



Transforming Lowland Waterway Networks

A Combined Catchment Management Plan for Greenpark, Ellesmere, Leeston & Taumutu Land Drainage Schemes

Prepared by EOS Ecology & Aqualinc Research

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Prepared by:



Shelley McMurtrie
Zoë Dewson
Baily Lelieveld
Bronwyn Gay
Ariana Painter

Andrew Dark
Aimee Calkin

In co-design with:

Te Komiti Waioira District Land Drainage and Waterway Committee, consisting of:

Te Taumutu Rūnanga, Wairewa Rūnanga, Te Tuahuriri Rūnanga, Land Drainage Committee chairs,
Te Rūnanga o Ngāi Tahu, Department of Conservation, Fish & Game, Lake Settlers Group,
Eastern Plains Land User Group, Canterbury Regional Council, and Selwyn District Council.

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Foreword

<i>Te wai tuku kiri</i>	<i>Waters lap on the shores of ancestral land</i>
<i>Te wai tipua</i>	<i>The waters, challenging waters!</i>
<i>Te kare maioha e rere nei</i>	<i>Beckoning voices, whisper, ripple over</i>
<i>Ko koe te wai oraka mō tō iwi</i>	<i>ripple You are the life source for your people</i>
<i>Rere rere ripo ana e</i>	<i>Rippling, flowing, swirling around</i>
<i>Tīhei mauri ora!</i>	<i>Behold, it is life!</i>

Te Waihora sits at the heart of the takiwā of Ngāi Te Ruahikihiki ki Taumutu and Te Taumutu Rūnanga. Known ancestrally as Te Kete Ika a Rākaihautū – the fish basket of Rākaihautū – it has long sustained Ngāi Te Ruahikihiki and Ngāi Tahu Whānui through its abundant mahinga kai, waters, and wetlands.

Over generations, extensive drainage, flood management, and primary production have reshaped the landscape. Te Waihora has been reduced to less than half its original size, and the health of its waters has been significantly compromised. Yet the relationship between Ngāi Te Ruahikihiki ki Taumutu and Te Waihora has never diminished. The ahi kā remains, and so too does the responsibility of kaitiakitanga.

As kaitiaki, Ngāi Te Ruahikihiki ki Taumutu and Te Taumutu Rūnanga, carry an enduring obligation to restore, protect, and enhance the mana and mauri of Te Waihora and its connected waterways. This work is not solely environmental. It is cultural, intergenerational, and associative. The health of Te Waihora and its catchment reflects the health of the people.

Partners from Te Taumutu Rūnanga, Te Rūnanga o Ngāi Tahu, Selwyn District Council, Canterbury Regional Council, Department of Conservation and the Osborne Drainage Committee have worked hard for over 20 years to respond to localised degraded waterways. They have set the precedent for wider catchment management plans. The development of this plan under Te Komiti Waiora, is an outcome of that partnership. This Combined Catchment Management Plan for Greenpark, Ellesmere, Leeston and Taumutu Land Drainage Schemes reflects a shared commitment between tangata whenua, local government, and landowners.

The Combined Catchment Management Plan also reflects a shared aspiration to improve water quality and strengthen ecological outcomes within the catchment, and beyond to Te Waihora.

Ngāi Te Ruahikihiki ki Taumutu (Te Taumutu Rūnanga) recognise the mauri of the waterways in the catchment, and of all indigenous flora and fauna. Mauri can be interpreted as the ‘life force of all living things’; it is this life force that underpins and reinforces how we value the natural world. Mauri is used as an indicator for the health of a waterway or indigenous biodiversity, or for the success of a restoration project for instance. If there is no mauri, there is no life force and no life. Therefore, the implementation of this plan is critical. This Combined Catchment Management Plan outlines the future interventions required to continue to improve water quality, ecological and mahinga kai outcomes, and ultimately for restoring the mauri of Te Waihora.

Through collective effort and sustained partnership, the aim of this plan is to contribute to the long-term restoration and resilience of Te Waihora, and the communities that live, work and play on its shores.

Mā pango, mā whero; ka oti te mahi | Only together, will the job get done

on behalf of
Te Taumutu Rūnanga

For more information see Te Taumutu Rūnanga Natural Resources Management Plan (Te Taumutu Rūnanga, 2013).

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This Catchment Management Plan (CMP) is designed to work in conjunction with the Implementation Guide (IG) first developed for Ararira/LII.





Te Pā o Moki for Te Taumutu Runanga, one of the 18 papatipu rūnanga of Ngāi Tahu, and mana whenua of Te Waihora

Image source: EOS Ecology

1 Introduction

Large areas of Aotearoa New Zealand's lowland agricultural landscape were developed through the conversion of forests and wetlands to pasture. The Selwyn District land drainage schemes within the Te Waihora/Lake Ellesmere catchment, including the Greenpark, Ellesmere, Leeston, and Taumutu schemes, are examples of these past land development practices, which relied on digging drainage channels and installing networks of subsurface drains to make previously unsuitable land viable for pastoral agriculture. Whilst recognising the indelible effect this has had on our waterway landscape, the resulting drainage schemes are not only essential to maintaining productive land but are steeped in a history of back-breaking pioneering and form part of the cultural identity of many New Zealanders. These agricultural drains are often seen as having low ecological value, but they still retain important natural values – they are tributaries of larger waterways and sensitive receiving environments, and in many areas, they provide the only remaining habitat for our indigenous freshwater flora and fauna. Routine mechanical clearing of sediment and macrophytes is needed to preserve the drainage function of these waterways, but this can further impact these natural values whilst traditional funding mechanisms limit opportunities to trial and adopt alternative methods.

Finding a balance between using land for productivity and supporting livelihoods, while minimising the risk of environmental degradation and the erosion of indigenous rights, culture, and identity, is a challenge that is seen across the globe. *'Our Freshwater 2026'* (MfE and Stats NZ, 2026) is the latest report on the state of Aotearoa New Zealand's freshwater environment and summarises the challenge well. In urban catchments, efficient stormwater networks short-circuit the natural runoff cycle, altering the hydrological regime and transporting contaminants from hard surfaces (such as roads and roofs) into waterbodies. Both rural and urban catchments can contribute sediment, nutrients, pathogens, heavy metals, pesticides, and other contaminants, all of which deteriorate water quality and aquatic habitats. Many of these changes are insidious and difficult to reverse, with a delayed environmental response (i.e., a 'lag effect') – particularly in catchments with significant groundwater-surface

