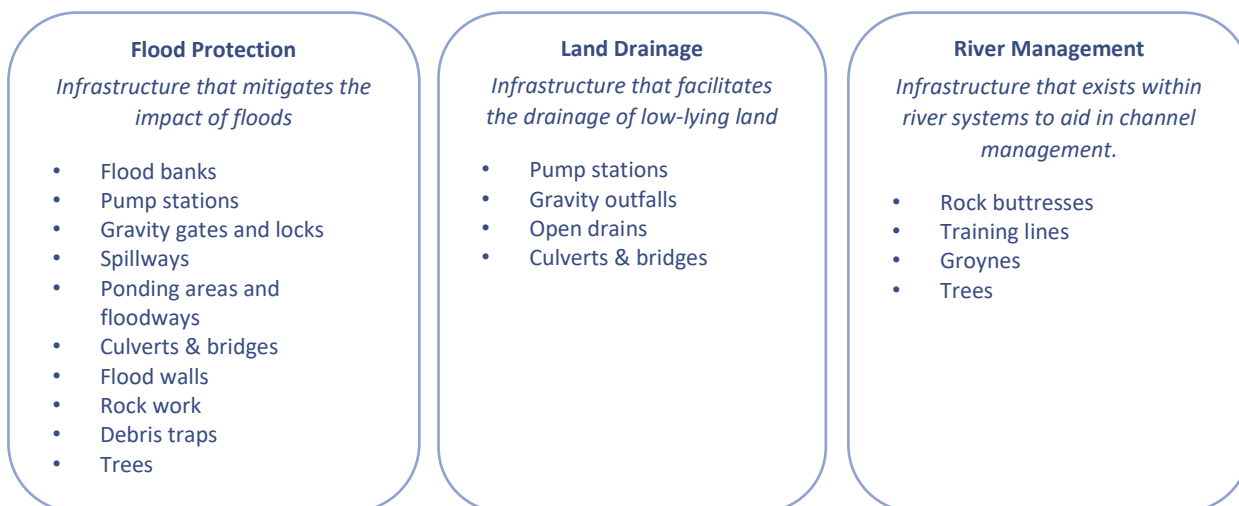
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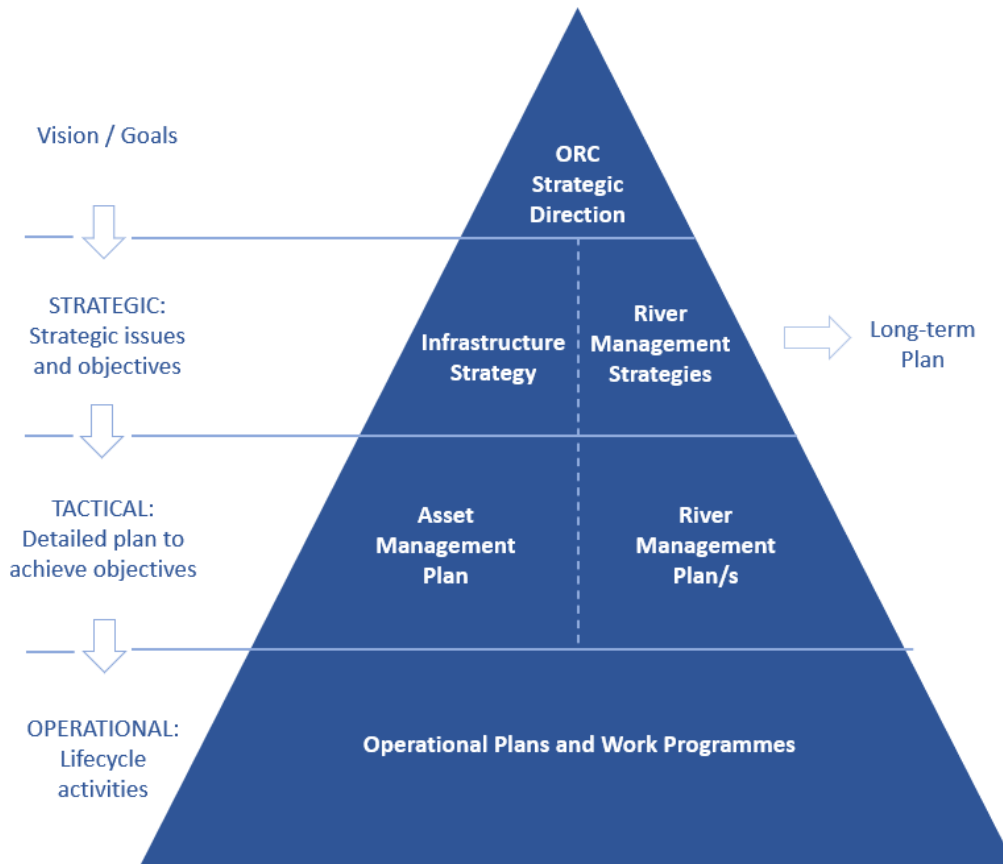
# 1. Introduction

Otago is situated in the southern half of the South Island, and with an area of approximately 32,000 square kilometres. Otago Regional Council (ORC) owns and maintains flood protection, land drainage and river management infrastructure across Otago, providing flood protection and land drainage to approximately 43,000 hectares of rural and urban land in Otago. This infrastructure plays a critical role in mitigating against the full consequences of damaging flood events. Figure 1 outlines the types of infrastructure owned and maintained by ORC.



**Figure 1. Types of flood protection, land drainage and river management infrastructure covered by this Infrastructure Strategy.**

The purpose of this Infrastructure Strategy (Strategy) is to identify significant infrastructure issues for Otago Regional Council over the 30-year period covered by this Strategy in relation to flood protection, land drainage and river management infrastructure, and identify the principal options for managing those issues and the implications of those options. This is a requirement as part of the preparation and adoption of Council’s Long-term Plan, as required by Section 101B of the Local Government Act 2002. Further statutory requirements of the Local Government Act 2002 are detailed in Section 1.1. This Infrastructure Strategy fits within a decision-making and operational framework that ultimately provides direction for the Long-term Plan (LTP). This is depicted in Figure 2. The framework helps give effect to ORC’s responsibilities under the Soil Conservation and Rivers Control Act 1941 and the Land Drainage Act 1908.



**Figure 2. Linkages between the Infrastructure Strategy and other key Council documents. River Management Strategies (Morphology and Riparian Management) currently exist for the following rivers – Waianakarua, Pomahaka, Kakanui, Taieri (Strath Taieri), Shag/Waihemo.**

Table 1 summarises the sections included in this Infrastructure Strategy and their content.

**Table 1. Sections and content of this Infrastructure Strategy**

<b>Section</b>	<b>Content</b>
<b>Introduction</b>	This section discusses the purpose of the Infrastructure Strategy, the minimum legislative requirements to meet and how the Infrastructure Strategy links with other key Council documents.
<b>Infrastructure Overview</b>	This section provides a summary of Council’s infrastructure portfolio encompassing flood protection, drainage, and river management infrastructure.
<b>Significant Issues and Options</b>	Key significant issues are highlighted and discussed alongside various options considered to address the issues, the implications of each of those options, and the most likely scenarios for addressing each issue.
<b>Infrastructure Investment Programme</b>	The infrastructure investment programme derived from this Strategy, with its foundation in Council’s asset management practices, is presented in this section. Council’s key programmes of work and likely significant decision points are addressed, alongside the assumptions and uncertainties associated with this programme.

## 1.1 Statutory Requirements

The Local Government Act (Section 101B) sets out the requirements for infrastructure strategies, as summarised in Table 2. These requirements are addressed in this Infrastructure Strategy.

**Table 2. Local Government Act (Section 101B) requirements for an Infrastructure Strategy**

Clause	Detail	Section
<b>1</b>	A local authority must, as part of its long-term plan, prepare and adopt an infrastructure strategy for a period of at least 30 consecutive financial years.	1
<b>2(a)</b>	The purpose of the infrastructure strategy is to identify significant infrastructure issues for the local authority over the period covered by the strategy.	3
<b>2(b)</b>	The purpose of the infrastructure strategy is to identify the principal options for managing those issues and the implications of those options	3
<b>3</b>	The infrastructure strategy must outline how the local authority intends to manage its infrastructure assets, considering the need to: <ul style="list-style-type: none"> <li>a. renew or replace existing assets;</li> <li>b. respond to growth/decline in the demand for services reliant on those assets;</li> <li>c. allow for planned increases or decreases in levels of service provided through those assets;</li> <li>d. maintain or improve public health and environmental outcomes or mitigate adverse effects on them;</li> <li>e. provide for the resilience of infrastructure assets by identifying and managing risks relating to natural hazards and by making appropriate financial provision for those risks.</li> </ul>	3
<b>4</b>	The infrastructure strategy must outline the most likely scenario for the management of the local authority's infrastructure assets over the period of the strategy and, in that context, must:	3
<b>4(a)</b>	show indicative estimates of the projected capital and operating expenditure associated with the management of those assets: <ul style="list-style-type: none"> <li>i. in each of the first 10 years covered by the strategy; and</li> <li>ii. in each subsequent period of 5 years covered by the strategy</li> </ul>	4.2
<b>4(b)</b>	identify: <ul style="list-style-type: none"> <li>i. the significant decisions about capital expenditure the local authority expects it will be required to make;</li> <li>ii. when the local authority expects those decisions will be required;</li> <li>iii. for each decision, the principal options the local authority expects to have to consider; and</li> <li>iv. the approximate scale or extent of the costs associated with each decision</li> </ul>	4.4
<b>4(c)</b>	Include the following assumptions on which the scenario is based: <ul style="list-style-type: none"> <li>i. the assumptions of the local authority about the life cycle of significant infrastructure assets;</li> <li>ii. the assumptions of the local authority about growth or decline in the demand for relevant services;</li> <li>iii. the assumptions of the local authority about increases or decreases in relevant levels of service</li> </ul>	4.5
<b>4(d)</b>	if assumptions referred to in paragraph (c) involve a high level of uncertainty: <ul style="list-style-type: none"> <li>i. identify the nature of that uncertainty; and</li> <li>ii. include an outline of the potential effects of that uncertainty</li> </ul>	4.5

## 2. Infrastructure Overview

ORC owns and maintains infrastructure across two functions within its Engineering team:

- Flood protection, drainage, and river control schemes
- River management (outside of the schemes)

This section also contains narrative on third-party flood protection, land drainage and river management infrastructure that is not owned, controlled, or maintained by ORC.

### 2.1 Flood Protection, Drainage and River Control Scheme Infrastructure

Otago Regional Council owns and maintains flood, drainage and river control schemes across Otago. Schemes consist of infrastructure (Figure 1) that has been constructed and is being maintained to assist in the drainage of low-lying areas of land, and/or mitigate the risk of flooding to a particular area. This infrastructure was designed to provide a set performance level of service to the area/s that it serves.

Otago Regional Council owns and maintains the following schemes across Otago:

- Four flood protection schemes:
  - Alexandra Flood Protection Scheme
  - Leith Flood Protection Scheme
  - Lower Taieri Flood Protection Scheme
  - Stoney Creek Flood Protection Scheme
- Three drainage schemes:
  - East Taieri Drainage Scheme
  - West Taieri Drainage Scheme
  - Tokomairiro Drainage Scheme
- One combined flood and drainage scheme – Lower Clutha Flood Protection and Drainage Scheme
- One river control scheme – Lower Waitaki River Control Scheme (portion within Otago)

Figure 3 depicts the location of each scheme. Lindsay Creek Flood Mitigation Scheme is indicated in this figure as a provisional scheme as a programme of work exists to further investigate and implement a scheme following Council decisions within the lifetime of this Strategy (see Infrastructure Investment Programme).

Not all infrastructure is located within the schemes listed above. A smaller quantity of infrastructure exists outside of flood protection and drainage schemes and is managed as part of the river management infrastructure portfolio. This infrastructure is detailed in the following section.

This section provides more detail on each of the flood protection and drainage schemes across Otago, including the key contextual considerations associated with managing each scheme at a strategic level.



# Otago Regional Council

Flood Protection, Drainage and River Control Schemes



- |  |  |   |
|--|--|---|
| <span style="color: red;">●</span> Alexandra Flood Protection                | <span style="color: yellow;">●</span> Lower Clutha Flood Protection & Drainage | <span style="color: purple;">●</span> Tokomairiro Drainage      |
| <span style="color: red;">●</span> East Taieri Drainage Scheme               | <span style="color: green;">●</span> Lower Taieri Flood Protection             | <span style="color: pink;">●</span> West Taieri Drainage Scheme |
| <span style="color: orange;">●</span> Leith Flood Protection Scheme          | <span style="color: cyan;">●</span> Lower Waitaki Floodways                    |   |
| <span style="color: cyan;">●</span> Lindsay Creek Flood Scheme (Provisional) | <span style="color: blue;">●</span> Stoney Creek Flood Protection Scheme       |   |

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Figure 3. Location of flood protection and drainage schemes across Otago



Flood protection, river and drainage infrastructure, and the schemes it makes up, primarily consist of floodbanks, pump stations and culverts. Table 3 provides a high-level summary of the key flood protection and drainage infrastructure included within this strategy.

**Table 3. Asset portfolio summary for flood protection and drainage schemes across Otago. This list is meant as a summary of the key infrastructure and is therefore not exhaustive.**

Scheme	Catchment Area (,000 ha)	Area Protected (,000 ha)	Infrastructure Assets					
			Floodbanks (km)	Open Drains (km)	Pump Stations	Culverts	Bridges	Other
Alexandra Flood Protection Scheme	1,511	0.01	1	-	3	-	-	-
Leith Flood Protection Scheme	4	0.2	-	-	-	-	-	Concrete or rock weirs: 29 Debris traps: 2 Concrete/stone walls: 2.2 km Concrete/stone channels: 2.8 km Rock retaining walls: 1.7 km Gabion basket walls: 200 m
Lower Clutha Flood Protection and Drainage Scheme	2,110	9.3	110	153	5	189	4	-
Lower Taieri Flood Protection Scheme	565	13	107	-	-	-	-	-
West Taieri Drainage Scheme	8	8.1	-	144	3	22	20	-
East Taieri Drainage Scheme	17	4.8	-	128	3	84	1	-
Tokomairiro Drainage Scheme	40	7.7	-	110	-	74	17	-
Lower Waitaki River Control Scheme *	N/A	N/A	-	-	-	-	-	Groynes: 8 Cross-banks: 6 Trees: 22 km
<b>Total</b>	<b>4,255</b>	<b>43</b>	<b>218</b>	<b>535</b>	<b>14</b>	<b>369</b>	<b>42</b>	<b>N/A</b>

\*Note that only a portion of the Lower Waitaki River Control Scheme is located within Otago. The floodways are managed as part of the river management infrastructure portfolio.

There are some key contextual considerations that are currently impacting, or are expected to impact, on all scheme infrastructure throughout the lifetime of this Infrastructure Strategy. These issues provide further context for the overarching significant issues, decision-making timeframes and investment programme detailed later in this Infrastructure Strategy. Table 4 details those contextual considerations that are common across all schemes, while the following sections detail more specific contextual considerations pertaining to individual schemes.

**Table 4. Contextual considerations that are common across all schemes**

<b>Description of Contextual Consideration</b>
Residual flood risk posed by the proximity of waterways, flood protection, drainage, and river management infrastructure, to sensitive land use activities.
Community and infrastructure adaptation may be required over the lifetime of this Infrastructure Strategy to address the climatic changes that result from increasing frequency and intensity of rainfall events.
Safe and reliable handling of super design rainfall events and flows.
Managing natural processes, for example gravel movement and sediment transport processes, to balance protection and environmental significance of our natural and built environments.
Schemes consist of hard engineering infrastructure that is not always conducive to allowing rivers room to move and better enable environmental benefits and the natural management of flood waters.

### 2.1.1 Alexandra Flood Protection Scheme

The Alexandra Flood Protection Scheme mitigates the risk of flooding, caused by high flows in the Clutha and Manuherikia Rivers, to approximately 10 hectares of the Alexandra township, including residential and commercial properties.

Three major floods entered the town and flooded residential and commercial areas in 1994, 1995 and 1999, exacerbated by sedimentation caused by the Roxburgh Dam. The Alexandra Flood Protection Scheme was subsequently built in 2001 and consists of approximately 1.1km of floodbanks and three pump stations. The design philosophy of the scheme is to provide protection for a conservative flood water level (matching the largest flood event on record) at the Alexandra bridge over the Clutha River, just upstream of the confluence with the Manuherikia River.

The stormwater drainage system in Alexandra drains to each of the three pump stations. The pump stations allow stormwater and seepage water to drain under gravity conditions while river levels in the Manuherikia and Clutha Rivers are low, or pump when river levels are high. Two roads penetrate the floodbanks, so these roads are closed and stoplogs installed during severe floods.

Table 5 outlines some of the key contextual considerations that are currently impacting, or are expected to impact, on the Alexandra Flood Protection Scheme throughout the lifetime of this Infrastructure Strategy.

**Table 5. Contextual considerations impacting, or expected to impact, on the Alexandra Flood Protection Scheme.**

<b>Description of Contextual Considerations</b>
Management of the sediment and the changing characteristics to the lakes and rivers (including confluence of Manuherikia and Clutha), which is through Contact Energy Limited’s resource consents.
Sediment deposition within Lake Roxburgh and the Clutha Mata-Au / Manuherikia River confluence and its contribution to flood hazard at Alexandra.
Flood damage compensation conditions in Contact Energy Limited’s resource consents for damming of the Clutha River at Lake Roxburgh. This resource consent expires in 2042.
Renewal of Contact Energy Limited’s resource consents for the Clutha Hydro Scheme in 2042.

### 2.1.2 Leith Flood Protection Scheme

The Leith Flood Protection Scheme mitigates the risk of flooding to an area of approximately 200 hectares extending from Malvern Street in Glenleith to the north, to Rattray Street in the Dunedin CBD to the south.

The Water of Leith catchment is located to the north of the Dunedin Central Business District (CBD) and has a catchment area of approximately 42 square kilometres. Key Dunedin infrastructure such as the existing and new Dunedin Hospitals, University of Otago, Otago Polytechnic Te Pūkenga, and Forsyth Barr Stadium are afforded some level of protection protected by the scheme. The upper section of the catchment and its tributaries, that include Lindsay Creek that flows through North East Valley, are relatively steep hydraulically compared to the flatter lower reaches. These catchment characteristics allow floodwaters to rise quickly.

Table 6 outlines some of the key contextual considerations that are currently impacting, or are expected to impact, on the Leith Flood Protection Scheme throughout the lifetime of this Infrastructure Strategy.

**Table 6. Contextual considerations impacting, or expected to impact, on the Leith Flood Protection Scheme**

Description of Contextual Considerations
The proximity of the lower reaches of the Water of Leith to Dunedin Central Business District, as well as to University of Otago and Otago Polytechnic Te Pūkenga, means that there is public interest and opportunities to provide public access and amenity value, particularly from Forth Street to the harbour where previous work to improve flood resilience and amenity did not reach.
Historically, substantial lengths of the Water of Leith were channelised using concrete and stone walls to minimise bank erosion and facilitate urban development of the floodplain. Due to their age, the walls likely require replacement during the lifetime of this Infrastructure Strategy. This also provides an opportunity to improve environmental and amenity qualities of this waterway.

### 2.1.3 Lower Clutha Flood Protection and Drainage Scheme

The Lower Clutha Flood Protection and Drainage Scheme mitigates the risk of flooding and facilitates land drainage to the Lower Clutha Delta, which extends from 4km north of Balclutha to the sea. The flood and drainage scheme covers an area of approximately 9,300 hectares (flood and drainage scheme combined).

This scheme combines both flood protection and drainage works. Construction of this scheme started in 1960 and was completed in 1991. The Clutha is the second longest river in New Zealand, and the largest by mean flow. The Clutha's headwaters are in the Southern Alps above lakes Wakatipu, Wānaka, and Hāwea. The Clutha River bifurcates (splits into two) just downstream of Balclutha. Between 60% and 70% of the flow goes down the Koau Branch and 30% to 40% down the Matau Branch. The island formed between the branches is called Inch Clutha. There is a floodway (area designed to carry floodwaters when the river level rises) at the top of Inch Clutha. As well as the Clutha River/Mata-Au, water flows into the delta from several other sources including Lovells Stream and Lake Tuakitoto; Waitepeka River; Puerua River and Barrata Creek. Land drainage is provided by a network of 153 km of drains in four regions: Barnego; Stirling/Kaitangata; Inch Clutha; and Otanomomo/Paretai. Drainage in Balclutha and Finegand is not owned or operated by the ORC.

Coastal erosion and shoreline retreat is a known issue to be impacting the flood protection and drainage infrastructure within the scheme and is projected to expose more of this coastal infrastructure to the impacts of sea level rise and coastal inundation well into the future, directly impacting on training lines and floodbanks, as well as impacting the functionality land drainage within the scheme. The southern training line at the Koau mouth of the Clutha Mata-Au River is already suffering damage from such exposure which in turn impacts on the culverts within the structure to drain the Puerua River and subsequently the drainage component of the scheme. Significant decisions will need to be made in the near future about adaptation of the scheme in this area.

Table 7 outlines some of the key contextual considerations that are currently impacting, or are expected to impact, on the Lower Clutha Flood Protection and Drainage Scheme throughout the lifetime of this Infrastructure Strategy.

**Table 7. Contextual considerations impacting, or expected to impact, on the Lower Clutha Flood Protection and Drainage Scheme**

<b>Description of Contextual Considerations</b>
Shoreline retreat affecting the functioning of flood protection and drainage infrastructure in the Lower Clutha delta. As the shoreline naturally migrates inland, there is increasing exposure of this infrastructure to coastal hazards such as storm surge and wave action.
Rising sea and groundwater levels impacting on drainage infrastructure such as drains and pump stations.
Residual flood risk posed by the proximity of the Clutha River and its tributaries to Balclutha and its surrounding townships and industries.
Contact Energy Limited funding, under their resource consent conditions, contributes towards riverbank/coastal erosion reporting (50%), remedial actions from reporting/inspections (50%) and maintaining efficient egress (90%). Contact Energy Limited Consents expire in 2042.
Renewal of Contact Energy Limited’s resource consents for the Clutha Hydro Scheme in 2042.

#### 2.1.4 Tokomairiro Drainage Scheme

The purpose of the Tokomairiro Drainage Scheme is to ensure the provision of effective and reliable land drainage for the Tokomairiro area surrounding Milton, and to reduce flooding impacts on Milton and its surrounds.

The Tokomairiro Drainage Scheme is situated in the flat basin surrounding Milton, surrounded on three sides by inland hills, and by coastal hills to the southeast. The scheme consists entirely of open drains, with associated culverts and bridge crossings, designed to assist in the drainage of relatively low-lying farmland in this area. It has no pumps or control structures. Many of the drains were originally creeks that have been realigned.

The contextual considerations that are current impacting, or are expected to impact, on the Tokomairiro Drainage Scheme throughout the lifetime of this Infrastructure Strategy are outlined in Table 4 (contextual considerations common across all schemes).

### 2.1.5 Lower Taieri Flood Protection Scheme

The Lower Taieri Flood Protection Scheme mitigates the risk of flooding to the Taieri plains, including the townships of Mosgiel, Outram and Henley, as well as critical infrastructure such as key transport routes (state highway and railway networks), Dunedin airport and power and three waters utility infrastructure.

The Lower Taieri Flood Protection Scheme was the first scheme to be developed in Otago, alongside the East and West Taieri Drainage Schemes, when works commence in 1870. It is a complex network, with multiple rivers affecting the scheme. The scheme makes use of ponding areas that act to detain peak flows and ease pressure on downstream portions of the scheme, subsequently minimising the risk of failure of the scheme. Silver Stream, Waipori River and the Ōwhiro Stream are also tributaries to this lower portion of the Taieri River.

Table 8 outlines some of the key contextual considerations that are currently impacting, or are expected to impact, on the Lower Taieri Flood Protection Scheme throughout the lifetime of this Infrastructure Strategy.

**Table 8. Contextual considerations impacting, or expected to impact, on the Lower Taieri Flood Protection Scheme**

Description of Contextual Considerations
Known structural deficiencies with existing Taieri River floodbanks.

### 2.1.6 West Taieri Drainage Scheme

The West Taieri Drainage Scheme facilitates the effective and reliable drainage of the land in West Taieri, the area bounded by the floodbanks and Contour Channel that form part of the Lower Taieri Flood Protection Scheme.

The West Taieri Drainage Scheme covers the area bounded by the Taieri River, Lake Waipori, and the West Taieri Contour Channel. A small part of the scheme lies within the Henley Floodway. The West Taieri area differs from the other drainage schemes in that water cannot drain out of the scheme under gravity: it must be pumped out. A significant portion of the scheme lies at or below 1m of sea level. There are three pump stations in the West Taieri Drainage Scheme: Waipori; Henley; and Lake Ascog.

Table 9 outlines some of the key contextual considerations that are currently impacting, or are expected to impact, on the West Taieri Drainage Scheme throughout the lifetime of this Infrastructure Strategy.

**Table 9. Contextual considerations impacting, or expected to impact, on the West Taieri Drainage Scheme**

Description of Contextual Considerations
Increasing pressure for land drainage schemes to manage urban stormwater runoff, resulting from increased demand for urban development (Outram).
Vulnerability of floodbank along edge of Lake Waipori to seismic event leading to “sunny day” flooding of parts of West Taieri and damage to the Waipori Pumping Station.
Potential for rising groundwater due to sea level rise.

### 2.1.7 East Taieri Drainage Scheme

The East Taieri Drainage Scheme facilitates the effective and reliable drainage of the land in East Taieri.

The East Taieri Drainage Scheme is physically divided into two areas by the Silver Stream, which flows across the Taieri Plain in a south-westerly direction. Drains on the northern side of the Silver Stream generally flow toward what is called the Upper Ponding area. Drains on the Southern side of the Silver Stream flow toward the Lower Ponding area. When the Taieri River is at low flow these drains flow out to the river by gravity, whereas when the Taieri River is at high flows, gravity gates close and pump stations are used.

Table 10 outlines some of the key contextual considerations that are currently impacting, or are expected to impact, on the East Taieri Drainage Scheme throughout the lifetime of this Infrastructure Strategy.

**Table 10. Contextual considerations impacting, or expected to impact, on the East Taieri Drainage Scheme**

Description of Contextual Considerations
Land use changes to allow for more residential development and increasing pressures for land drainage infrastructure to manage urban stormwater runoff.
Increasing pressure for land drainage schemes to manage urban stormwater runoff, resulting from increased demand for urban development.

### 2.1.8 Lower Waitaki River Control Scheme

The purpose of the Lower Waitaki River Control Scheme is to maintain the system of braided river channels within defined fairway and active riverbed widths, and to limit erosion of the active bed vegetated margins.

The Lower Waitaki River Control Scheme is made up of groynes and riparian plantings that aid in the limiting the position of the fairway. Most of this infrastructure was initially established by the former Waitaki Catchment Commission in the 1960s and 1970s. The Otago Regional Council owns this infrastructure within its boundary on the right bank of the lower portion of the Waitaki River. The management of this infrastructure is contracted to Environment Canterbury as part of their overall management of the Lower Waitaki River Control Scheme<sup>1</sup> that falls predominantly within the Canterbury region. Flows in the river are moderated by a series of dams that were constructed on the river, starting with the Waitaki Dam in the 1920s and 1930s. In 2023 Meridian Energy applied for consents for the continued operation of the Waitaki Hydro Scheme.

There are also three floodways that assist in conveying flows from the foothills, across low lying farmland to the Waitaki River, however these are managed separately as river management infrastructure.

Table 11 outlines some of the key contextual considerations that are currently impacting, or are expected to impact, on the Lower Waitaki River Control Scheme throughout the lifetime of this Infrastructure Strategy.

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<sup>1</sup> Lower Waitaki River Control Scheme Operation Agreement, Otago Regional Council and Canterbury Regional Council, signed 2023.



**Table 11. Contextual considerations impacting, or expected to impact, on the Lower Waitaki River Control Scheme**

<b>Description of Contextual Considerations</b>
Ongoing community expectation to manage funding of repair and maintenance works that result from repeated flood events typical within the dynamic braided environment of the Waitaki River.
Meridian Energy fund 30% of the operation and maintenance costs of the Lower Waitaki River Control Scheme. The funding is not recorded in a formal agreement.
Joint management and funding of scheme with Environment Canterbury. Agreement in place to document respective rights and responsibilities.

### 2.1.9 Stoney Creek Flood Protection Scheme

Stoney Creek has a steep alpine catchment that discharges into Lake Wanaka across an alluvial fan. Increased urban development of the alluvial fan in the early 2000’s led to the need for infrastructure to be established to mitigate the risk of alluvial fan migration and flood risk. The work consisted of developing a system of natural and engineering features, including channel modifications and debris traps, as part of Stage 1 of the work. Stage 2 of this work is planned to be completed within the lifetime of this Strategy.

The contextual considerations that are current impacting, or are expected to impact, on the Stoney Creek Flood Protection Scheme throughout the lifetime of this Infrastructure Strategy are outlined in Table 4 (contextual considerations common across all schemes).

## 2.2 River Management Infrastructure

Otago Regional Council also owns and maintains river management infrastructure across Otago. This includes several smaller schemes and isolated pieces of infrastructure outside of the main flood protection and drainage schemes discussed previously. Figure 4 depicts the location of key river management infrastructure across Otago and is summarised as follows:

- Shotover Training Line, Queenstown – Guides flows and sediment in the Shotover River.
- Matukituki Training Line, Matukituki River – Training line structure that deflects flood waters to the true left of the Matukituki River so that the downstream floodplain on the right bank could be re-established as farmland.
- Albert Town Rock Buttress, Albert Town – Mitigate the risk of erosion and land movement.
- Lower Waitaki Floodways, North Otago – Conveyance of flows from foothills to the Waitaki River.
- Lindsay Creek, Dunedin – Some rockwork and concrete walls exist to minimise erosion and help retain the creek within its existing channel and there is a debris trap at Bethunes Gully.
- Kaikorai Stream Stilling Basin, Green Island, Dunedin – Dissipates energy in the channel.
- Trees and vegetation that is planted and maintained along river channels and margins to mitigate the risk of erosion and manage channel migration.
- Placed rock to mitigate the risk of erosion.

Some of these assets are not fully captured in the asset management database and work will be ongoing to ensure this infrastructure is accurately recorded in the database.

There are some key contextual considerations that are currently impacting, or are expected to impact, on Council infrastructure within river management areas, outside of the flood protection, drainage and river control schemes. These issues provide further context for the overarching significant issues, decision-making timeframes and investment programme detailed later in this Infrastructure Strategy. Table 12 details those contextual considerations within each river management area.

**Table 12. Contextual considerations impacting, or expected to impact, on Council infrastructure within each river management area**

<b>Description of Contextual considerations</b>	
<b>General</b>	
Residual flood risk posed by the proximity of waterways to their surrounding land use activities.	
Community and infrastructure adaptation will be required over the lifetime of this Infrastructure Strategy to address the climatic changes that result from increasing frequency and intensity of rainfall events.	
<b>Dunedin River Management Area</b>	
Sections of Lindsay Creek have insufficient channel capacity to convey flood flows, increasing the risk of flows breaking out into nearby properties and roads. A higher and more uniform standard of flood protection will need to be considered to provide a standard of flood protection that is more comparable with other urban areas across New Zealand. It is envisaged that works will be required for flood risk management during the lifetime of this Strategy which is noted as a provisional Lindsay Creek Scheme. This may consist of natural and built features to aid in flood risk management.	
Debris flow and flood risk mitigation for the Middlemarch area – Rainfall events in recent years have caused streams to rise and break out of their channels, resulting in flooding in and around the Middlemarch area. Further work is required, alongside the Dunedin City Council, to investigate and put appropriate measures in place to mitigate these risks.	
<b>Whakatipu River Management Area</b>	
Ongoing river management activities in relation to Dart and Rees River floodplains and Glenorchy, as related to the Head of Lake Whakatipu work programme led by Natural Hazards.	
<b>Wānaka River Management Area</b>	
Alluvial fan migration and flood risk management for Stoney Creek. Stage 2 works are envisaged during the lifetime of this Strategy.	

# Otago Regional Council

River Management Infrastructure



Information on this map may not be used for the purposes of any legal disputes. The user should independently verify the accuracy of any information before taking any action in reliance upon it. This map was generated for A4 printing on 28/02/2024 at the scale of 1:1,350,000.

Figure 4. Location of key infrastructure within river management areas

### 2.3 Third-Party Infrastructure

Not all flood protection, land drainage and river management infrastructure in Otago is owned, controlled or maintained by ORC. Third parties including territorial authorities, government agencies and private landowners also construct, own, control and maintain such infrastructure. Notable examples include (but are not limited to):

- Hospital Creek floodbank, Balclutha (Clutha District Council)
- Tokomairiro River floodbank and stormwater pumping station, Milton (Clutha District Council)
- Milton diversion swale, Milton (Clutha District Council)
- Tuapeka Creek Channel Lining, Lawrence (Clutha District Council)
- Glenorchy floodbank, Glenorchy (Queenstown Lakes District Council)
- Horne Creek channel, sports field detention area and bund and detention dam, Queenstown (Queenstown Lakes District Council)
- Shotover delta revetment attached to ORC's training line, Queenstown (Queenstown Lakes District Council)
- Shotover Country subdivision rock revetment, Queenstown (Queenstown Lakes District Council)
- Reservoir Creek channel lining, Roxburgh (Central Otago District Council)
- Abbotsford landslide stormwater control and dewatering infrastructure, Dunedin (Dunedin City Council)
- Clutha River/Mata-Au rockwork, Bendigo (adjacent private landowners)
- Karitane estuary rock groyne (abandoned)
- Lindsay Creek, Dunedin (some infrastructure along Lindsay Creek is owned, controlled and maintained by Dunedin City Council and adjacent private landowners)

This Infrastructure Strategy assumes that ORC does not take on ownership, control or maintenance of this infrastructure.

ORC is also not responsible for infrastructure that forms part of other utility networks such as power conduits, water/wastewater pipework, or road and rail bridges. These come under the jurisdiction of the utility or network owner. Where appropriate the ORC liaises with territorial authorities and utility owners to align work programmes in proximity to this infrastructure where practicable.



### 3. Significant Issues and Options

This section summarises the significant issues that the Otago Regional Council faces in the management of flood protection, drainage and river management infrastructure, and the principle options and implications available to Council in the management of these issues throughout the lifetime of this Strategy and beyond. These issues are presented diagrammatically in Figure 5. All significant issues are inextricably linked to one another, with one common denominator being ‘Risk Exposure’.