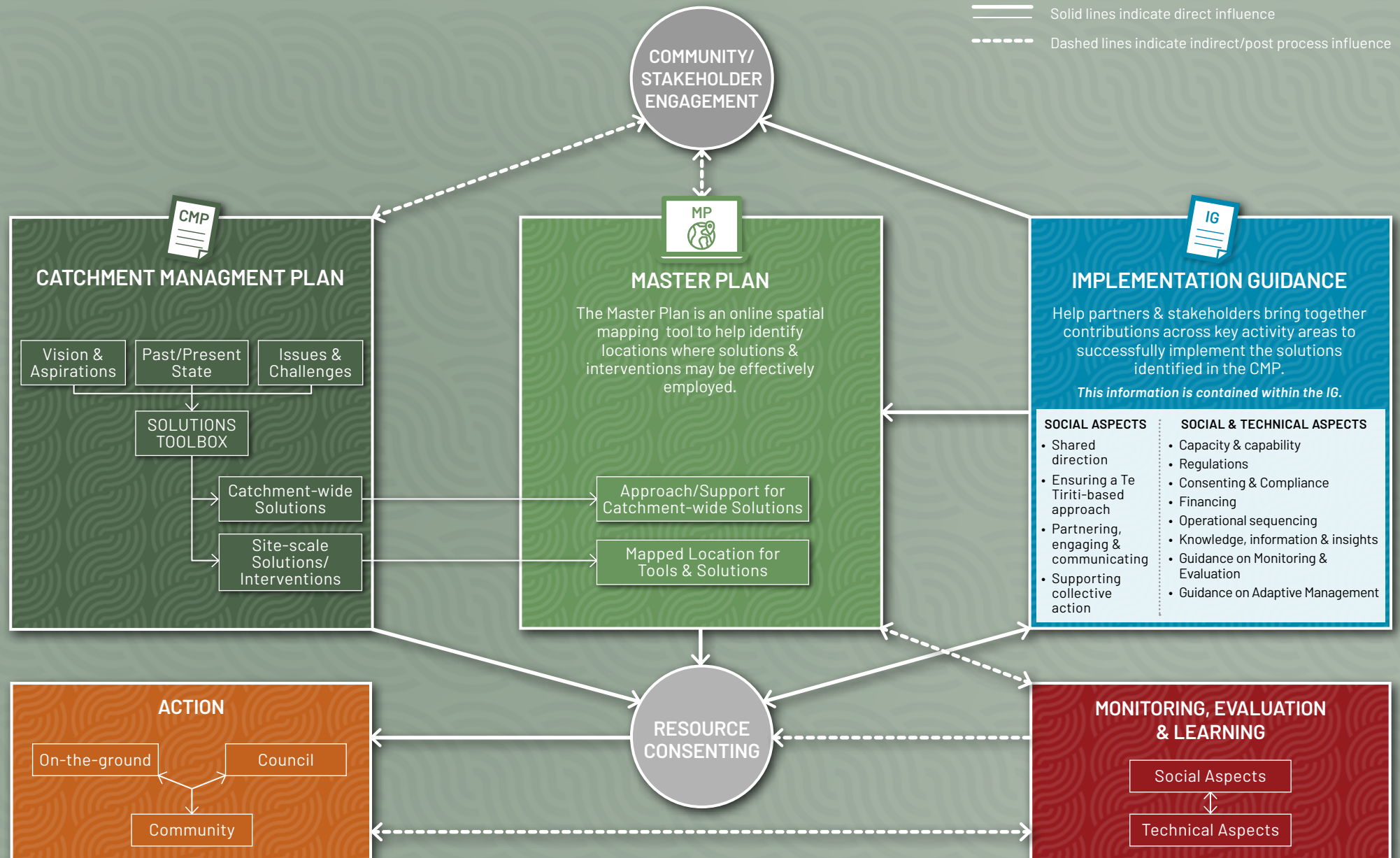
water interactions – meaning that we may only now be experiencing the consequences of degradation that began decades ago, while improvements from better environmental practices may take decades more to become evident. This challenge is highlighted in *Our Freshwater 2026*, which emphasises that long-term commitments are required to see meaningful improvements, especially in groundwater-influenced systems where there may be considerable delays before positive outcomes are observed.

To meet the challenges of preserving the ecological function in the drainage network and receiving environment of Te Waihora/Lake Ellesmere, Selwyn District Council (SDC) has implemented a range of actions. They have moved to district wide rating for land drainage (including rating all properties across the district for waterway enhancement in the land drainage schemes), are exploring opportunities for leveraging funding mechanisms, and have supported the development of Catchment Management Plans (CMPs) for their land drainage catchments (Ararira/LII scheme (EOS Ecology *et al.*, 2023), Osbornes Drain (EOS Ecology & Aqualinc, 2026a), Wairiri scheme (EOS Ecology & Aqualinc, 2026b) and Greenpark, Ellesmere, Leeston, and Taumutu schemes in this document). Beyond this CMP, the next steps involve engaging with the community, developing a masterplan, and establishing partnerships to support implementation, including co-funding opportunities to ensure the long-term success of the CMP and its initiatives (Figure 1).

Water is fundamental to our survival, and the ecological health of our water bodies – oceans, lakes, and rivers – should concern us all. Our futures, as individuals, communities, and nations, are deeply interconnected with the state of the planet’s water. Improving the state of Aotearoa New Zealand’s freshwaters requires transformative actions informed by a catchment-based approach. Whilst the changes proposed in this Catchment Management Plan (CMP) are aspirational, they are also essential and can be used as a ‘new normal’ for waterway management. While some of these solutions may initially be more costly than current practices, their multiple benefits – environmental, social, and cultural – outweigh the purely financial considerations and pave the way for a more sustainable future for the catchment.

FIGURE 1:  Interrelationships between the ‘Combined Greenpark, Ellesmere, Leeston & Taumutu Catchment Management Plan’ (CMP) and supporting documents, illustrating how the CMP informs subsequent steps such as community engagement, masterplan development, and partnership building to enable implementation and secure co-funding opportunities for long-term success.

— Solid lines indicate direct influence
 - - - Dashed lines indicate indirect/post process influence



1.1 Greenpark, Ellesmere, Leeston & Taumutu Catchments

The Selwyn District Council manages seven classified land drainage schemes, including the Greenpark, Ellesmere, Leeston, and Taumutu schemes (Figure 2). Each scheme has a corresponding surface water catchment (herewith referred to as the ‘catchment’), which may be larger or smaller than the rated land drainage catchment (‘rated catchment’). While this CMP focuses primarily on the rated catchments, it is important to recognise the influence of the wider surface water catchments, and that effective catchment-scale solutions (Section 6) and interventions (Section 7) may need to extend beyond the rated areas. The rated catchments vary widely in size, from the 1,266-ha Ellesmere rated catchment to the 10,749-ha Leeston rated catchment (Table 1). Across all schemes, the rated drainage network totals 256 km in length, most of which lies within the Leeston catchment. These catchments occupy low-lying, flat, or gently sloping land around the margins of Te Waihora/Lake Ellesmere, and boundaries between them may be indistinct because of the minimal elevation changes.

Aside from the Greenpark rated catchment, several named waterways intersect each of the rated catchments (Table 1). Many of these waterways are natural or modified channels, rather than artificially constructed drains, although they are now closely integrated with the rated drainage system and may be included within the classified/rated drain length for each catchment. The most significant river (in terms of overall catchment size) within this wider area is the Waikirikiri/Selwyn River, which discharges to Te Waihora/Lake Ellesmere between the Ellesmere and Leeston rated catchments (Figure 2). Whilst the rated catchments are adjacent to this river, the Waikirikiri/Selwyn River is excluded from this CMP as it falls outside the rated catchment areas and largely falls under the purview of Environment Canterbury. Muriwai/Coopers Lagoon is also not included in this CMP as it has its own management plan and is directly managed by Te Taumutu Rūnunga.