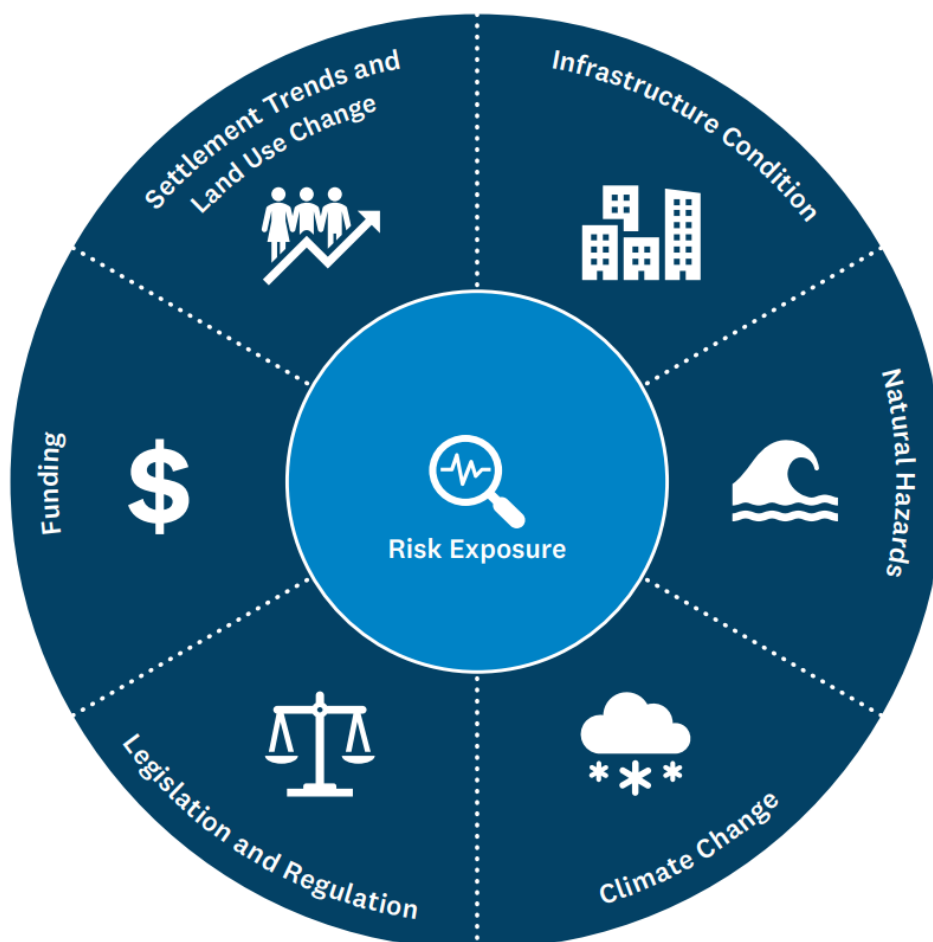


Figure 5. Significant issues and associated links

The following pages in this section provide detail on why each issue has been identified, Council’s preferred approach to managing the issue and the alternative approaches identified. While Council has a preferred approach to managing the issues, the alternative scenarios are sometimes dependent on external factors such as unforeseen environmental or economic factors outside of Council’s control.

### 3.1 Significant Issue: Risk Exposure

Risk exposure is at the core of the significant issues identified. This is because Council's response to all the other issues identified will always impact on the level of risk to which Council's infrastructure, people and their communities and lifelines are exposed. The Council's response to all other issues will ultimately impact on the risk associated with the operation of Council's flood protection, drainage, and river management infrastructure. In turn, the operation of the Council's infrastructure will subsequently impact on the overall risk and resilience of communities and their awareness of such.



Extreme weather events that have occurred in New Zealand in recent times (for example, Cyclone Gabrielle's impact on parts of the North Island in February 2023) have illustrated the impact such extreme events can have on flood protection infrastructure and its criticality for providing lifelines and community resilience. Over the last five years Otago has experienced several flood events, most notably in November 2019, February 2020, January 2021, July/August 2022, and September 2023. With the occurrence of recent and ongoing extreme weather events comes expanding community interest in the performance of flood protection infrastructure and the associated vulnerabilities and resilience of communities.

The modern approach to flood risk management is to take greater account of residual risk and consider how schemes and infrastructure perform beyond design up to Probable Maximum Flood or Maximum Credible Event. Infrastructure should be designed to fail safely under super design (overdesign) events. ORC is incorporating this approach into the way it manages its schemes and infrastructure.

Over time several factors may affect the ability of flood protection, drainage, or river management infrastructure to meet the standards it was designed to, including:






- Changes in the climate that impact on the intensity of rainfall events and their duration.
- Changes in community tolerance and vulnerability.
- Changes in the geomorphology of the landscape within river catchments that prompts changes in river behaviour, such as increased build-up of sediment in the lower lying reaches of the schemes, that in turn leads to a reduction in capacity of a flood protection scheme during a flood event.
- Improved hydrological analyses and understanding of the behaviour of the natural environment in response to the environmental and geomorphological changes outlined above.

Understanding risk exposure associated with living, working, and playing around Otago's rivers is an important consideration in future decision making about the levels of service provided by flood protection, land drainage and river management infrastructure. It is vital that communities are part of longer-term decision making around risk tolerance and associated costs.

#### Principal Options and Implications

Table 13 summarises the principal options that Council has considered to address risk as a significant issue. It also summarises the potential implications identified for each option and identifies the preferred option/s selected.

**Table 13. Principal options for managing the significant issue of risk, and the associated implications of those options**

Principal Options	Implications	Preferred Option/s
<p><b>Undertake periodic risk assessments of scheme condition and performance to inform risk analysis. Incorporate analysis of super design events to further inform understanding and communication of risk.</b></p>	<ul style="list-style-type: none"> <li>• Improved and ongoing understanding of risk and associated implications of that risk on infrastructure and communities.</li> <li>• Ability to share information with communities to improve their understanding of risk and resilience, to better enable their decision making around what this may mean to them.</li> <li>• Alignment with what New Zealanders are experiencing, and will continue to experience, in relation to extreme rainfall/flood events across the country.</li> </ul>	
<p><b>Increased community engagement about risk and resilience. Share learnings with affected communities to involve them in decision making about potential changes to levels of service.</b></p>	<ul style="list-style-type: none"> <li>• Communities are better informed about risk and resilience in relation to how it may impact on them and their livelihoods.</li> <li>• Community involvement in decision making process about future changes to levels of service that may impact on them.</li> </ul>	
<p><b>Incorporate resilience improvements into maintenance and renewals where appropriate.</b></p>	<ul style="list-style-type: none"> <li>• Proactive approach to incorporating resilience where appropriate, leading to improved resilience over time.</li> <li>• Improved community resilience over time.</li> <li>• Ability to incorporate design considerations for Probable Maximum Flood or Maximum Credible Event, including designing infrastructure to fail safely.</li> </ul>	
<p><b>Maintain or increase current levels of service in response to risk analysis.</b></p>	<ul style="list-style-type: none"> <li>• Existing level of flood mitigation is provided to communities.</li> <li>• Maintains status quo while risks are better understood in relation to this significant issue and others.</li> <li>• Enables incorporation of resilience measures as part of the toolbox to mitigate the risk of flooding and enable recovery.</li> </ul>	
<p><b>Incorporate learnings from community engagement and response to other significant issues into decision making when considering potential changes to levels of service.</b></p>	<ul style="list-style-type: none"> <li>• Acknowledgement that some changes to levels of service may be necessary based on increased understanding of risk and community and Council direction.</li> <li>• Ability to programme and plan expenditure around any potential changes to levels of service.</li> </ul>	



### Examples of the Preferred Option/s in Practice

The following are examples of the types of work programmes that would be implemented by adopting the most likely scenario for managing infrastructure in response to risk as a significant issue:

- Routine condition and risk assessments.
- Ongoing community engagement to share information about risk and gather feedback on possible future changes to levels of service.
- Forward planning and prioritisation for increases to levels of service where these are appropriate based on risk and community feedback.
- Where possible provide for super design events up to Probable Maximum Flood/Maximum Credible Event and ensure communities understand the implications and impacts of residual risk.
- Use infrastructure as just one component of the wider PARA framework (see Section 4.1.3).
- Utilise ORC's Natural Hazards Risk Framework (in preparation) to inform prioritisation.

### 3.2 Significant Issue: Infrastructure Condition

Otago Regional Council’s flood protection, drainage and river infrastructure has been constructed over a period of 150 years. This means that construction records for some of the older flood protection, drainage, and river infrastructure do not exist or are not up to today’s quality standard in terms of construction method or materials. Floodbanks alone have several potential failure modes including overtopping during flood conditions, slope and foundation stability (under flood, non-flood and seismic conditions), and seepage through the floodbank or its foundation.



Also, as infrastructure ages the condition can degrade, the technology becomes redundant, or the principle of Te Mana o te Wai changes the way we consider the ongoing use of some structures in proximity to Otago’s waterways. Factors such as installation, operational environment and manufacturing defects can also reduce the useful life of infrastructure. Continuing to maintain assets beyond their intended useful life:

- can increase the frequency and cost of operation and maintenance activities, including the risk of failure,
- does not enable forward planning to design and construct fit for purpose solutions with longer term environmental outcomes, and
- can lead to a lengthy amount of time while decisions are made, and the infrastructure can be replaced or adapted.

#### Principal Options and Implications

Table 14 summarises the principal options that Council has considered to address infrastructure condition as a significant issue. It also summarises the potential implications identified for each option and the preferred option/s selected.

**Table 14. Principal options for managing the significant issue of infrastructure condition, and the associated implications of those options**

Principal Options	Implications	Preferred Option/s
<b>Take a risk management approach to prioritise and schedule infrastructure renewals and subsequent investment over the lifetime of the infrastructure.</b>	<ul style="list-style-type: none"> <li>• Planned approach that enables multiple benefits to be realised where relevant.</li> <li>• Reduced operational risk with increased reliability of performance during flood events and increased confidence in resilience.</li> <li>• Planned expenditure.</li> <li>• Some programme flexibility should there be a flood event that reprioritises programme or expenditure.</li> </ul>	✓
<b>Replace infrastructure at point of failure.</b>	<ul style="list-style-type: none"> <li>• Heightened operational risk and decreased confidence in resilience.</li> <li>• Unreliable infrastructure with unknown performance during flood events.</li> <li>• Unplanned expenditure.</li> </ul>	✗

### Examples of the Preferred Option/s in Practice

The following are examples of the types of work programmes that would be implemented by adopting the most likely scenario for managing infrastructure in response to infrastructure condition as a significant issue:

- Ongoing maintenance and inspection programmes for infrastructure, for example bridges, culverts, floodbanks, drains and pump stations.
- Renewals being scheduled based on identified risks and prioritised accordingly. Programme of renewals managed to balance risk and funding availability where possible.
- Assessment and analysis of floodbank condition and integrity for a range of potential failure modes.
- Control external activities that may impact on infrastructure condition through the Designations and Bylaw approval processes, avoiding activities that increase residual risk.

### 3.3 Significant Issue: Natural Hazards

The Otago region comprises a diverse and dynamic environment ranging from flat coastal lowlands and intensively used alluvial floodplains, through to large sparsely populated and steep mountainous areas. As such Otago is exposed to a broad range of natural hazards, including flooding, landslides, debris flows, seismic activity, coastal erosion, tsunami, storm surge and wind.



These natural hazards all present hazards to flood protection, drainage and river management infrastructure. For example, major earthquakes could result in cracking, slumping and/or settlement of floodbanks.

#### Principal Options and Implications

Table 15 summarises the principal options that Council has considered to address natural hazards as a significant issue. It also summarises the potential implications identified for each option and identifies the preferred option/s selected.

*Table 15. Principal options for managing the significant issue of natural hazards, and the associated implications of those options*

Principal Options	Implications	Preferred Option
<b>Maintain current hazard readiness, response and recovery processes.</b>	<ul style="list-style-type: none"> <li>• Learnings established from observations during flood events (both in Otago and nationally) will not be incorporated into hazard readiness, response, and recovery processes.</li> <li>• Heightened risk of poor planning and associated impacts on people and wider communities if practices are not updated to reflect learnings.</li> <li>• Resiliency of communities diminishes over time.</li> </ul>	<b>x</b>

Principal Options	Implications	Preferred Option
<b>Maintain and improve current practice around hazard readiness, response and recovery, as Council continues to learn from past events across the region and New Zealand.</b>	<ul style="list-style-type: none"> <li>• Learnings incorporated into processes to improve readiness, response, and recovery.</li> <li>• Ability to work with communities to develop further resilience.</li> </ul>	✓
<b>Align with readiness and response to natural hazard events within ORC and external stakeholders.</b>	<ul style="list-style-type: none"> <li>• Support Civil Defence Emergency Management.</li> <li>• Development of consistent response and recovery plans across ORC and external stakeholders.</li> </ul>	✓

#### Examples of the Preferred Option/s in Practice

The following are examples of the types of work programmes that would be implemented by adopting the most likely scenario for managing infrastructure in response to natural hazards as a significant issue:

- Up to date preparedness for flood response and recovery that contributes to community preparedness and resilience, and enables an efficient response and recovery in relation to infrastructure damage.
- Co-ordinated response to flood response across Otago Regional Council and external stakeholders.
- Where possible, design infrastructure to be resilient to the effects of natural hazards.

### 3.4 Significant Issue: Climate Change

Otago’s climate is changing, and with increases in temperature come other impacts, such as changes in precipitation and wind patterns. These in turn can increase the intensity and frequency of rainfall events, and wind patterns, leading to increased flows in rivers and changes in coastal shoreline brought on by sea level rise and coastal erosion processes.



In 2019 the National Institute of Water and Atmospheric Research (NIWA) analysed projected climate changes, including hydrological change, for the Otago region and reported that changes to Otago’s future climate are likely to be significant with extreme, rare events projected to become more severe, and average annual flows expected to increase across the region, with floods expected to become larger.

The effects of climate change will impact the environment both regionally and nationally. There will be sea level rise, and changes in wind and weather patterns, higher water tables, and the frequency of extreme weather events will increase. These climatic changes will put increased pressure on flood protection, drainage, and river management infrastructure, and challenge the levels of service they can provide. The uncertainty associated with the rate of future climate change will require an adaptive approach that will require infrastructure to be relocated, modified, or created.

#### Principal Options and Implications

Table 16 summarises the principal options that Council has considered to address climate change as a significant issue. It also summarises the potential implications identified for each option and identifies the preferred option/s selected.

*Table 16. Principal options for managing the significant issue of climate change, and the associated implications of those options*

Principal Options	Implications	Preferred Option/s
<b>Little investment in understanding future climate change effects on flood protection, drainage and river management infrastructure.</b>	<ul style="list-style-type: none"> <li>Reactive approach to climate change and potential increases or changes to levels of service.</li> <li>Changes to levels of service may be costly in terms of capital expenditure and or personal costs to communities.</li> </ul>	✘
<b>Investment in understanding future climate change effects on flood protection, drainage and river management infrastructure.</b>	<ul style="list-style-type: none"> <li>Incorporation of this knowledge into decision-making processes to enable informed decisions, alongside communities, on changes to levels of service where appropriate.</li> <li>Allows for time to make decisions around levels of service, and ability to prioritise changes where necessary.</li> </ul>	✔
<b>Incorporation of climate change learnings into wider community led adaptation planning.</b>	<ul style="list-style-type: none"> <li>Working with communities to understand the critical role of infrastructure and the impact of climate change.</li> <li>Active engagement on information to provide communities with knowledge of how infrastructure adaptation may impact future considerations and decisioning.</li> </ul>	✔

### Examples of the Preferred Option/s in Practice

The following are examples of the types of work programmes that would be implemented by adopting the most likely scenario for managing infrastructure in response to climate change as a significant issue:

- Work programmes would take account of the Otago Climate Change Risk Assessment.
- Incorporation of impacts into risk assessments and analysis of future scheme performance. This in turn would further enable risk-based prioritisation of renewals or changes in levels of service, including the timing of such renewals. These decisions could utilise Toka Tu Ake EQC's Risk Tolerance Methodology.
- Community engagement on climate change and impacts on levels of service to support planning and decision-making around adaptation.
- Adopt the Dynamic Adaptive Pathways Approach (DAPP) to management of infrastructure.

### 3.5 Significant Issue: Legislation and Regulatory

Otago Regional Council’s flood protection and drainage schemes were designed and built at various times over the past 150 years and reflect the values, knowledge and understanding of the time that they were designed and constructed. Most of these schemes were developed and constructed in an era when economic growth and development were the primary focus. Flood protection and drainage infrastructure enabled farmland and agricultural initiatives to develop and prosper.



Community values and expectations have changed, and will continue to change, in relation to environmental outcomes and the legislation that regulates associated standards and performance. The following are examples of such changes that will impact on the management of flood protection, drainage, and river management infrastructure:

- Three Waters Reform.
- Resource Management Reform, including the proposed Climate Change Adaptation Act.
- Regional Policy Statement and Land and Water Regional Plan implementation.
- Future District Council planning initiatives and the development of District Plans.
- Emergency Management Bill and increase in resilience of critical infrastructure (Government led response).
- The proposed National Policy Statement for Natural Hazards Decision-Making 2023 (NPS-NHD).
- The outcome of the government’s Inquiry into Community-Led Managed Retreat.
- Changes to the Flood Protection Management Bylaw 2022 during periodic review.