The Greenpark, Ellesmere, and Leeston rated catchments discharge to Te Waihora/Lake Ellesmere, while the Taumutu rated catchment discharges directly to the coast. At 198 km², Te Waihora/Lake Ellesmere is New Zealand’s largest coastal hāpua/waituna, as well as being Canterbury’s largest and New Zealand’s fifth largest lake. As one of the most polluted coastal hāpua/waituna in New Zealand, Te Waihora/Lake Ellesmere receives nitrogen, and phosphorus loads two to four orders of magnitude greater than all other monitored lakes (Drake *et al.*, 2009). With most of the Te Waihora/Lake Ellesmere catchment used for intensive agriculture and the lake level artificially managed, the lake is now excessively enriched with nutrients and has an accumulation of fine sediment, high algal biomass, and poor water clarity. Improving the health of Te Waihora/Lake Ellesmere

is crucial to the long-term health and wellbeing of all those who interact with the lake, and it is expected that improving the health of the waterways of the Greenpark, Ellesmere, Leeston, and Taumutu rated catchments and the water quality of the discharge from these catchments will contribute to the greater challenge of improving the health of Te Waihora/Lake Ellesmere.

TABLE 1:
Summary of the features of the Greenpark, Ellesmere, Leeston, and Taumutu rated catchments. Rated catchment area and rated drain lengths have been provided by Selwyn District Council.

Land Drainage Scheme rated catchment	Rated catchment area ha	Length of rated drains km	Other features/assets	History	Natural/named waterways/ waterbodies intersecting the rated catchment
Greenpark	2,243	21.6	No additional assets	Rated drains installed progressively from the 1850s, with the purpose of lowering groundwater for the productive use of land. Scheme discharges to Te Waihora/ Lake Ellesmere.	None known
Ellesmere	3,550	25.9	Includes: several privately owned flood flap valves	Rated drains installed progressively from the 1850s, with the purpose of lowering groundwater for the productive use of land. Scheme discharges to Te Waihora/ Lake Ellesmere.	Baileys Creek, McGraths Creek, Silverstream, Snake Creek, Wrights Creek/Miles Drain
Leeston	10,749	212.4	Includes: 34 headwalls 14 weirs 1 floodgate 816 m of pipes	Rated drains installed progressively from the 1850s, with the purpose of lowering groundwater for the productive use of land. Scheme discharges to Te Waihora/ Lake Ellesmere.	Birdlings Brook, Boggy Creek, Boyce Stream, Doyleston Drain, Hanmer Road Drain, Harts Creek, Leeston Creek, Waikewai Creek
Taumutu	986	10.4	Includes: 7 headwalls 308 m of pipes	Rated drains installed progressively from the 1850s, with the purpose of lowering groundwater for the productive use of land. Scheme discharges directly to the coast.	Cryers Creek, Jollies Brook, Lee River, Tent Burn, Youngs Creek, Muriwai/Coopers Lagoon ¹

¹ Muriwai/Coopers Lagoon itself is excluded from this CMP as it is directly managed by Te Taumutu Rūnunga under its own management plan.

**Te Waihora/
Lake Ellesmere
Catchment Overview**

SELWYN DISTRICT RATED CATCHMENTS:

-  Ellesmere
-  Greenpark
-  Leeston
-  Taumutu
-  Ararira
-  Osbornes
-  Wairiri Valley

OTHER

-  Te Waihora/Lake Ellesmere surface water catchment
-  Subcatchments
-  Major waterways



Map © EDS Ecology, 2025 / www.eosecology.co.nz

Layer source: Waterways (River Environment Classification (REC); NIWA), hill shade (Land Information New Zealand; LINZ), rated catchments (Selwyn District Council), Te Waihora/Lake Ellesmere surface water catchment (REC; NIWA), roads (Esri vector tile service)

Basemap: LCDB v6 (Manaaki Whenua; Landcare Research)

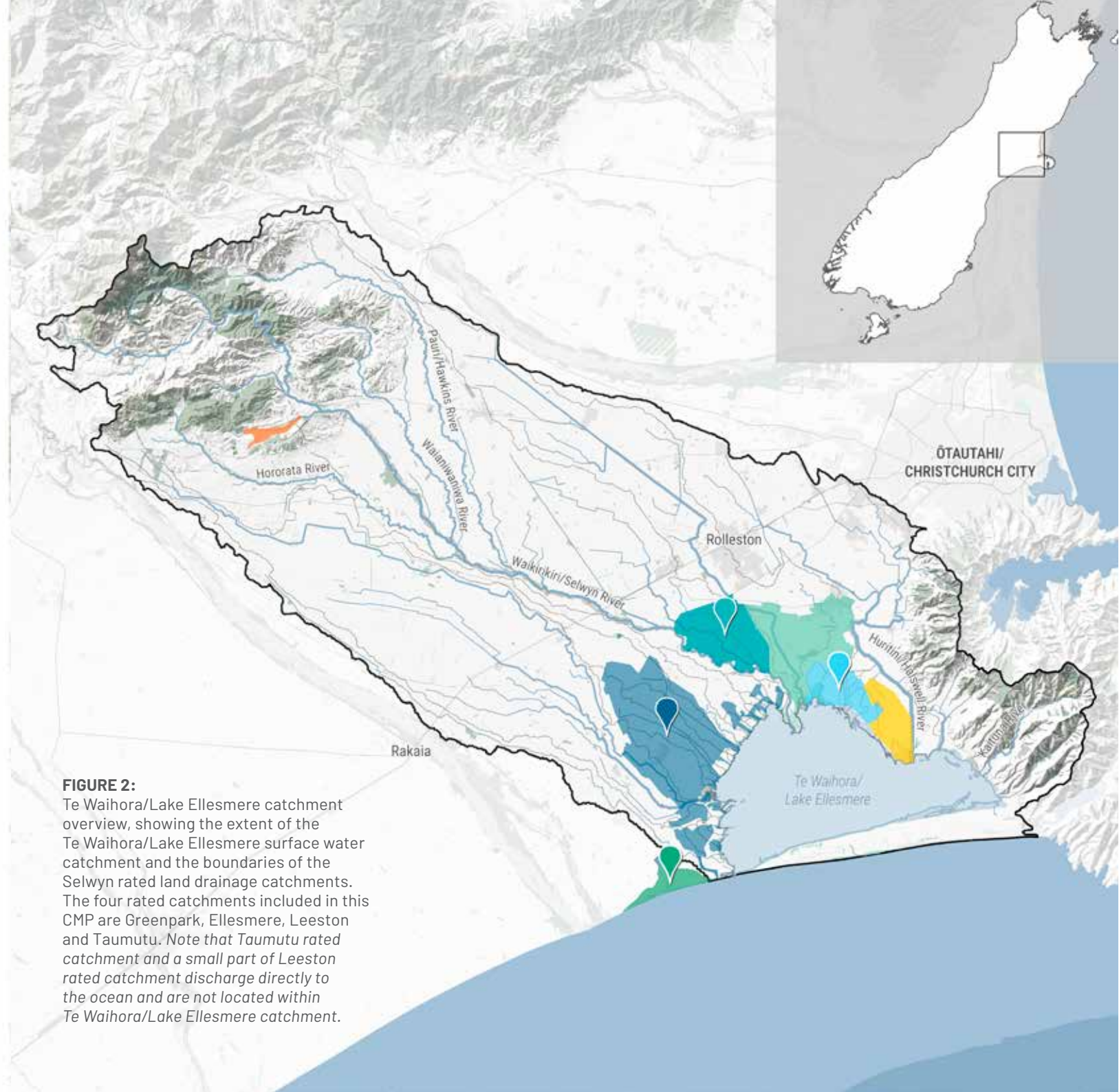


FIGURE 2:

Te Waihora/Lake Ellesmere catchment overview, showing the extent of the Te Waihora/Lake Ellesmere surface water catchment and the boundaries of the Selwyn rated land drainage catchments. The four rated catchments included in this CMP are Greenpark, Ellesmere, Leeston and Taumutu. Note that Taumutu rated catchment and a small part of Leeston rated catchment discharge directly to the ocean and are not located within Te Waihora/Lake Ellesmere catchment.



Looking north across Leeston catchment
and edge of Te Waihora, from Taumutu

Image source: EOS Ecology



Perennial tributary in the
Ellesmere catchment

Image source: EOS Ecology

2 Vision for the Greenpark, Ellesmere, Leeston & Taumutu Catchments

2.1 Vision & Values for Combined Greenpark, Ellesmere, Leeston & Taumutu CMP

The vision and values of the Greenpark, Ellesmere, Leeston, and Taumutu catchments have been developed by Te Komiti Waiora – District Land Drainage and Waterway Committee, consisting of representatives from Te Taumutu Rūnanga, Wairewa Rūnanga, Te Tuahuriri Rūnanga, Land Drainage Committee chairs, Te Rūnanga o Ngāi Tahu, Department of Conservation, Fish & Game, Lake Settlers Group, Eastern Plains Land User Group, Canterbury Regional Council, and Selwyn District Council.

Vision Statement

Our aim with this initiative is to see the catchment as a network that supports not just our waterways but also the people and ecosystems that depend on them. We're all about backing practices that are both innovative and healing for the land. By working together with everyone involved, we'll nurture a spirit of kaitiakitanga and careful management, making sure Te Waihora thrives now and for generations to come.

Key Value Baskets

The Mauri & Ecosystem Health of the Lake

- Taonga species protected.
- Native biodiversity.
- A healthy Te Waihora.
- Restore mauri of the waterways in the catchment.
- Ki uta ki tai – mountains to the sea approach to management of all waterways.
- Waipuna health – protecting & valuing springs & natural landscapes.

Thriving Communities – Providing for Current & Future Generations

- Resilient communities.
- Te Waihora lake management.
- Embracing innovation.
- Partnership approaches.
- Community engagement & participation.
- Common 'terminology' reflects values of environment & culture.
- Clear & agreed management strategy for catchment.

A Healthy Lake Supports Healthy People

- Recognising our social history.
- Connected people to land.
- Can swim in Te Waihora.
- Recreation & educational opportunities.
- Well-monitored & integrated water quality monitoring.
- Ahi kā – recognising people – past, present & future.

A Prosperous Land- & Water-based Economy is Maintained

- Drainage system that supports social resilience.
- Land use supports people/communities.
- Regenerative practices for all land use.
- Sustainable economy – includes research farms, etc.
- Reliable rural & urban drainage – protecting productive soils, farms & houses.
- Avoiding flooding & groundwater flooding.

2.2 Resource Consents

Selwyn District Council plans to apply for resource consents to continue operating and improving management of six land drainage schemes: Greenpark, Ararira/LII, Ellesmere, Leeston, Taumutu, and Wairiri Valley. These consents will cover routine maintenance of the rated drain network, which has been carried out for decades, as well as some improvement works within these catchments. Each catchment's CMP will outline these works in a 'toolbox' of interventions (see Sections 6 and 7). This toolbox will include practical measures designed to enhance ecological health and water quality within the land drainage network of waterways and channels, as well as recommended catchment-wide approaches to future management. The specific types and locations of interventions will be confirmed during the master planning stage (see Figure 1).

Based on the resource consent that will be applied for, routine maintenance activities will only occur in waterways designated as part of the land drainage network. However, other management works and interventions to improve ecological health and water quality may be carried out anywhere within the scheme boundaries. In addition to land use consent for maintenance and other works, SDC requires a discharge permit for water released from the six land drainage schemes. The Wairiri scheme and part of the Ellesmere scheme discharges to the Waikirikiri/Selwyn River, while the Greenpark, Leeston, and Ararira/LII schemes directly discharge to Te Waihora/Lake Ellesmere. The Taumutu scheme (and a small part of the Leeston scheme) discharges directly to the coastal marine area.



Perennial channel in
Greenpark rated catchment

Image source: EOS Ecology



Roadside channel downstream of Leeston township, Leeston rated catchment

Image source: EOS Ecology

3 State of the Catchments

3.1 Past State

Across the Greenpark, Ellesmere, Leeston, and Taumutu catchments, podocarp forest was the dominant pre-human land cover, accounting for between 45% and 99% of each rated catchment (Table 2), but this changed with human settlement, urban growth, and farming intensification (Figure 3). Ellesmere was likely almost entirely covered in podocarp forest, while Leeston and Taumutu also supported extensive wetlands (Figure 4). Greenpark similarly contained wetland areas but additionally featured a strip of duneland extending across the mid-catchment.

TABLE 2:
Summary of the past land cover/vegetation type categories for Greenpark, Ellesmere, Leeston, and Taumutu catchments¹. This table uses modelled information to show the expected past vegetation cover of the catchment, in the absence of human intervention. Based on Bioeconomy Science Institute (formerly Manaaki Whenua – Landcare Research) potential vegetation pattern for New Zealand GIS layer (Leathwick, 2001).

Category	Greenpark		Ellesmere		Leeston		Taumutu ²		Further Details
	ha	%	ha	%	ha	%	ha	%	
Podocarp (native conifers)	1,579	76.4	3,503	98.7	7,812	73.6	445	45.5	Kahikatea-pukatea-tawa, Matai-kahikatea-totara, Kahikatea-totara and Rimu-matai-miro-totara/kamahi, Rimu-matai-miro-totara/kamahi forest types.
Wetlands	219	10.6	-	-	2,767	26.1	532	54.5	Wetlands occur where the water table is at or near the surface of the land, or where the land is covered by water, either permanently or temporarily. They can include streams, swamps, bogs, lakes, lagoons, estuaries, mudflats, and flood plains. Most extensive in the lowlands of Northland, Waikato, coastal Bay of Plenty, and Southland.
Dunelands	238	11.5	-	-	-	-	-	-	Hilly areas of sand found behind beaches, most extensive along the west coast of the North Island in Northland, Auckland, Waikato, and Manawatū, and in coastal Canterbury and Southland.
Unclassified	31	1.5	47	1.3	31	0.3	-	-	Unclassified areas include permanent snow and ice, rivers, lakes, urban areas etc.