Changes in government and legislation are expected throughout the lifetime of this Infrastructure Strategy as it can be expected that environmental performance and increasing interest in enabling co-benefits, for example biodiversity and environmental benefits, will be a constant driver of change in this space. Opportunities exist to provide for environmental enhancement, for example fish passage or establishment of wetlands, through decisions that Council make about the renewal or replacement of its infrastructure throughout the lifetime of this strategy.

#### Principal Options and Implications

Table 17 summarises the principal options that Council has considered to address legislation and regulatory as a significant issue. It also summarises the potential implications identified for each option and identifies the preferred option/s selected.

**Table 17. Principal options for managing the significant issue of legislation and regulatory, and the associated implications of those options**

Principal Options	Implications	Preferred Option
<b>Engagement with territorial authorities and central government</b>		
<b>Take a reactive approach in terms of engagement with territorial authorities and central government on the development of policies and plan implementation.</b>	<ul style="list-style-type: none"> <li>• Low level of awareness associated with incoming changes that may affect operations.</li> <li>• Shorter timeframe to make operational changes.</li> <li>• Unplanned expenditure associated with implementation of operational change.</li> </ul>	<b>x</b>



Principal Options	Implications	Preferred Option
<b>Engagement with territorial authorities and central government</b>		
<b>Engage proactively with territorial authorities and central government (where appropriate) on the development of policies and plan implementation.</b>	<ul style="list-style-type: none"> <li>• Increased awareness and opportunity to lead in this space.</li> <li>• Participation in decision making in the earlier stages of policy development and plan implementation.</li> <li>• Better enablement of transition through change and opportunities to incorporate into internal operations.</li> </ul>	✓
<b>Environmental performance and outcomes</b>		
<b>Limited improvement to environmental performance or outcomes.</b>	<ul style="list-style-type: none"> <li>• Shorter-term outcomes for the environment and communities.</li> <li>• Multiple benefits not realised.</li> </ul>	✗
<b>Seek improved environmental performance and seek to achieve multiple outcomes by incorporating nature-based solutions where possible.</b>	<ul style="list-style-type: none"> <li>• Sustainable and longer-term outcomes for the environment and communities.</li> <li>• Multiple benefits realised.</li> <li>• Alignment with Council’s strategic direction, with the principle of ki uta ki tai and with Te Mana o te Wai.</li> </ul>	✓

### Examples of the Preferred Option/s in Practice

The following are examples of the types of work programmes that would be implemented by adopting the most likely scenario for managing infrastructure in response to legislation and regulatory as a significant issue:

- Ongoing engagement with territorial authorities and central government on the development of policies and plan implementation to increase awareness and better enable any transitions to new ways of operating.
- Updated work programmes and operating procedures to incorporate improved environmental outcomes.
- Incorporation of nature-based thinking into options considered for renewal or replacement of infrastructure, while working alongside other Otago Regional Council teams and stakeholders where appropriate to achieve multiple outcomes.
- Development of interface agreements with Otago territorial authorities to record how interface issues will be managed.
- Demonstrate alignment with Council’s strategic direction and the principles of ki uta ki tai and Te Mana o Te Wai, through better enabling fish passage and other environmental enhancements in renewal or replacement of flood protection, drainage, or river management infrastructure.
- Alignment with Integrated Catchment Management (ICM) Catchment Action Plans (CAPs).

### 3.6 Significant Issue: Settlement Trends and Land Use Change

Settlement trends and land use changes can place pressure on existing infrastructure to continue to perform and in some instances places a greater number of people, including their health and livelihoods, at risk in the event of underperformance or failure of flood protection, drainage and river management infrastructure.



Settlement trends and land use changes will continue to occur throughout the lifetime of this strategy. This can place pressure on scheme and river management infrastructure in relation to the level of service it provides, particularly where different flow patterns and the scale of stormwater runoff may impact on the performance of drainage schemes, or where the level of flood mitigation provided may need to be increased in response to land use change. This is often coupled with improving the environmental and amenity values of the area where any work may be undertaken.

#### Principal Options and Implications

Table 18 summarises the principal options that Council has considered to address settlement trends and use change as a significant issue. It also summarises the potential implications identified for each option and identifies the preferred option/s selected.

**Table 18. Principal options for managing the significant issue of settlement trends and land use change, and the associated implications of those options**

Principal Options	Implications	Preferred Option
<b>Take a reactive approach to development and associated land use change.</b>	<ul style="list-style-type: none"> <li>• Low level of awareness associated with potential changes that may affect operations.</li> <li>• Shorter timeframe to consider impacts of potential developments and provide input to enable better outcomes.</li> </ul>	✘
<b>Utilise planning controls to mitigate the impact of development.</b>	<ul style="list-style-type: none"> <li>• Status quo approach that will be maintained.</li> <li>• Implementation of the PARA Framework (see Section 4.1.3).</li> </ul>	✔
<b>Be proactive in collaborating with territorial authorities, communities, and stakeholders.</b>	<ul style="list-style-type: none"> <li>• Maintain key relationships with all stakeholders to better enable information sharing and knowledge building (in relation to hazards and impacts) over time.</li> <li>• Participation in consideration of impacts in advance of needing to provide feedback or make decisions under existing regulatory timeframes.</li> </ul>	✔

#### Examples of the Preferred Option/s in Practice

The following are examples of the types of work programmes that would be implemented by adopting the most likely scenario for managing infrastructure in response to settlement trends and land use as a significant issue:

- Proactive engagement with territorial authorities, communities, and stakeholders regarding land use changes. This will include early engagement where possible and will include inputs to Future Development Strategies and district plan development, along with attendance at pre-application meetings and review of consent applications as appropriate.
- Utilisation of the PARA framework to appropriately balance land use controls and infrastructure solutions.

### 3.7 Significant Issue: Funding

The potential impact of natural hazards events (including flood events) on the Otago Regional Council’s financial position is dependent on the scale, duration, and the location of the event. The unpredictable nature of such events means that the funding needs of any recovery are also difficult to predict and provide for at short notice. Funding needs are large for significant pieces of infrastructure to be renewed or replaced; however, some of these, such as floodbanks, have an exceptionally long useful life and therefore provide intergenerational benefits. Otago has had some notable rainfall/flood events affecting different parts of the region in recent years (e.g., February 2020, January 2021, July/August 2022, September 2023) which also leads to overlapping recovery programmes that need to be funding, often at the expense of planned work. Some financial reserves are built up over time to assist in funding response and recovery to such events, however these can be depleted following major events.



Funding sources may include:

- Central Government – Otago Regional Council has previously been successful in obtaining funding under the ‘Shovel Ready’ Climate Resilience Funding (Ministry of Business, Innovation and Employment Provincial Growth Fund), and has had more recent input into a co-investment case submitted to Central Government as part of a second tranche of Climate Resilience funding in December 2022<sup>2</sup>. This has so far been unsuccessful in securing funding; however, the Otago Regional Council continues to pursue funding in this space.
- National Emergency Management Agency (NEMA) to repair essential infrastructure following emergencies. This includes a 60% subsidy from Central Government above 0.002% of net capital value for regional councils.
- Potential for other funding sources for projects that also provide for nature-based solutions.

#### Principal Options and Implications

Table 19 summarises the principal options that Council has considered to address funding as a significant issue. It also summarises the potential implications identified for each option and identifies the preferred option/s selected.

**Table 19. Principal options for managing the significant issue of funding, and the associated implications of those options**

Principal Options	Implications	Preferred Option
<b>Do nothing in terms of seeking out additional funding sources.</b>	<ul style="list-style-type: none"> <li>• Funding for ongoing work will need to be predominantly provided for by ratepayers (contributions to reserves).</li> <li>• Reduced level of service if funding is unable to match expenditure required to operate and maintain infrastructure to desired standard.</li> <li>• Increased risk of exposure to flooding should level of service be reduced.</li> <li>• Trade-offs in levels of service and risk.</li> </ul>	<b>x</b>

<sup>2</sup> Central Government Co-investment in Flood Protection Schemes – A report to request for Budget 2023 funding to build community climate-change resilience against flood risks, Te Ura Kahika – Regional and Unitary Councils Aotearoa, December 2022.

Principal Options	Implications	Preferred Option
<b>Continue to engage through sector to source Central Government co-funding.</b>	<ul style="list-style-type: none"> <li>Funding to support ongoing works that are required to maintain levels of service.</li> </ul>	✓
<b>Seek out co-benefits and subsequent alternative funding sources e.g. biodiversity.</b>	<ul style="list-style-type: none"> <li>Collaboration with territorial authorities and third parties provide opportunities to leverage funding and increase co-benefits.</li> </ul>	✓

### Examples of the Preferred Option/s in Practice

The following are examples of the types of work programmes that would be implemented by adopting the most likely scenario for managing infrastructure in response to funding as a significant issue:

- Improved confidence in ability to delivery key programmes of work to improve resilience and incorporate nature-based solutions with lesser financial impact on ratepayers should funding come to fruition.
- Accelerated work programmes with the ability to move key programmes of work forward if funding is successful, increasing resilience faster.
- Planning for scenarios with and without central government co-investment.

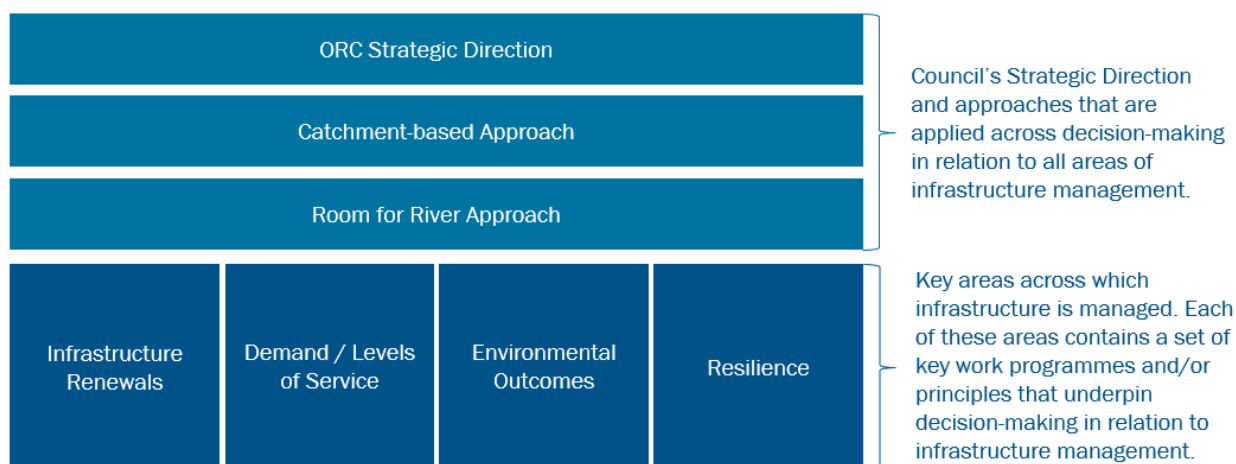
## 4. Infrastructure Investment Programme

This section aims to address the significant issues, options and implications that have been highlighted in the preceding section through the infrastructure investment programme presented here. This investment programme is founded on Council’s growing maturity in its asset management practices and a management approach that provides the overarching principles of Council’s decision making in relation to flood protection, drainage and river management infrastructure.

This section also identifies the significant decisions Council expects to make over the lifetime of this Strategy in relation to this investment programme and outlines the options that are likely to be presented in relation to each of these decisions. Current assumptions and uncertainties are also presented here.

### 4.1 Infrastructure Management Approach

Further to the significant issues and preferred options for managing each issue discussed in the previous section, Council must also account for the need to renew its infrastructure, respond to growth or decline (including changes in levels of service), and achieve environmental outcomes and resilience, as required by the Local Government Act 2002. While Council has some key work programmes and principles that separately underpin decision making in relation to each of these areas of infrastructure management, there are also some key principles that span decision-making in all areas. These include the application of Council’s Strategic Direction and taking catchment-based and ‘room for river’ approaches across all areas where infrastructure management decisions are required. Figure 6 provides a diagrammatic summary of each area and their relationship. Each of these areas is described in more detail below.



**Figure 6. Key areas of infrastructure management and their relationship.**

#### 4.1.1 Strategic Direction

ORC’s Vision for Otago sets the direction for improving the social, economic, environmental, and cultural wellbeing for the Otago communities now and into the future, through a single articulated vision:

*Our environment and communities are healthy and connected ki uta ki tai (from the mountains to the sea).*

ORC will ensure that infrastructure management decisions are in alignment with this vision and the six key community outcomes related to climate, resilience, transport, environment, partnerships, and communities.

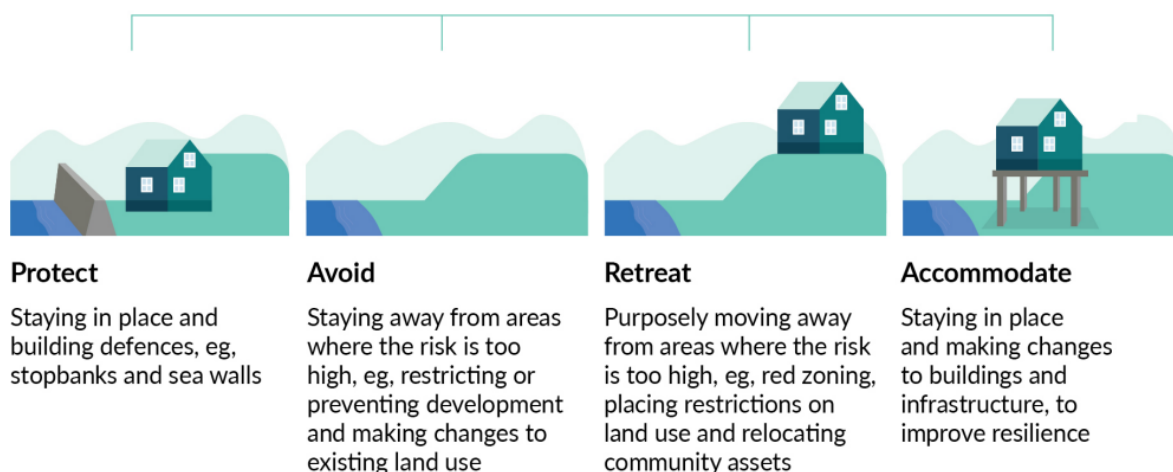
### 4.1.2 Catchment-based Approach

Through a catchment-based approach it is expected that Council will examine possible solutions that consider the wider catchment for potential interventions where practicable. Throughout the lifetime of this strategy, we also expect to see increasing engagement with communities and tangata whenua on giving effect to ki uta ki tai and Te Mana o Te Wai when making decisions about current and future flood protection, drainage, and river management infrastructure.

Council also takes an Integrated Catchment Management (ICM) approach that is based on a holistic, natural resource management philosophy that recognises that all elements of an ecosystem, including the people are connected. This involves facilitating the development and implementation of Integrated Catchment Action Plans that are developed in collaboration with iwi and community. Future decision-making in relation to flood protection, drainage and river management infrastructure will therefore be aligned through this approach.

### 4.1.3 Room for River Approach

The Protect, Avoid, Retreat, Accommodate (PARA) Framework (Ministry for the Environment) is internationally used to explain the types of adaptation actions that can be taken to build resilience to the current effects, and predicted impacts, of the increasing risks posed by natural hazards (Figure 7).



**Figure 7. The Protect, Avoid, Retreat, Accommodate (PARA) Framework (Ministry for the Environment, 2023)**

The flood protection, drainage, and river infrastructure that Council owns and manages falls into the ‘Protect’ category. This infrastructure acts as a form of defence against water and enables people, and their homes and businesses, to stay where they are placed. Historically this approach has resulted in rivers being constrained to a narrower floodplain that limits the flood carrying capacity of the river by denying it the opportunity to behave naturally and spread out across their floodplain during high flows.

Increasingly Council is looking to diversify its infrastructure to include more nature-based solutions that allow rivers room to move within their natural floodplains. The subsequent adaptation of flood protection, drainage, and river management infrastructure, and communities alongside, will lead to solutions being adopted that fall more appropriately into the Avoid, Retreat and Accommodate categories of the PARA Framework. This approach is also more aligned with Te Mana o Te Wai and the catchment-based approach discussed below.

#### 4.1.4 Infrastructure Renewals

Council carries out a routine programme of inspections and condition assessments of its flood protection, drainage, and river management infrastructure, annually or as otherwise programmed in Operations and Maintenance Manuals. This programme is complemented by a programme of more significant structural audits of key infrastructure. Incorporating a risk-based approach, these inspections and assessments may lead to recommendations to remediate or replace a piece of infrastructure, and overall, this contributes to the ongoing performance and resilience of an asset.

#### 4.1.5 Demand and Levels of Service

Settlement trends and land use changes are expected to impact on the demand for flood protection, drainage, and river management infrastructure to perform. This will require decisions about maintaining or increasing levels of service throughout the lifetime of this Strategy.

A risk-based approach is expected to be adopted in relation to these decisions, alongside consideration of other key principles discussed in this section.

#### 4.1.6 Environmental Outcomes

It is expected that environmental outcomes will be achieved through the application of the above principles, including Council's Strategic Direction, 'Room for River' and catchment-based approaches. This will involve the consideration and incorporation of more nature-based solutions in place of hard infrastructure where practicable, or steps taken in the longer term to establish nature based solutions through the adaptation and application of the PARA Framework.