¹ Catchment areas calculated from GIS files that have been used in the preparation of this CMP.
² The total area includes a portion of the coastal marine area which is not included in the vegetation cover classifications.

Past State

PRE 1330 AD Pre-human Settlement



Te Waihora/Lake Ellesmere was predominantly a freshwater lake with infrequent natural openings to the sea, at which time it would become brackish. The area of the lake would become substantially larger than it is today before a natural opening would occur. Outside of the lake, the natural vegetation would have been dominated by podocarp forest (native conifers).

1330 ONWARDS Māori Settlement



The plentiful resources and mahinga kai of Te Waihora/Lake Ellesmere made it a focus of Māori settlement, with many wāhi taonga/significant places located around Te Waihora/Lake Ellesmere, including pā/fortified settlements, kāinga/unfortified settlements, and urupā/burial grounds (Department of Conservation & Te Rūnanga o Ngāi Tahu, 2005).

1800 ONWARDS European Settlement



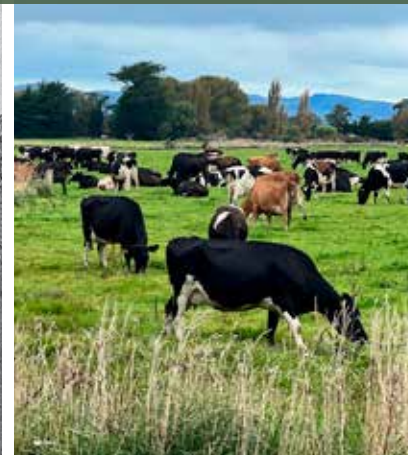
As farming established around Te Waihora/Lake Ellesmere from the 1840s, there became a need to maintain lower lake levels to provide for this. Regular openings of Te Waihora/lake Ellesmere began in 1868.

1860 S ONWARDS Urban Creation



Leeston was established in 1864 as a service centre for the surrounding farmlands and is now the main urban area within these catchments. This image from an 1899 issue of the Canterbury Times shows the developing town centre. Image source: Christchurch City Libraries, item identifier CCL-Selwyn-PA160773.

1980 S ONWARDS Urban Growth & Farming Intensification



In recent decades, these catchments have seen an intensification of farmland and further urban expansion.

FIGURE 3:

A visual history of the changing states of the Greenpark, Ellesmere, Leeston, and Taumutu catchments.



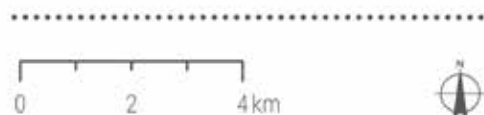
Te Waihora Lowlands Pre-human Vegetation

VEGETATION TYPES:

- Podocarp (native conifers)
- Rimu-matai-broadleaf
- Wetlands (partial)
- Dunelands
- Unclassified

OTHER:

- Surface water catchment
- Land drainage catchment (rated)
- Rated drain
- Roads



Map © EOS Ecology, 2025 / www.eosecology.co.nz

Layer source: Vegetation types (Manaaki Whenua; Landcare Research), surface water catchment (River Environment Classification (REC); NIWA), land drainage catchment & rated drains (Selwyn District Council), hill shade (LINZ), roads (Esri vector tile service).

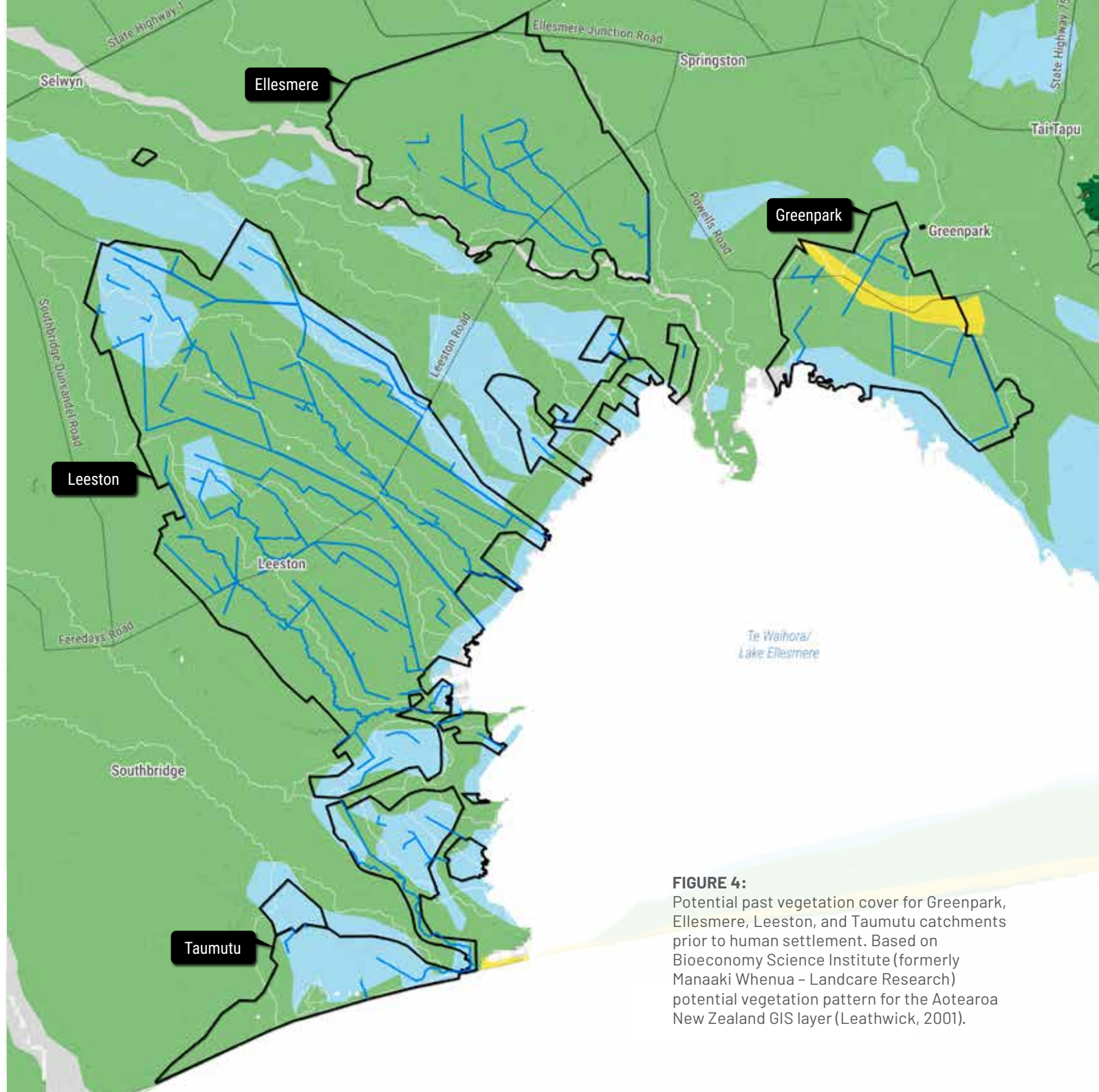


FIGURE 4:

Potential past vegetation cover for Greenpark, Ellesmere, Leeston, and Taumutu catchments prior to human settlement. Based on Bioeconomy Science Institute (formerly Manaaki Whenua – Landcare Research) potential vegetation pattern for the Aotearoa New Zealand GIS layer (Leathwick, 2001).