#### 4.1.7 Resilience

Throughout the lifetime of this Strategy, it is expected that Council will:

- Continue to undertake periodic risk assessments of infrastructure condition and performance to further inform understanding and communication of risk.
- Understand the impact of super design (over design) events on scheme infrastructure and incorporate into risk assessments and subsequent decision-making.
- Incorporate resilience improvements into maintenance and renewals where appropriate. This may involve maintaining or increasing current levels of service in response to risk analysis.
- Increase community engagement about risk and resilience, and increased involvement of community in decision making.



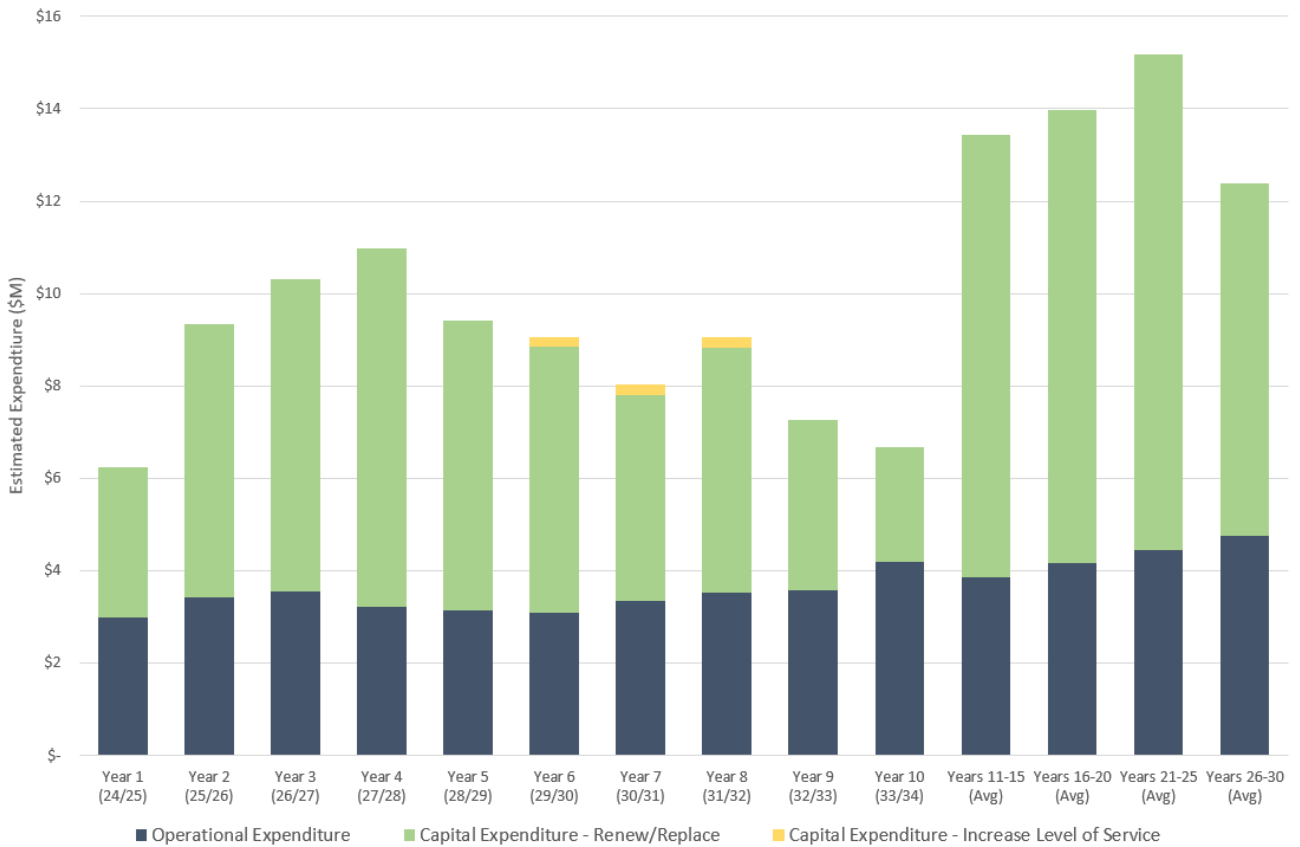
## 4.2 Operational and Capital Expenditure Summary

Figures 8 and 9 summarise the estimated distribution of operational and capital expenditure over the lifetime of this Strategy for all scheme and river management infrastructure respectively. Table 20 further breakdowns these costs by expenditure type to give the overall expenditure estimated over the lifetime of this Strategy.

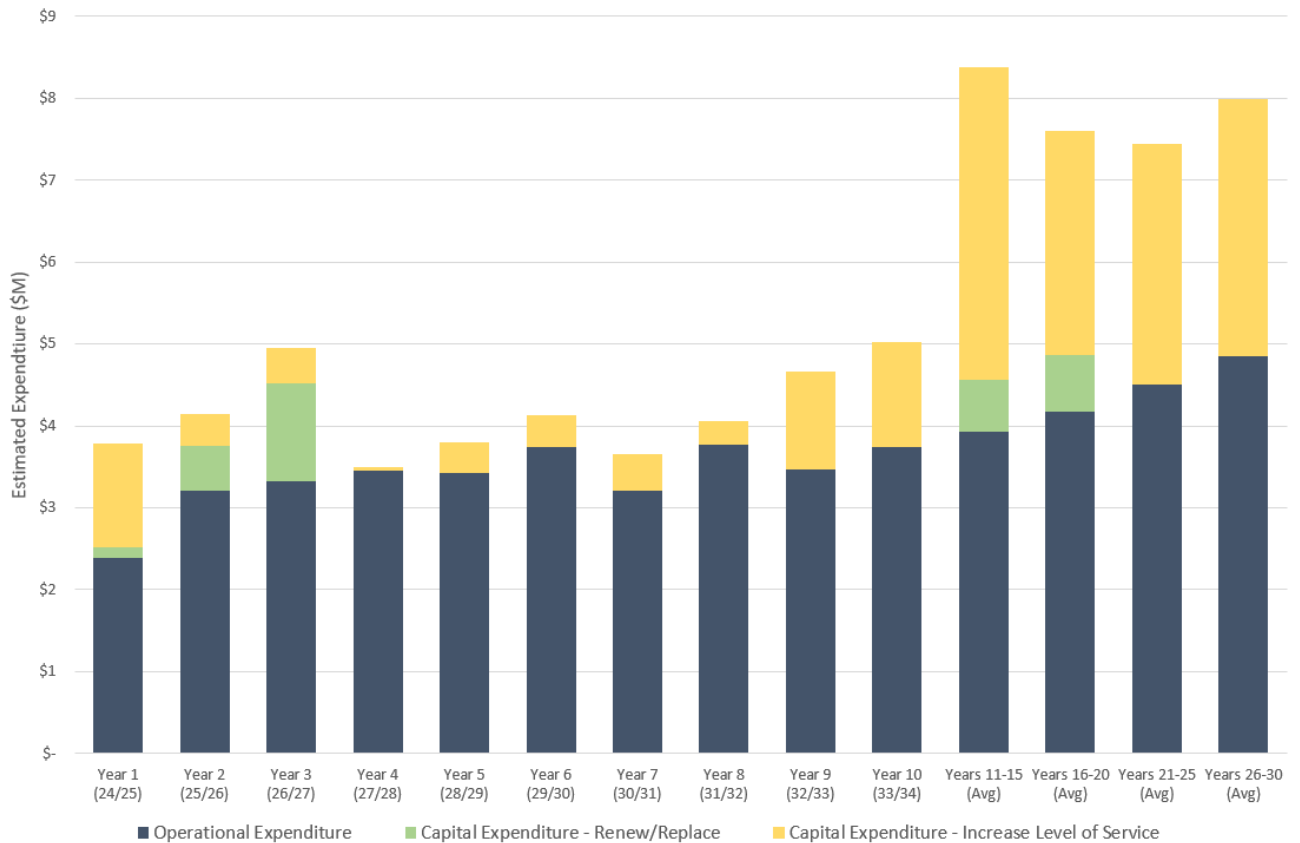
The following general assumptions have been made regarding estimated expenditure:

- Staff time and overheads have been excluded.
- Depreciation is not included.
- Best efforts have been made in relation to construction assumptions and associated estimates. Where opportunities exist, Council will endeavour to take the most optimal financial solution.

In general, there is a higher degree of certainty in the first ten years of the investment forecast, however projects and programmes identified in the subsequent two decades may change in response to new information and changes in demand and future needs. There remains some uncertainty within the first ten years, particularly where investigations and design are to commence.



**Figure 8. Breakdown of estimated operational and capital expenditure for flood protection and drainage infrastructure**



**Figure 9. Breakdown of estimated operational and capital expenditure for river management infrastructure. Note that the operational expenditure represented above also includes expenditure for riparian and channel management that is not directly related to infrastructure.**

Table 20. Summary of capital and operational expenditure by category

Expenditure Type	Year 1 (24/25)	Year 2 (25/26)	Year 3 (26/27)	Year 4 (27/28)	Year 5 (28/29)	Year 6 (29/30)	Year 7 (30/31)	Year 8 (31/32)	Year 9 (32/33)	Year 10 (33/34)	Years 11-15 (Average)	Years 16-20 (Average)	Years 21-25 (Average)	Years 26-30 (Average)
<b>Flood Protection and Drainage Scheme Infrastructure</b>														
Operational Expenditure	\$3.00M	\$3.42M	\$3.56M	\$3.22M	\$3.14M	\$3.09M	\$3.35M	\$3.54M	\$3.58M	\$4.19M	\$3.85M	\$4.17M	\$4.46M	\$4.76M
Capital Expenditure – Renew/Replace	\$3.23M	\$5.93M	\$6.76M	\$7.76M	\$6.29M	\$5.75M	\$4.45M	\$5.29M	\$3.68M	\$2.48M	\$9.58M	\$9.79M	\$10.73M	\$7.61M
Capital Expenditure – Increase Levels of Service	\$0.00M	\$0.00M	\$0.00M	\$0.00M	\$0.00M	\$0.22M	\$0.23M	\$0.23M	\$0.00M	\$0.00M	\$0.00M	\$0.00M	\$0.00M	\$0.00M
<b>Sub-total (Scheme Infrastructure)</b>	<b>\$6.23M</b>	<b>\$9.34M</b>	<b>\$10.32M</b>	<b>\$10.98M</b>	<b>\$9.43M</b>	<b>\$9.07M</b>	<b>\$8.03M</b>	<b>\$9.06M</b>	<b>\$7.26M</b>	<b>\$6.67M</b>	<b>\$13.44M</b>	<b>\$13.96M</b>	<b>\$15.19M</b>	<b>\$12.38M</b>
<b>River Management Infrastructure</b>														
Operational Expenditure	\$2.39M	\$3.21M	\$3.32M	\$3.45M	\$3.42M	\$3.74M	\$3.21M	\$3.77M	\$3.47M	\$3.75M	\$3.93M	\$4.18M	\$4.51M	\$4.84M
Capital Expenditure – Renew/Replace	\$0.13M	\$0.54M	\$1.20M	\$0.00M	\$0.00M	\$0.00M	\$0.00M	\$0.00M	\$0.00M	\$0.00M	\$0.63M	\$0.68M	\$0.00 M	\$0.00 M
Capital Expenditure – Increase Levels of Service	\$1.27M	\$0.39M	\$0.42M	\$0.05M	\$0.38M	\$0.39M	\$0.46M	\$0.29M	\$1.19M	\$1.27M	\$3.81M	\$2.74M	\$2.94M	\$3.14M
<b>Sub-total (River Management Infrastructure)</b>	<b>\$3.79M</b>	<b>\$4.14M</b>	<b>\$4.95M</b>	<b>\$3.50M</b>	<b>\$3.80M</b>	<b>\$4.13M</b>	<b>\$3.66M</b>	<b>\$4.06M</b>	<b>\$4.66M</b>	<b>\$5.02M</b>	<b>\$8.37M</b>	<b>\$7.60M</b>	<b>\$7.44M</b>	<b>\$7.98M</b>
<b>Total Expenditure</b>	<b>\$10.02M</b>	<b>\$13.49M</b>	<b>\$15.27M</b>	<b>\$14.48M</b>	<b>\$13.23M</b>	<b>\$13.20M</b>	<b>\$11.69M</b>	<b>\$13.12M</b>	<b>\$11.91M</b>	<b>\$11.69M</b>	<b>\$21.81M</b>	<b>\$21.57M</b>	<b>\$22.63M</b>	<b>\$20.36M</b>

### 4.3 Investment Programme

The following diagrams provide a further breakdown of the indicative estimates of the projected capital and operating expenditure associated with the management of Council's flood protection, drainage, and river management infrastructure in each of the first ten years and subsequent periods of five years up to the 30-year lifetime of this Strategy.

Throughout the lifetime of this Strategy, it is expected that Council will reach several decision points related to key projects and programmes of work that may come with significant implications in terms of cultural, environmental, social and/or economic impact. The estimated timing of these decisions is highlighted in the following diagrams, with further discussion on the decision drivers, options and assumptions in the section that follows.

The diagrams are ordered as follows:

- Diagram 1 Alexandra Flood Protection Scheme
- Diagram 2 Leith Flood Protection Scheme
- Diagram 3 Lower Clutha Flood Protection & Drainage Scheme
- Diagram 4 Lower Taieri Flood Protection Scheme
- Diagram 5 West Taieri Drainage Scheme
- Diagram 6 East Taieri Drainage Scheme
- Diagram 7 Tokomairiro Drainage Scheme
- Diagram 8 River Management Infrastructure  
(including Lindsay Creek Flood Mitigation Scheme – a provisional scheme within this Strategy)

Diagram 1: Alexandra Flood Protection Scheme

Year	Estimated Expenditure \$,000's													
	Y1 2024/25	Y2 2025/26	Y3 2026/27	Y4 2027/28	Y5 2028/29	Y6 2029/30	Y7 2030/31	Y8 2031/32	Y9 2032/33	Y10 2033/34	Y11-15 2035-39	Y16-20 2040-44	Y21-25 2045-49	Y26-Y30 2050-54
<b>Routine / Business as Usual Activities</b>														
Scheduled Maintenance and Inspections					2,338						1,451	1,565	1,679	1,794
Pump Maintenance					101									
Contact Energy Consent Renewal												41		
<b>Projects</b>														
Public Safety Assessment	10													
Pump Renewals											3,808			

Diagram 2: Leith Flood Protection Scheme

Year	Estimated Expenditure \$,000's													
	Y1 2024/25	Y2 2025/26	Y3 2026/27	Y4 2027/28	Y5 2028/29	Y6 2029/30	Y7 2030/31	Y8 2031/32	Y9 2032/33	Y10 2033/34	Y11-15 2035-39	Y16-20 2040-44	Y21-25 2045-49	Y26-Y30 2050-54
<b>Routine / Business as Usual Activities</b>														
Scheduled Maintenance and Inspections					1,599						1,079	1,164	1,249	1,334
Designation / Bylaw Renewal										60	63	68	73	78
<b>Projects</b>														
Leith Model Build	204													
Public Safety Assessment	10													
Leith Historic Walls: Feasibility	203										63	68	73	78
Leith Historic Walls: Construction				1,189							3,173	3,423	3,673	3,923
Leith Amentiy: Feasibility		682									63	68	73	78
Leith Amentiy: Construction						2,508					3,173	3,423	3,673	3,923

**Key**  
 Operational Expenditure   
 Capital Expenditure   
 Significant Decision Point

Diagram 3: Lower Clutha Flood Protection and Drainage Scheme

Year	Estimated Expenditure \$,000's													
	Y1 2024/25	Y2 2025/26	Y3 2026/27	Y4 2027/28	Y5 2028/29	Y6 2029/30	Y7 2030/31	Y8 2031/32	Y9 2032/33	Y10 2033/34	Y11-15 2035-39	Y16-20 2040-44	Y21-25 2045-49	Y26-Y30 2050-54
<b>Routine / Business as Usual Activities</b>														
Scheduled Maintenance and Inspections					5,343						3,065	3,307	3,548	3,790
Reactive Maintenance					553						317	342	367	392
River Channel Maintenance					3,783						2,475	2,670	2,865	3,060
Routine Condition Assessments and Monitoring					974						190	205	220	235
Risk Management (Ongoing Performance and Risk Assessments)					166				298		317	342	367	392
Flood Preparedness and Response Plan	81			86			92				159	171	184	196
Designation / Bylaw Renewal			212							242	254	274	294	314
Culvert Renewal Programme						1,011					635	685	735	785
Crest Levelling Programme						451					317	342	367	392
Contact Energy Consent Renewal												41		
<b>Projects</b>														
Puerua Outfall Tactical Maintenance		307												
Public Safety Assessment	10													
Pump Station Weed Management - Research and Development		156												
Balclutha Township Relief Well Replacements			262			279			297				1102	
Pump Station Communications Upgrade		263												
Puerua Outfalls Culvert (Training Line) Adaptation	C	1,490												
Lower Clutha Drain 222 Bridge Improvements	615													
Lower Clutha Drainage Model Build		105												
Provision for Floodbank Track Development Contribution						684								
Scheme Performance and Risk Assessments	309													
Scheme Impacts and Options			267											
Managed Relocation of Infrastructure								4,130			6,346	6,846	7,346	7,846
Clutha Delta Split Lagoon Enhancement: Feasibility		207												
Clutha Delta Split Lagoon Enhancement: Construction				E	1,111									
Floodbank realignment: Feasibility	101													
Floodbank realignment: Construction			F	1,670										
Pump Station Upgrades (Pumps)											6,981	9,584	10,284	8,631

**Key**  
 Operational Expenditure   
 Capital Expenditure   
 Significant Decision Point

Diagram 4: Lower Taieri Flood Protection Scheme

Year	Estimated Expenditure \$,000's													
	Y1 2024/25	Y2 2025/26	Y3 2026/27	Y4 2027/28	Y5 2028/29	Y6 2029/30	Y7 2030/31	Y8 2031/32	Y9 2032/33	Y10 2033/34	Y11-15 2035-39	Y16-20 2040-44	Y21-25 2045-49	Y26-Y30 2050-54
<b>Routine / Business as Usual Activities</b>														
Scheduled Maintenance and Inspections					2,377						1,371	1,479	1,587	1,695
Reactive Maintenance					276						165	178	191	204
River Channel Maintenance					2,858						2,158	2,328	2,498	2,668
Routine Condition Assessments and Monitoring					932						190	205	220	235
Risk Management (Ongoing Performance and Risk Assessments)					164				178		317	342	367	392
Designation / Bylaw Renewal										121	127	137	147	157
Flood Preparedness and Response Plan	305				55			58			127	137	147	157
Crest Levelling Programme						451					317	342	367	392
<b>Projects</b>														
Silver Stream Capacity Maintenance*		829												
Geotechnical Investigations		231												
Public Safety Assessment	10													
Contour Channel Resilience Upgrade: Completion of Current Programme	1,000													
Contour Channel Resilience Upgrade: Continuation of Programme					8,810						6,346	6,846	7,346	7,846
Lower Pond Gravity Gates Renewal		1,751												
Scheme Performance and Risk Assessments		412												
Climate Adaptation (Scheme Impacts and Options)					272									
Lower Taieri Climate Adaptation (Flood Protection)									1,780					
Climate Adaptation: Ongoing Assessment											127	137	147	157
Climate Adaptation & Resilience: Ongoing Implementation											1,904	2,054	2,204	2,354
Riverside Spillway: Investigations and Planning	204													
Riverside Spillway: Construction					1,071									
Outram Floodbank Resilience Improvements: Feasibility	203													
Outram Floodbank Resilience Improvements: Construction					5,300									
Taieri/Waipori Confluence Floodbank Realignment: Construction					1,138									
Taieri/Waipori Confluence: Morphological Modelling					109									
Taieri/Waipori Confluence: Nature-based Solution											635			

\* Ongoing capacity maintenance incorporated as routine activity from Year 5 onwards (River Channel Maintenance).

**Key**  
 Operational Expenditure   
 Capital Expenditure   
 Significant Decision Point



Diagram 5: West Taieri Drainage Scheme

Year	Estimated Expenditure \$,000's													
	Y1 2024/25	Y2 2025/26	Y3 2026/27	Y4 2027/28	Y5 2028/29	Y6 2029/30	Y7 2030/31	Y8 2031/32	Y9 2032/33	Y10 2033/34	Y11-15 2035-39	Y16-20 2040-44	Y21-25 2045-49	Y26-Y30 2050-54
<b>Routine / Business as Usual Activities</b>														
Scheduled Maintenance and Inspections					2,652						1,523	1,643	1,763	1,883
Reactive Maintenance					332						190	205	220	235
Routine Condition Assessments and Monitoring					477						317	342	367	392
Designation / Bylaw Renewal										121	127	137	147	157
Culvert Renewal Programme						1,011					381	411	441	471
<b>Projects</b>														
Pump Station Communications Upgrade			263											
Scheme Performance and Risk Assessment		156												
Lake Ascog Pump Station: Pump Renewals		521												
Bridge Renewals		2,031												
Public Safety Assessment	10													
West Taieri Drainage Model Build		255												
Waipori Pump Station Capacity & Seismic Improvements: Assessment			260											
Waipori Pump Station Capacity & Seismic Improvements: Implementation				535										
Pump Station Upgrades (Pumps)											6,346	6,846	7,346	

**Key**  
 Operational Expenditure   
 Capital Expenditure   
 Significant Decision Point

Diagram 6: East Taieri Drainage Scheme

Year	Estimated Expenditure \$,000's													
	Y1 2024/25	Y2 2025/26	Y3 2026/27	Y4 2027/28	Y5 2028/29	Y6 2029/30	Y7 2030/31	Y8 2031/32	Y9 2032/33	Y10 2033/34	Y11-15 2035-39	Y16-20 2040-44	Y21-25 2045-49	Y26-Y30 2050-54
<b>Routine / Business as Usual Activities</b>														
Scheduled Maintenance and Inspections						2,294					1,333	1,438	1,543	1,648
Reactive Maintenance						387					222	240	257	275
Routine Condition Assessments and Monitoring						430					317	342	367	392
Culvert Renewal Programme						1,106					476	513	551	588
Designation / Bylaw Renewal										121	127	137	147	157
<b>Projects</b>														
Pump Station Communications Upgrade			263											
Scheme Performance and Risk Assessment		156												
Owhiro Drainage Improvements								1,163						
Silver Stream Pump Station Condition/Environmental Improvement			1,900											
East Taieri Model Build		261												
Public Safety Assessment	10													
Weir and Detention Gate Investigations	41													
Pump Station Upgrades (Pumps)											6,346	6,846	7,346	

Diagram 7: Tokomairiro Drainage Scheme

Year	Estimated Expenditure \$,000's													
	Y1 2024/25	Y2 2025/26	Y3 2026/27	Y4 2027/28	Y5 2028/29	Y6 2029/30	Y7 2030/31	Y8 2031/32	Y9 2032/33	Y10 2033/34	Y11-15 2035-39	Y16-20 2040-44	Y21-25 2045-49	Y26-Y30 2050-54
<b>Routine / Business as Usual Activities</b>														
Scheduled Maintenance and Inspections						1,139					651	702	754	805
Reactive Maintenance						221					127	137	147	157
Routine Condition Assessments and Monitoring						405					317	342	367	392
Designation / Bylaw Renewal										60	63	68	73	78
Culvert Renewal Programme						1,112					476	513	551	588
<b>Projects</b>														
Bridge Repairs		619												
Tokomairiro Drainage Scheme Model Build				270										
Public Safety Assessment	10													

**Key**  
 Operational Expenditure   
 Capital Expenditure   
 Significant Decision Point

## Diagram 8: River Management Infrastructure

Year	Estimated Expenditure \$,000's													
	Y1 2024/25	Y2 2025/26	Y3 2026/27	Y4 2027/28	Y5 2028/29	Y6 2029/30	Y7 2030/31	Y8 2031/32	Y9 2032/33	Y10 2033/34	Y11-15 2035-39	Y16-20 2040-44	Y21-25 2045-49	Y26-Y30 2050-54
<b>Routine / Business as Usual Activities</b>														
Dunedin Area: Channel and Riparian Management*					5,947						3,427	3,765	3,967	4,315
Clutha Area: Channel and Riparian Management*					7,105						4,315	4,450	4,922	5,100
Central Otago Area: Channel and Riparian Management*					5,127						3,268	3,457	3,783	4,041
Wakatipu Area: Channel and Riparian Management**					4,774						2,830	2,985	3,203	3,578
Wanaka Area: Channel and Riparian Management***					3,370						1,701	1,807	1,895	2,103
Waitaki Area: Channel and Riparian Management*					4,346						2,634	2,841	3,049	3,256
Lower Waitaki River Control Scheme: Contribution to Scheme Operation					2,545						1,480	1,596	1,713	1,830
<b>Dunedin Area Projects - Infrastructure Related Only</b>														
Middlemarch: Hazard Mitigation Investigations		156												
Middlemarch: Tactical Maintenance		154												
Middlemarch: Hazard Mitigation Improvements						335					6,346			
Lindsay Creek / North East Valley Resilience: Flood Response Plan	5													
Lindsay Creek: Legalisation of land ownership		101												
Lindsay Creek: Identification of flood mitigation options		155												
Lindsay Creek: Hydraulic Modelling		450												
Lindsay Creek: Implementation of Flood Mitigation							3,525				12,692	13,692	14,692	15,692
Lindsay Creek: Quarry Bridge	1,000													
Kaikorai Stilling Basin: Resilience and Environmental Enhancement		1,714									3,173	3,423		
Kaikorai Stream: Improvements		156												
River Mouth Monitoring Technology Installation		123												
<b>Clutha Area Projects - Infrastructure Related Only</b>														
River Mouth Monitoring Technology Installation		41												
<b>Wanaka Area Projects - Infrastructure Related Only</b>														
Stoney Creek: Investigation		41												
Stoney Creek: Staged Improvements			106				57			60				
<b>Waitaki Area Projects - Infrastructure Related Only</b>														
Completion of Waitaki Designation	100													
<b>All Areas - Infrastructure Related Only</b>														
All - Public Safety Assessment	75													

\* Channel and Riparian Management is the total estimated expenditure for routine works within each river management area. Note that only a portion of this expenditure relates to river management infrastructure.

\*\* Includes Shotover Training Line and Dart/Rees (Head of Lake Whakatipu Natural Hazards Adaptation), related works.

\*\*\* Includes Albert Town Rock Buttress.

**Key**  
 Operational Expenditure   
 Capital Expenditure   
 Significant Decision Point

## 4.4 Significant Decisions

The Infrastructure Investment Programme in the preceding section identifies several significant decisions that Council is expected to consider over the lifetime of this strategy.



This section provides more detail about each significant decision point, including the decision drivers, options, and assumptions (Tables 21 to 25).

The anticipated scale of costs has been included to meet the requirements of the Local Government Act; however, it is noted that there are other values that will need to be considered at the time of any decision making including, environmental, social, and cultural values. Risk exposure will also require consideration. The scale of costs has been given a low to high rating that is defined as follows:





- Low – Costs estimated to be in the order of tens of thousands.
- Moderate – Costs estimated to be in the order of hundreds of thousands.
- High – Costs estimated to be in the order of millions.
- Very high – Costs estimated to be in the tens of millions.

Note that the options presented in Tables 21 to 25 are subject to change based on investigation and optioneering work that will precede each decision.


**Table 21. Leith Flood Protection Scheme – Significant decision points, decision drivers, options, and assumptions.**

Decision/Project Decision Timing	Principal Options		Assumptions
	Options	Scale of Costs	
<p><b>A</b></p> <p><b>Leith Historic Walls</b> Year 3 (2026/27)</p> <p>Decision Drivers (Key Significant Issues):</p> 	Continue to maintain historic walls in current state.	<p>Low to moderate (ongoing operational costs, increasing with time)</p> <p>Moderate (unplanned capital, in event of damage or failure)</p>	<p>No increase to scheme levels of service anticipated through the replacement of the historic walls.</p> <p>Assumes some alignment with amenity work (Significant Decision B) where practicable.</p>
	Replace historic walls within Leith Flood Protection Scheme.	<p>Very High (initial capital combined with amenity works)</p> <p>Low (ongoing operational costs)</p>	
<p><b>B</b></p> <p><b>Leith Amenity</b> Year 4 (2027/28)</p> <p>Decision Drivers (Key Significant Issues):</p> 	Do nothing. Ongoing maintenance of concrete structures and no change in amenity value.	Low to moderate (ongoing operational costs)	<p>No increase to scheme levels of service anticipated through this work, however opportunities to increase levels of service would be explored during design process.</p>
	Undertake amenity works from Forth Street to Harbour.	<p>High (initial capital combined with historic walls work)</p> <p>Low (ongoing operational costs)</p>	


**Table 22. Lower Clutha Flood Protection and Drainage Scheme – Significant decision points, decision drivers, options, and assumptions.**

Decision/Project Decision Timing	Principal Options		Assumptions
	Options	Scale of Costs	
<p><b>C</b></p> <p><b>Puerua Outfalls Culvert (Training Line) Adaptation</b> Year 1 (2024/25)</p> <p>Decision Drivers (Key Significant Issues):</p> 	Do nothing. Continue to undertake tactical maintenance to retain Puerua River outlet and training line.	Moderate (ongoing reactive operational costs)	<p>No increase to levels of service.</p> <p>Managed retreat would be a staged and long-term approach to be implemented alongside other scheme wide adaptation measures.</p> <p>Changes to levels of service anticipated through adaptation measures, however scale to be determined.</p>
	Retain and improve resilience of existing training line and culverts.	High (capital and ongoing reactive operational costs)	
	Managed retreat from area.	High (initial capital) Low (ongoing operational costs)	
<p><b>D</b></p> <p><b>Managed Relocation of Infrastructure</b> Year 6 (2029/30)</p> <p>Decision Drivers (Key Significant Issues):</p> 	Do nothing. Ongoing maintenance and repair of critical flood protection infrastructure.	Moderate to High (ongoing operational costs and capital for repairs)	<p>No increase to levels of service.</p> <p>Staged adaptation of the coastal area consistent with 'C' above will require infrastructure modifications to continue to provide flood protection and land drainage.</p> <p>Changes to levels of service anticipated through adaptation measures, however scale to be determined.</p>
	Planned and staged relocation of infrastructure.	Very High (initial capital) Low to moderate (ongoing operational costs)	
<p><b>E</b></p> <p><b>Clutha Delta Split Lagoon Enhancement</b> Year 4 (2027/28)</p> <p>Decision Drivers (Key Significant Issues):</p> 	Do nothing.	Low to moderate (ongoing operational costs)	<p>No increase to levels of service.</p> <p>Work will be carried out in collaboration with other interested parties and stakeholders.</p>
	Replace culverts.	Moderate (initial capital) Low (ongoing operational costs)	
	Replace culverts and integrate nature-based solution.	Moderate to high (initial capital) Low (ongoing operational costs)	
<p><b>F</b></p> <p><b>Floodbank Realignment</b> Year 3 (2026/27)</p> <p>Decision Drivers (Key Significant Issues):</p> 	Retain current floodbank alignment at location downstream of Riverbank Road.	Moderate to high (ongoing operational costs and capital costs associated with ongoing repair)	<p>No changes to current levels of service.</p>
	Realign floodbank downstream of Riverbank Road to improve resilience of floodbank and retain current level of service.	High (initial capital) Low to moderate (ongoing operational costs)	



**Table 23. Lower Taieri Flood Protection Scheme – Significant decision points, decision drivers, options, and assumptions.**

Decision/Project Decision Timing	Principal Options		Assumptions
	Options	Scale of Costs	
<b>G</b> <b>Climate Adaptation</b> Year 7 (2030/31) 	Do nothing. Make no changes to scheme to adapt to changing climate.	Low to moderate (operational costs, escalating costs as exposure to climate changes impacts on maintenance/repairs)	Assumes climate adaptation work will be staged.
	Adapt scheme to changing climate.	High to very high (capital costs)	
<b>H</b> <b>Riverside Spillway</b> Year 3 (2026/27)  Decision Drivers (Key Significant Issues): 	Do nothing. Maintain current spillway and operational protocols.	Low to moderate (ongoing operational and repair costs)	No increase to levels of service.  Assumes that removal of spillway gates will be considered.
	Modify spillway to operate at fixed level (or alternative as determined by investigations).	High (initial capital)  Low to moderate (ongoing operational and repair costs)	
<b>I</b> <b>Outram Floodbank Resilience Improvements</b> Year 2 (2025/26)  Decision Drivers (Key Significant Issues): 	Do nothing.	Low (ongoing operational costs)	No increase to levels of service.
	Improve resilience of floodbank in proximity to Outram.	High (initial capital cost)	
<b>J</b> <b>Taieri/Waipori Confluence Floodbank Realignment</b> Year 1 (2024/25)  Decision Drivers (Key Significant Issues): 	Repair floodbank on current alignment.	Low to moderate (ongoing operational costs for repairs and maintenance)	No increase to levels of service.
	Realign floodbank to maintain performance and improve resilience of this portion of the scheme.	High (initial capital cost)	
<b>K</b> <b>Taieri/Waipori Confluence: Nature-based Solution</b> Year 6 (2029/30)  Decision Drivers (Key Significant Issues): 	Do nothing.	Low (ongoing operational costs)	No increase to levels of service.
	Contribute to environmental value of the area by incorporating a wetland into adjoining wetlands.	High (initial establishment)	

**Table 24. West Taieri Drainage Scheme – Significant decision points, decision drivers, options, and assumptions.**

Decision/Project Decision Timing	Principal Options		Assumptions
	Options	Scale of Costs	
<p><b>L</b></p> <p><b>Waipori Pump Station Capacity and Seismic Improvements</b> Year 3 (2026/27)</p> <p>Decision Drivers (Key Significant Issues):</p> 	No capacity improvements.	Low (ongoing operational costs)	<p>Potential increase in levels of service depending on outcome of assessment and available solutions.</p> <p>Climate change adaptation will be incorporated.</p>
	Improve capacity by addition of a new pump.	Moderate (initial capital)	

**Table 25. Dunedin River Management Area – Significant decision points, decision drivers, options, and assumptions.**

Decision/Project Decision Timing	Principal Options		Assumptions
	Options	Scale of Costs	
<p><b>M</b></p> <p><b>Middlemarch Hazard Mitigation Improvements</b> Year 4 (2027/28)</p> <p>Decision Drivers (Key Significant Issues):</p> 	Do nothing. Ongoing maintenance of waterways.	<p>Low to moderate (ongoing operational costs)</p> <p>Moderate to high (costs associated with major events)</p>	<p>Increase in levels of service as a result of improved hazard mitigation.</p>
	Undertake hazard mitigation improvements.	<p>Moderate to high (capital costs)</p> <p>Low to moderate (costs associated with major events)</p>	
<p><b>N</b></p> <p><b>Lindsay Creek Flood Mitigation Implementation</b> Year 4 (2027/28)</p> <p>Decision Drivers (Key Significant Issues):</p> 	Do nothing. Ongoing maintenance of waterway and existing infrastructure.	<p>Low to moderate (ongoing operational costs)</p> <p>Moderate to high (costs associated with major events)</p>	<p>Increase in levels of service as a result of implementing flood mitigation options.</p> <p>A comprehensive flood protection scheme has been assumed for cost estimate in later years of this Strategy. Levels of service and tolerable residual risk to be determined.</p>
	Implement flood mitigation options that focus on nature-based solutions where practicable.	High to very high (initial capital and implementation costs)	
	Build a flood protection scheme that consists of hard engineering infrastructure.	Very high (initial capital cost)	



## 4.5 Scenarios, Assumptions and Uncertainty

The Local Government Act 2002 requires identification of the most likely scenario impacting infrastructure requirements along with assumptions, uncertainties, and potential impacts of these uncertainties. These have been set out below in Table 26.