3.2 Present State

3.2.1 Present Land Cover/Vegetation Types

Across the Greenpark, Ellesmere, Leeston, and Taumutu catchments, farming land cover is dominant, accounting for between 87% and 98% of each rated catchment (Table 3; Figure 5). Ellesmere has the highest proportion of farming land cover at 98%, with only very small areas of exotic forest, natural bare/ lightly vegetated, and exotic scrub/shrubland present. In Greenpark, an area classified as ‘other herbaceous’ corresponds to the reserve near the lake margins and may include freshwater or saline vegetation, along with pockets of indigenous scrub/shrubland and water bodies in the same area. Leeston is similarly dominated by farming land cover but is the only catchment with a substantial urban area, although this still represents less than 2% of its total area. Given the ongoing expansion of the Leeston urban area, this percentage is likely to be slightly higher than that presented in Table 3, as the underlying source data is from early 2024. While Taumutu rated catchment is also predominantly farmed, it includes almost 5% water bodies and a further 5% natural bare or lightly vegetated land cover along its coastal margins.

TABLE 3:

Summary of the land cover types present within Greenpark, Ellesmere, Leeston, and Taumutu rated catchments. Based on Bioeconomy Science Institute (formerly Manaaki Whenua – Landcare Research) Land Cover Database (LCDB) version 6, that was published in 2025 but includes data through to the summer of 2023/2024.

Category	Greenpark		Ellesmere		Leeston		Taumutu		Land Cover Database Version 6 (LCDB6) map layers combined into the category shown in the map
	ha	%	ha	%	ha	%	ha	%	
Artificial bare – Urban	–	–	–	–	198	1.8	–	–	Built-up Area (settlement), Surface Mines and Dumps, Transport Infrastructure, Urban Parkland/Open Space
Farming – Exotic grassland/ cropping/ horticulture	1,805	86.9	3,488	98.3	10,253	96.5	859	87.3	High Producing Exotic Grassland, Low Producing Grassland, Orchard Vineyard & Other Perennial Crops, Short-rotation Cropland
Forest – Exotic	28	1.4	48	1.4	71	0.7	13	1.3	Deciduous Hardwoods, Exotic Forest, Forest Harvested
Forest – Indigenous	–	–	–	–	–	–	–	–	Broadleaved Indigenous Hardwood, Indigenous Forest
Other herbaceous	158	7.6	–	–	95	0.9	17	1.7	Flaxland, Herbaceous Freshwater Vegetation, Herbaceous Saline Vegetation
Scrub/shrubland – Exotic	–	–	3	<0.1	0.4	<0.1	–	–	Gorse and/or Broom, Mixed Exotic Shrubland
Scrub/shrubland – Indigenous	27	1.3	–	–	–	–	–	–	Fernland, Mangrove, Manuka and/or Kanuka, Matagouri or Grey Scrub, Sub Alpine Shrubland
Tussock grassland	–	–	–	–	–	–	–	–	Tall Tussock Grassland
Water bodies	58	2.8	–	–	8	0.1	47	4.8	Estuarine Open Water, Lake or Pond, River
Natural bare/ lightly-vegetated	–	–	10	0.3	2	<0.1	48	4.9	Alpine Grass/Herbfield, Gravel or Rock, Landslide, Permanent Snow and Ice, Sand or Gravel



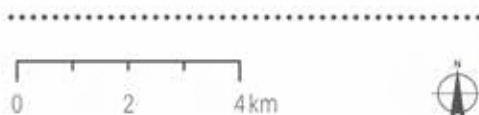
Te Waihora Lowlands Present Land Cover

LAND COVER/VEGETATION TYPES:

- Water bodies
- Natural bare/lightly-vegetated
- Artificial bare/urban
- Scrub/shrubland – Exotic
- Scrub/shrubland – Indigenous
- Forest – Indigenous
- Forest – Exotic
- Other herbaceous
- Farming
(exotic grassland/cropping/horticulture)

OTHER:

- Surface water catchment
- Land drainage catchment (rated)
- Rated drain
- Roads



Map © EOS Ecology, 2025 / www.eosecology.co.nz

Layer source: Vegetation types (Manaaki Whenua; Landcare Research), surface water catchment (River Environment Classification (REC); NIWA), land drainage catchment & rated drains (Selwyn District Council), hill shade (LINZ), roads (Esri vector tile service)



FIGURE 4:
Present land cover/vegetation types for Greenpark, Ellesmere, Leeston, and Taumutu rated catchments, based on modelled information from the Bioeconomy Science Institute (formerly Manaaki Whenua – Landcare Research).

3.2.2 Soil Types

Soil orders provide a broad national-level classification, with 15 orders recognised across Aotearoa New Zealand (Hewitt, 2013). According to modelled data from the New Zealand Soils Classification (NZSC), gley soils dominate the Greenpark, Ellesmere, Leeston, and Taumutu catchments (Table 4; Figure 6). While Ellesmere also contains a relatively high proportion of pallic soils (34%), the other catchments have only minor amounts of this soil type. Raw and recent soils occur across all catchments but are in relatively small proportions for Ellesmere and Leeston rated catchments. However, the Taumutu rated catchment has more than 20% recent soils and Greenpark contains around 12% raw soils.

Gley soils are saturated because of high groundwater levels or perched water tables and are low in oxygen (Hewitt *et al.*, 2021). Where they have not been drained, the vegetation is limited to wetland plants that are more tolerant of wet and low oxygen conditions. As gley soils represent typical wetland soil types, they can indicate the past extent of wetlands and often align with poor soil drainage, as is the case here (see Section 3.2.3).

Pallic soils, which are the second-most abundant soil type in the Ellesmere catchment, tend to have weak structure, high density, slow permeability, and high susceptibility to erosion and dispersion. When the protective surface soil layer is removed, highly erodible loess¹ subsoil is exposed. Loess tends to be internally homogenous with low permeability, resulting in high runoff coefficients (low infiltration rates). It is also highly prone to dispersion (i.e., rapidly dissolves in water), allowing it to be easily broken down and washed away. This creates challenges because, once these soils enter waterways, they are difficult to settle out.

¹ Loess is the primary parent material for pallic soils (Hewitt *et al.*, 2021).

TABLE 4:

Summary of the soil groups present within Greenpark, Ellesmere, Leeston, and Taumutu rated catchments¹, based on modelled data from S-map Online (accessed August 2025).