**Table 26. Likely scenarios, assumptions, level of uncertainty and reasons and effects of that uncertainty.**

Likely Scenario	Assumptions	Level of uncertainty	Reasons and effect of uncertainty
<b>Climate change including increased weather events and other Natural Hazard events</b>			
<p>Consideration and response to climate change will be consistent with current national and regional projections.</p> <p>Increased significant weather events, or other natural hazard emergencies will continue to occur.</p> <p>Infrastructure Strategy assumes there will be an average of (1) significant event<sup>3</sup> per financial year within Otago.</p>	<p>If climate change effects occur more quickly than anticipated in the investment programme there may be an increased adaption and response to climate change.</p> <p>Future sea level rise does not exceed that projected by current climate science within the 30-year planning horizon.</p> <p>Council cannot accurately predict when and where large flood events will occur, or the damage that may result from any flood event. There will be increased frequency of weather events that cause damage to infrastructure assets.</p>	Medium	<p>The effects of increased weather events that cause damage and potential other natural hazard events, on Councils financial position is dependent on the scale, duration, and location of the event.</p> <p>Potential climate change impacts are being considered through scheme performance and detailed investigation as prediction and adaptation information becomes available.</p> <p>The Council will manage the effect through its reserves to repair or replace infrastructural assets that are damaged and/or destroyed.</p> <p>The infrastructure strategy will use scheme reserves that are built up over time to help ensure funding up to 40% of the expenditure is available across the schemes.<sup>4</sup></p> <p>Within 50 years, climate changes will start to become more significant and will require response and or implementation of adaptation strategies within the 30-year timeframe. The infrastructure strategy allows for this, noting that there are 'known and unknown' effects. The key to appropriate planning and response is the investigations and planning to implement adaptation strategies.</p> <p>The infrastructure considers climate change and provides to investigate the impact on the management of flood protection and land drainage scheme assets.</p>

<sup>3</sup> Significant event is defined as flood protection trigger levels are reached or exceeded in a scheme and the event reaches repair cost threshold in accordance with NEMA guidelines.

<sup>4</sup> The Council has access to the National Emergency Management Agency (NEMA) which provides 60% funding of expenditure required to repair assets damage. This is dependent on the Council reaching its threshold which is 0.002% of the Rateable Value of Council infrastructure in the financial year in which the damage occurred.

Likely Scenario	Assumptions	Level of uncertainty	Reasons and effect of uncertainty
<b>Legislative Change</b>			
Legislative changes will change marginally, however current forecast allows for adaptation.	<p>There will be no major changes to key legislation that effects the ORC's strategy or has funding implications.</p> <p>Key legislation under this Infrastructure Strategy includes; Local Government Act 2002, Resource Management Act, and Soil Conservation and River Control Act 1941.</p>	High	There is a high level of uncertainty because legislative change is highly likely over the next 30 years. The potential effect of any new changes environmental or resource management will be determined on the response required, and the timing to effect such changes. Legislative changes may result in additional required expenditure to comply with new standards.
<b>Asset Lifecycle</b>			
<p>Council will invest in its owned infrastructure relating to flood protection, land drainage and river assets to ensure resilience and level of service to be provided by the infrastructure.</p> <p>Information contained in this Infrastructure Strategy is based on current known information which has been used to determine issues and understand the asset management requirement for a 30-year horizon.</p>	<p>The Council has sufficient funds to replace significant assets at the end of their useful lives.</p> <p>The Council has sufficient known information to support its asset lifecycle costs.</p>	Medium	<p>The continued development of asset management systems including forecasting and modelling tools will continue through Years 1 to 10. It is expected that maturity in asset management systems and consolidation of known information will provide Council an improved basis of determining capital renewals (increased levels of service) costs.</p> <p>Asset lifecycle costs are based on useful remaining lives, condition assessments and replacement values as of 30<sup>th</sup> June 2023, which has been drawn from known information available in Councils current systems.</p>
<b>Demand for Level of Service</b>			
Territorial Authorities through their respective planning processes will indicate growth across some areas of Otago in the short and long term, 30-year horizon.	That there will be a demand for flood protection, land drainage and river management and an associated level of service changes due to continued investment and land use change in both urban and rural areas.	Low	<p>That communities and other utility providers (rail, airport and roading networks) will expect the same (or increased) level of service in the future as to meet demand.</p> <p>Communities and other utility providers will be able to pay additional costs to maintain or (increase) that level of service.</p>

Likely Scenario	Assumptions	Level of uncertainty	Reasons and effect of uncertainty
<b>Natural Disaster</b>			
<p>Events across New Zealand have shown that natural disaster through prolonged weather events has had a destructive effect on infrastructure and communities.</p> <p>No allowance has been made in investment programmes for repairs to scheme assets resulting from natural disasters.</p>	<p>Natural disasters occur and exceed forecast expenditure and compromise infrastructure functionality.</p>	<p>Medium</p>	<p>Responding to major weather events or other natural disasters is funded through insurance (where insurable) and scheme reserves in response to events.</p> <p>Council has insurance for its above ground fixed assets, such as pumps, control structures etc. Floodbanks are not insured and rely on self-insurance.</p> <p>Council has material damage cover for its specified assets, detailed in relevant insurance schedules.</p> <p>The excess for its material damage policy is generally \$5,000 unless the cause of damage is landslip/subsidence which incurs a \$50,000 excess and damage caused by flood has a \$100,000 excess as at the 2023 renewal.</p> <p>Damage caused by Natural Disaster has an excess of 2.5% of sum insured (minimum \$5000).</p> <p>Council is not able to purchase insurance cover for floodbanks as they are considered as above ground large mounds of earth and as such, they are deemed uninsurable, and insurance cover is not available. It is for this reason that Council provides the mechanism of being self-insured for floodbank assets, which draws damage expenditure from respective scheme reserves.</p> <p>Increased renewals or maintenance due to natural disasters will be funded through reserves.</p> <p>Council also will have the ability to raise funding for the cost of unexpected works in response to weather events and natural disasters such as floods or earthquakes.</p> <p>The Infrastructure Strategy invests in analysis of flooding and disaster readiness and preparedness.</p>
<b>Giving 'rivers room to move' and PARA Framework</b>			
<p>The principles of 'giving rivers room to move' including Te Mana o Te Wai and investigating the inclusion of nature-based solutions to adapt to climate change and increased weather patterns within the</p>	<p>Progress towards incorporating and considering the PARA framework with regard to how our rivers, communities and infrastructure intersect will continue.</p>	<p>Low</p>	<p>The impacts of national direction, including Te Mana o Te Wai, climate change adaptation and changes to regional planning frameworks, have yet to be given effect. These changes may give greater recognition and protection of a range of values in rivers, including biodiversity and those of mana</p>

Likely Scenario	Assumptions	Level of uncertainty	Reasons and effect of uncertainty
<p>PARA Framework will be a Council priority.</p> <p>The ORC's approach to flood protection, land drainage and river management has been transitioning to consider whole of river and catchment approach with effect to giving rivers room to move and Te Mana of Te Wai.</p> <p>It is anticipated that the Council will continue to support the progress to take an integrated approach and align flood protection, land drainage and river management infrastructure to not only understanding these principles but implementing in our work activities.</p>	<p>National direction including regional planning framework will develop in the 30-year horizon that allows the PARA framework which to be implemented by giving effect to giving rivers room to move.</p>		<p>whenua, which may change priorities and outcomes. It is likely some changes will impact the current approach and rate of transition with infrastructural investment, if the changes do not have an appropriate transition period.</p> <p>This will reinforce the strategic directions that Council has set to proactively revive the mauri of rivers, ki uta ki tai including creating a landscape alignment to revive these critical ecological corridors from the mountains to the sea and restore the connections between communities and rivers, which enables adaption to proceed with connection as opposed to an intersection of communities and rivers.</p>

## Appendix A: Scheme Maps

Scheme maps are ordered as follows:

- Map 1 – Alexandra Flood Protection Scheme
- Map 2 – Leith Flood Protection Scheme
- Map 3 – Lower Clutha Flood Protection and Drainage Scheme
- Map 4 – Tokomairiro Drainage Scheme
- Map 5 – Lower Taieri Flood Protection Scheme
- Map 6 – West Taieri Drainage Scheme
- Map 7 – East Taieri Drainage Scheme
- Map 8 – Combined Lower Taieri Schemes (Flood Protection and Drainage)
- Map 9 – Lower Waitaki River Control Scheme
- Map 10 – Stoney Creek Flood Protection Scheme


Note: The maps show the locality of each Scheme and some of the key infrastructure for each Scheme but do not show all assets or features such as overland flow paths.

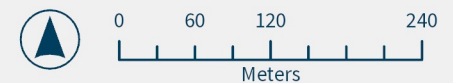


# Appendix Map 1

## Alexandra Flood Protection Scheme



 Pump Stations      Floodbanks



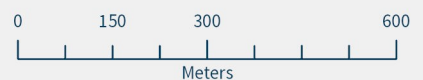


# Appendix Map 2

Leith Flood Protection Scheme



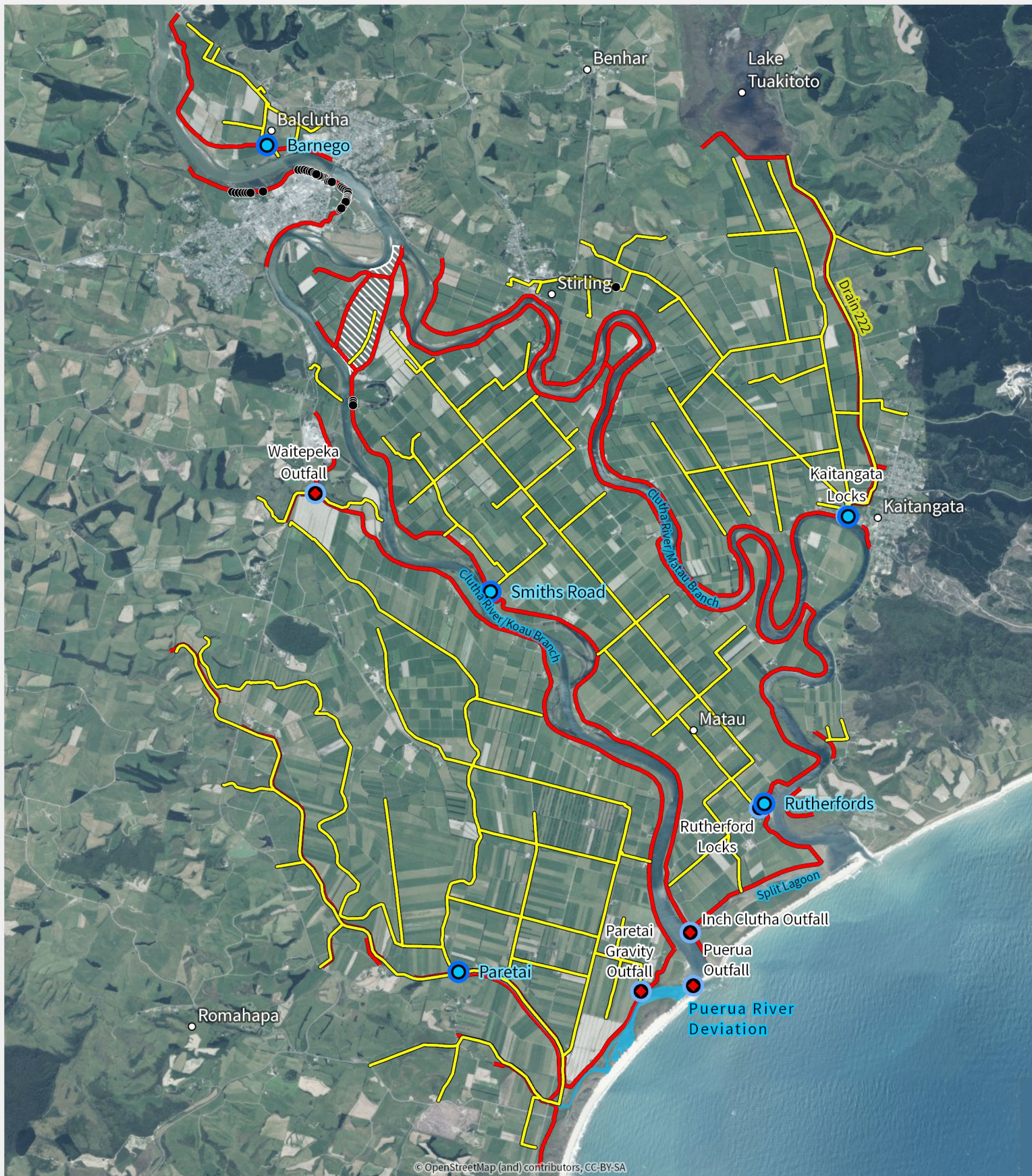
- Concrete/Rock Weir
- Dividing Wall
- Debris/Gravel Traps
- Channel Wall



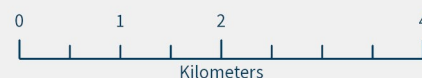


# Appendix Map 3

## Lower Clutha Flood Protection and Drainage Scheme



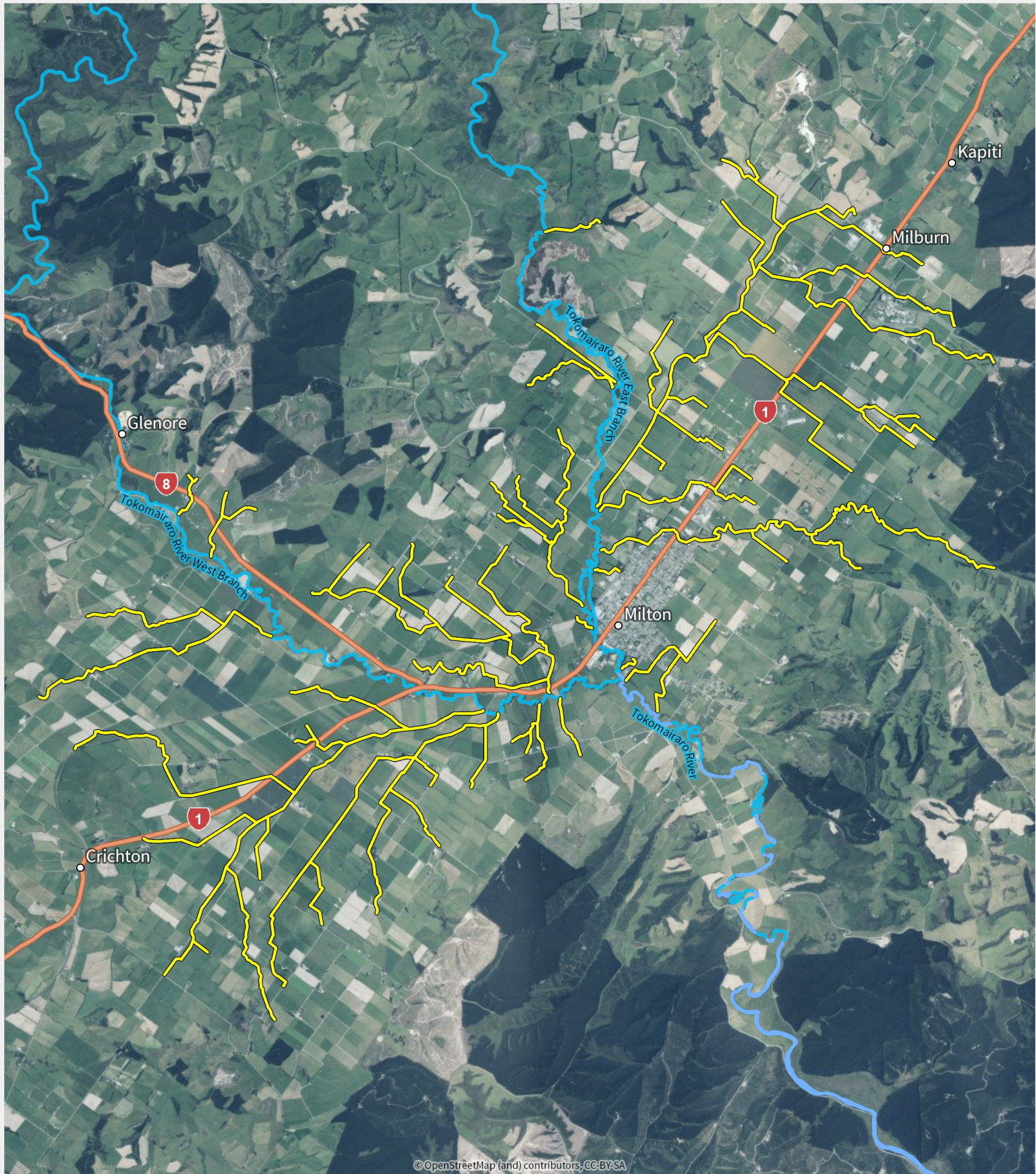
- Pump Stations
- Outfall Structures
- Relief Wells
- Drains
- Lower Clutha Floodway
- Floodbanks





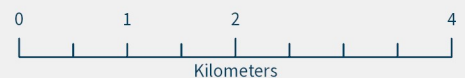
# Appendix Map 4

## Tokomairiro Drainage Scheme



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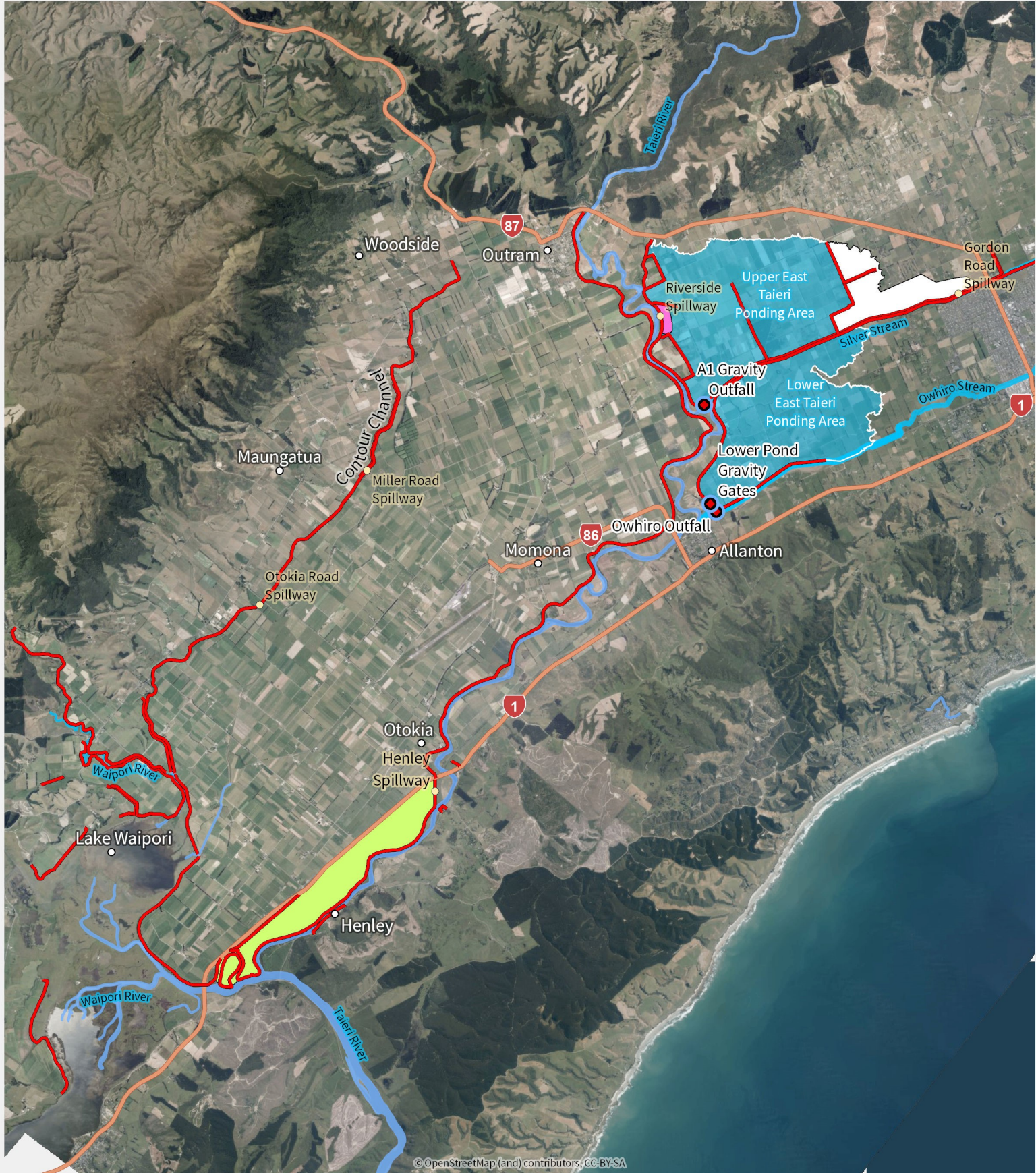
— Drains





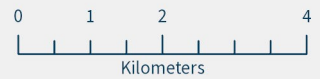
# Appendix Map 5

## Lower Taieri Flood Protection Scheme



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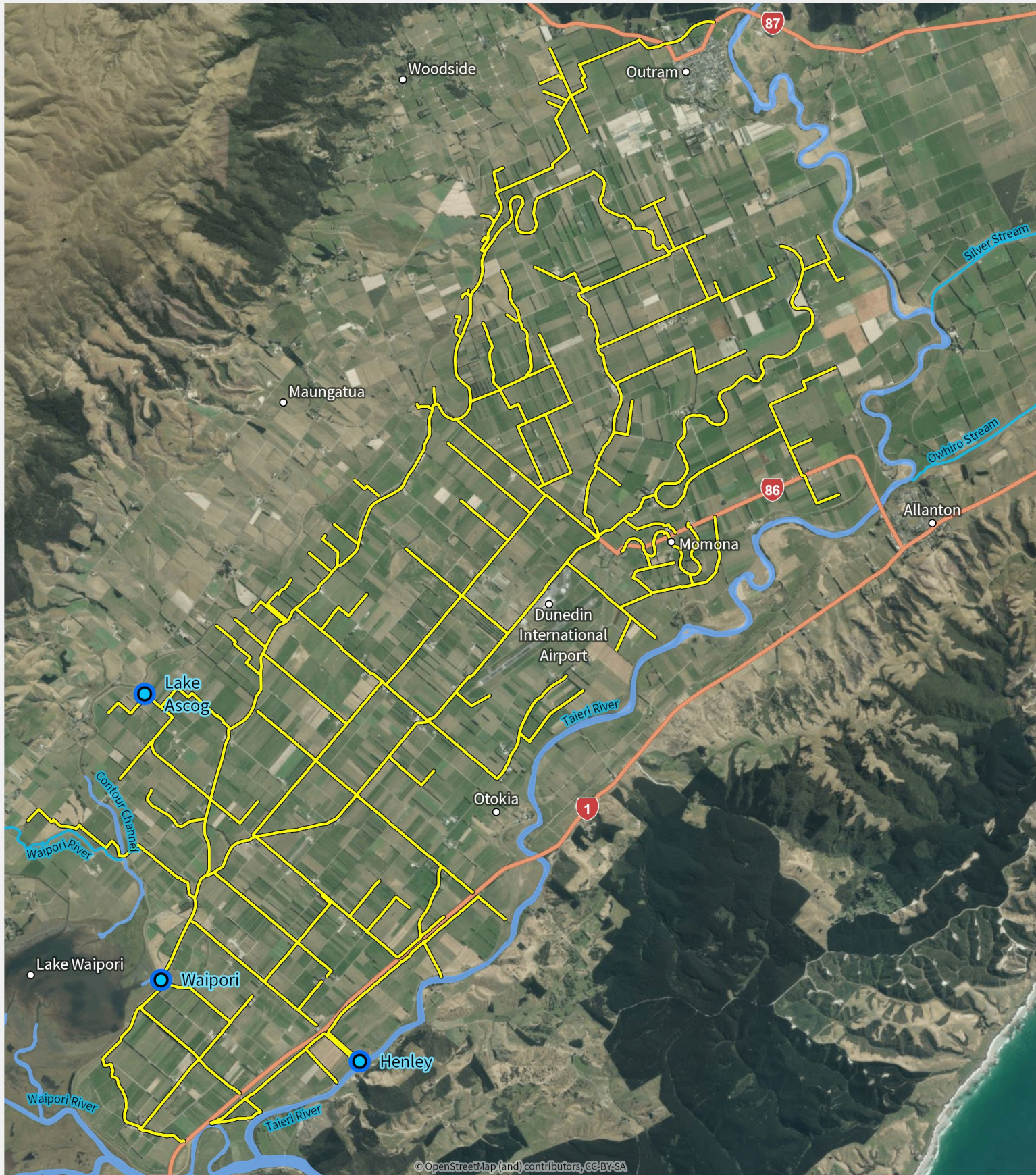
- Gordon Road Floodway
- Henley Floodway
- Floodbanks
- Riverside Road Floodway
- Ponding Areas
- Outfall Structures







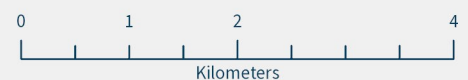
# Appendix Map 6

## West Taieri Drainage Scheme



### West Taieri Drainage Scheme:

-  Pump Stations
-  Drains





# Appendix Map 7

## East Taieri Drainage Scheme



### East Taieri Drainage Scheme:

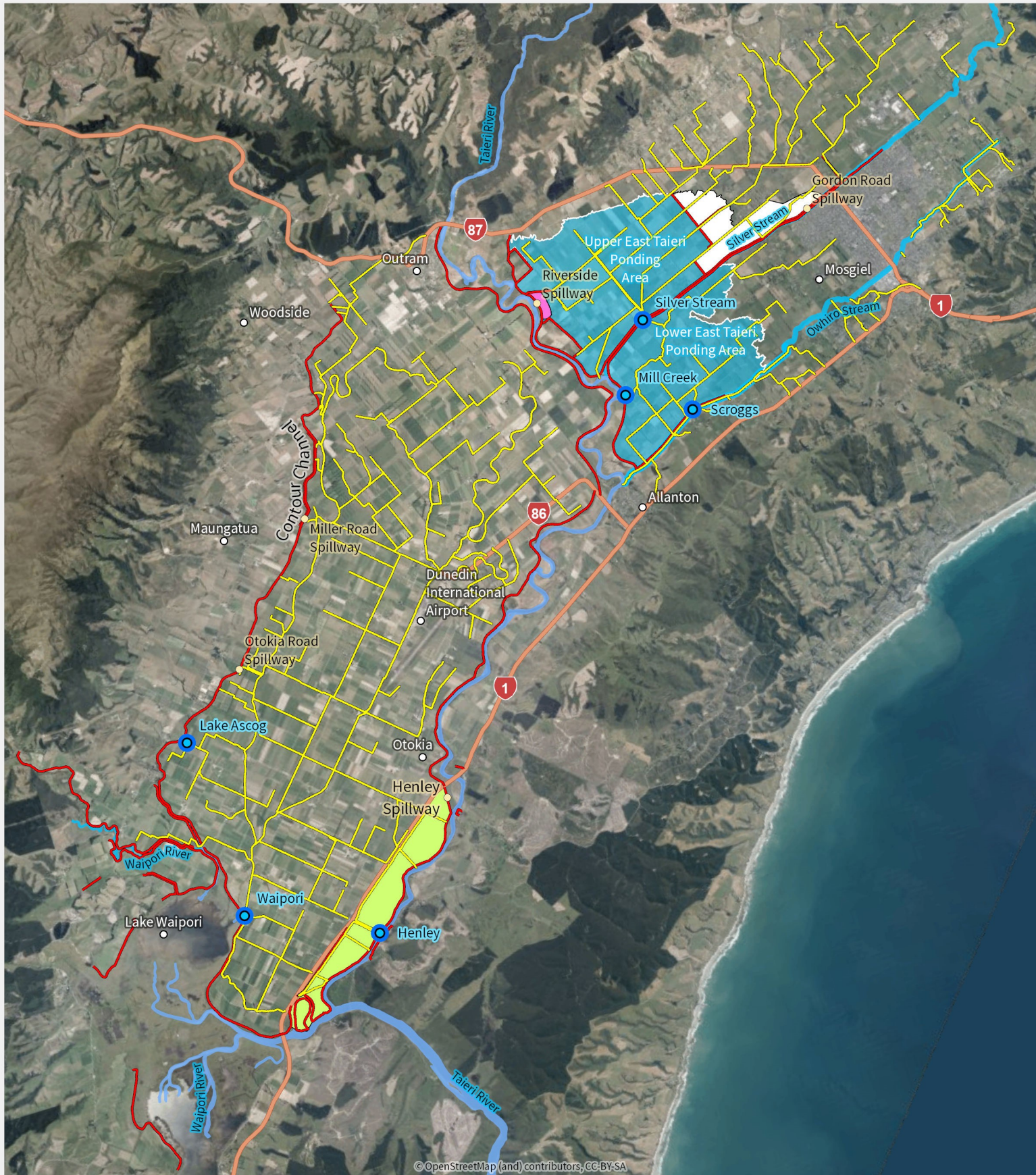
-  Drains
-  Pump Stations





# Appendix Map 8

Taiari Flood and Drainage Schemes Combined



**Drainage Scheme:**

● Pump Stations

**Flood Protection Scheme:**

— Drains

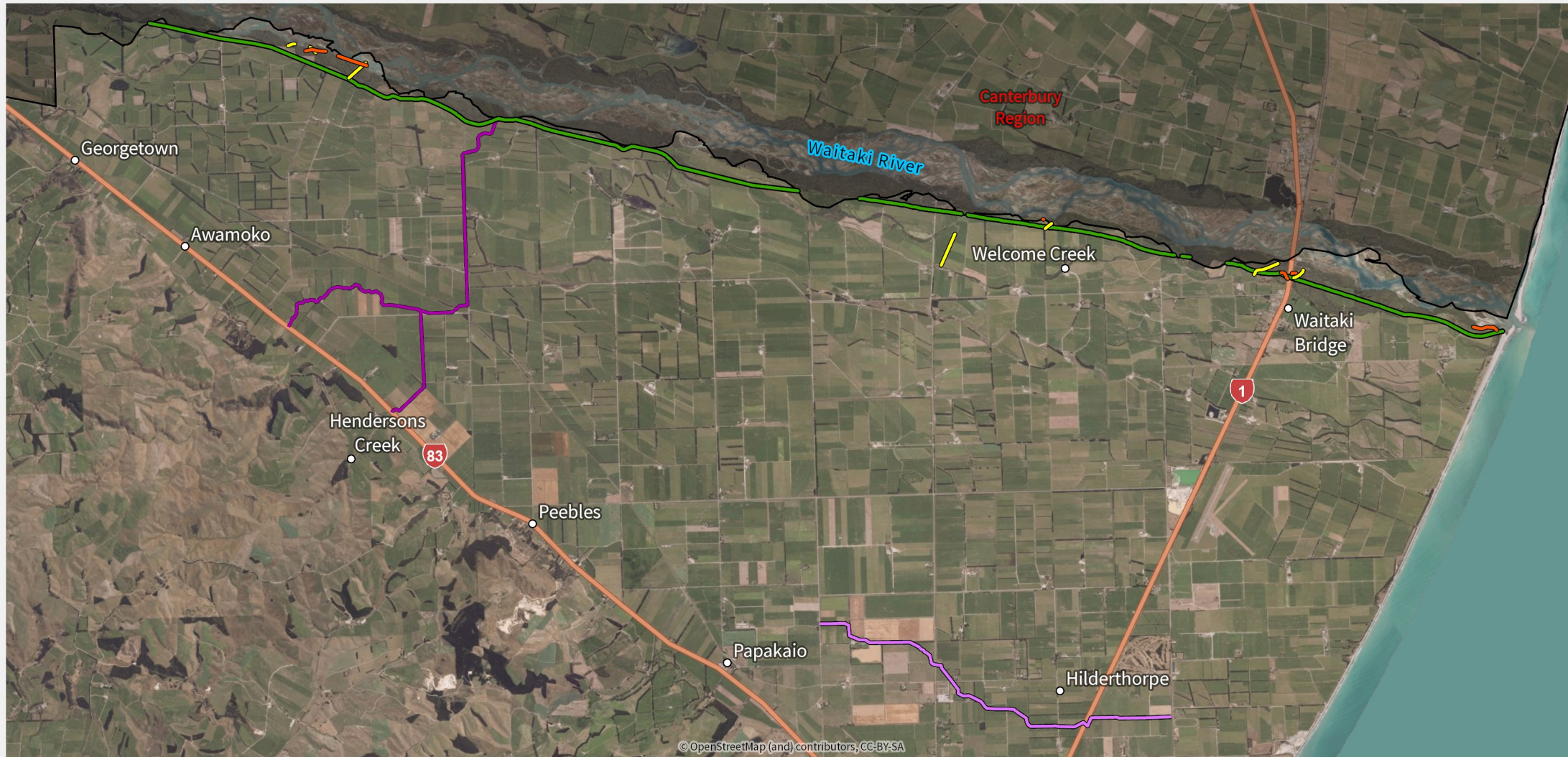
— Floodbanks








# Appendix Map 9

## Lower Waitaki River Control Scheme





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### Lower Waitaki River Control Scheme:

-  Cross Banks
-  Flood Protection Vegetation Boundary Line
-  Groynes

### River Management Infrastructure:

-  Hendersons and Waikoura Creek Floodway
-  Hilderthorpe Floodway





# Appendix Map 10

Stoney Creek Flood Protection Scheme



 Overflow Channel      Debris Trap