NZSC Soil Order	Greenpark		Ellesmere		Leeston		Taumutu ²		Description See this URL for further information on soil classification https://soils.landcareresearch.co.nz/topics/soil-classification
	ha	%	ha	%	ha	%	ha	%	
Gley	1,512	73.0	1,726	48.6	9,396	88.4	586	63.1	Light grey subsoils that together with 'organic' soils, represents the original extent of our wetlands. High groundwater tables, so strongly affected by waterlogging in winter/spring and can remain wet all year. Chemically reduced, organic matter high, soil organisms restricted due to anaerobic conditions.
Organic	–	–	–	–	545	5.1	–	–	Formed by partly decomposed remains of wetland plants (peat) or forest litter. Together with 'gley' soils, represents the original extent of our wetlands. Acts like a sponge, holding 20 times their weight in water. Low bulk densities (light soils), high shrinkage when dried. Strong-extremely acid, nutrient-deficient, organic matter high, soil organisms restricted due to anaerobic conditions.
Brown	162	7.8	372	10.5	–	–	–	–	Brown/yellow brown subsoil below dark grey-brown topsoil. Relatively stable topsoils, and biologically active (lots of soil organisms, especially earthworms). Occur where summer droughts and waterlogging in winter are uncommon. Most extensive soils, covering 43% of New Zealand.
Recent	152	7.3	164	4.6	240	2.3	214	23.0	Weakly developed, showing limited signs of soil-forming processes. Found on young land surfaces (alluvial floodplains, unstable steep slopes, slopes with volcanic ash). High spatial variability and variable soil texture. Deep rooting, high plant-available water capacity, high natural fertility; normally has a well established cover of vascular plants.
Pallic	–	–	1,219	34.3	407	3.8	69	7.4	Pale coloured subsoil due to low iron oxide content. Weak structure and high density (heavy soils – a cubic metre can weight >1.8 tonnes), that are dry in summer and wet in winter. Slow permeability with limited rooting depth. Susceptible to erosion due to potential for slaking and dispersion. Med-high nutrient content, strongly worm-mixed at the A-B horizon boundary.
Raw	244	11.8	69	1.9	29	0.3	60	6.5	Infant soils that may never grow older/lack distinct topsoil development because of active erosion, rockiness, or sedimentation. Associated with mountains, braided rivers, estuaries/beaches. High water table, limited fertility, nitrogen-deficient, little organic matter. Only sparse vegetation (moss, lichen, ephemeral herbaceous plants).

¹ Catchment areas calculated from GIS files that have been used in the preparation of this CMP.



Te Waihora Lowlands Soil Types

SOIL GROUP:

- Gley
- Organic
- Brown
- Recent
- Pallic
- Raw

OTHER:

- Surface water catchment
- Land drainage catchment (rated)
- Rated drain
- Roads

0 2 4 km



Map © EOS Ecology, 2025 / www.eosecology.co.nz

Layer source: Soil groups (Manaaki Whenua; Landcare Research), surface water catchment (River Environment Classification (REC); NIWA), land drainage catchment & rated drains (Selwyn District Council), hill shade (LINZ), roads (Esri vector tile service)

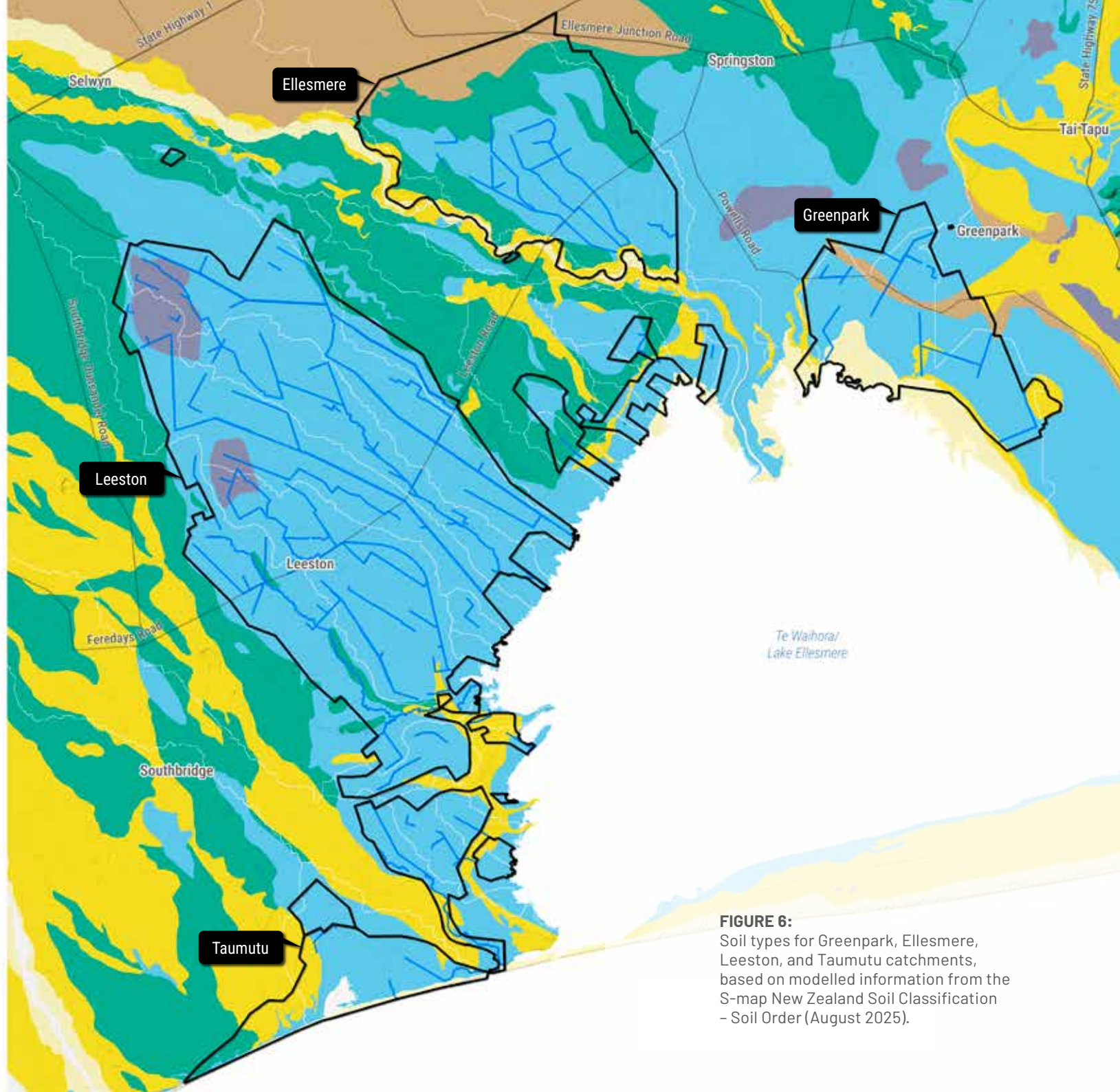


FIGURE 6:
Soil types for Greenpark, Ellesmere, Leeston, and Taumutu catchments, based on modelled information from the S-map New Zealand Soil Classification - Soil Order (August 2025).



Perennial inlet channel to Muruwai/
Coopers Lagoon, Taumutu rated catchment

Image source: EOS Ecology

3.2.3 Soil Drainage

According to modelled information from S-map Online (Bioeconomy Science Institute, formerly Manaaki Whenua – Landcare Research), soil drainage characteristics within the Greenpark, Ellesmere, Leeston, and Taumutu catchments range from very poorly drained to well drained (Table 5; Figure 7). The Greenpark catchment contains the highest proportion of very poorly drained land, while Ellesmere has the highest proportion of well-drained soils. Overall, Greenpark is dominated by very poorly drained soils, whereas the Ellesmere, Leeston, and Taumutu catchments are predominantly characterised by poorly drained soils (Figure 7). Such poor soil drainage has ultimately driven the creation of these drainage schemes, to enable productive farming in these areas.

TABLE 5:
Summary of the soil drainage characteristics present within Greenpark, Ellesmere, Leeston, and Taumutu rated catchments¹, based on modelled data from S-map Online (accessed August 2025).

Category	Greenpark		Ellesmere		Leeston		Taumutu		Description
	ha	%	ha	%	ha	%	ha	%	See this URL for further information on soil drainage characteristics https://soils.landcareresearch.co.nz/topics/soil-classification
Well drained	268	12.9	691	19.5	154	1.5	129	14.0	Soils that have no horizon within 90 cm of the mineral soil surface with more than 2% or more redox segregations.
Moderately well drained	-	-	116	3.3	171	1.6	139	14.9	Soils that have a horizon between 60-90 cm of the mineral soil surface with 50% or more low chroma mottles on cut faces OR soils that have a horizon between 30-90 cm of the mineral soil surface with 2% or more redox segregations.
Imperfectly drained	46	2.2	1,017	28.6	325	3.1	75	8.1	Soils that have a horizon between 30-60 cm of the mineral soil surface with 50% or more low chroma mottles on cut faces, OR soils that have in the top 30 cm of the profile or within 15 cm of the base of the A-horizon, 2% or more redox segregations or 50% or less low chroma colours on cut faces.
Poorly drained	614	29.7	1,726	48.6	8,967	84.4	403	43.4	Soils that are within 15 cm of the base of the A-horizon, or within 30 cm of the mineral soil surface, have 50% or more low-chroma colours on cut faces.
Very poorly drained	1,142	55.2	-	-	999	9.4	182	19.6	Peaty topsoil OR soils with 50% or more low-chroma colours on cut faces at less than 10 cm from the mineral soil surface.

¹ Catchment areas calculated from GIS files that have been used in the preparation of this CMP.



Te Waihora Lowlands Soil Drainage

SOIL DRAINAGE:

- Well drained
- Moderately well drained
- Imperfectly drained
- Poorly drained
- Very poorly drained

OTHER:

- Surface water catchment
- Land drainage catchment (rated)
- Rated drain
- Roads



Map © EOS Ecology, 2025 / www.eosecology.co.nz

Layer source: Soil drainage (Manaaki Whenua; Landcare Research), surface water catchment (River Environment Classification (REC); NIWA), land drainage catchment & rated drains (Selwyn District Council), hill shade (LINZ), roads (Esri vector tile service)

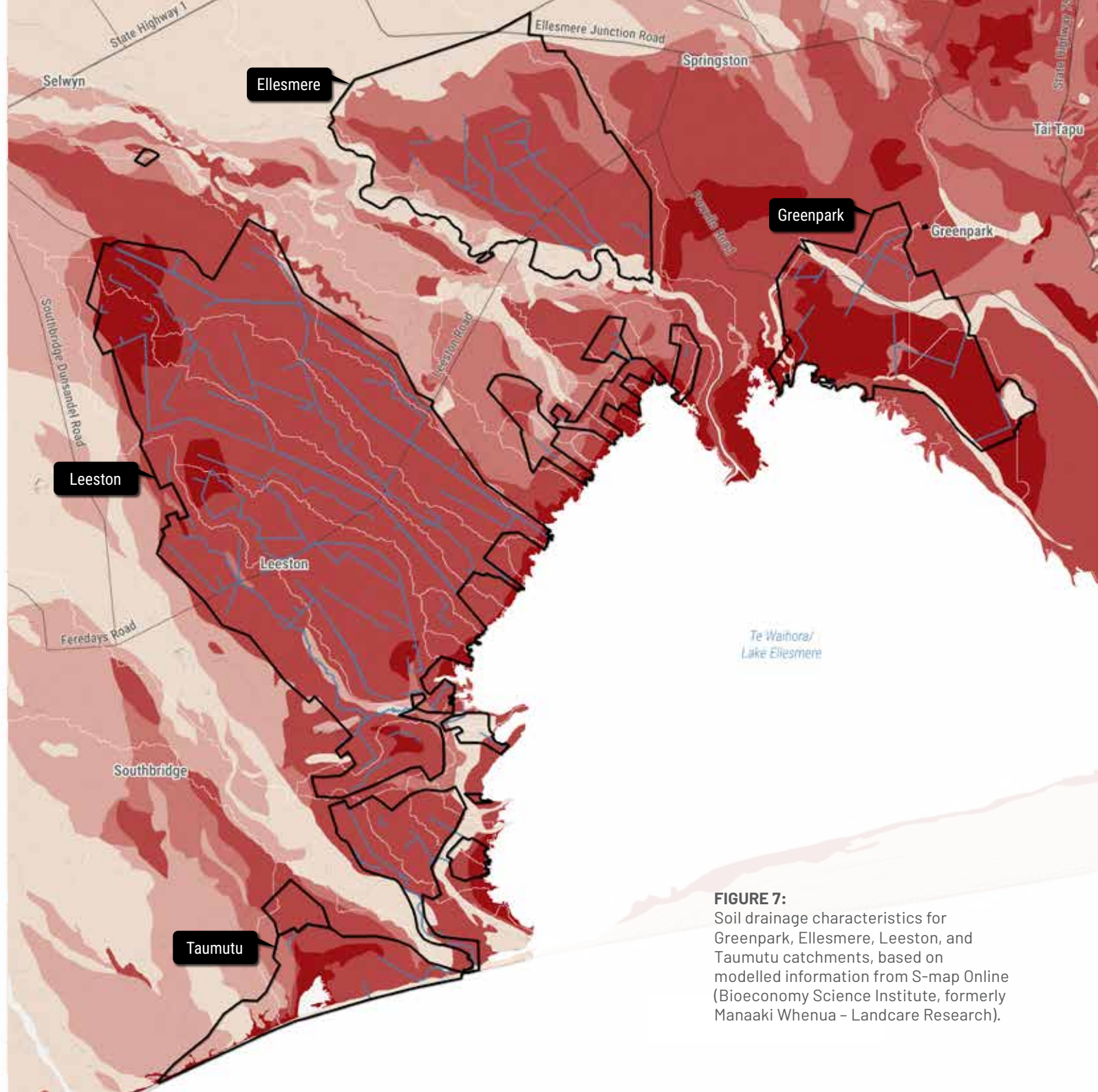


FIGURE 7: Soil drainage characteristics for Greenpark, Ellesmere, Leeston, and Taumutu catchments, based on modelled information from S-map Online (Bioeconomy Science Institute, formerly Manaaki Whenua – Landcare Research).

3.2.4 Protected Areas

There are small, protected areas within each of the Greenpark, Ellesmere, Leeston, and Taumutu rated catchments, including reserves, conservation areas, marine areas, and QEII open space (Table 6; Figure 8). Greenpark has the highest proportion of protected land, although this still accounts for less than 8% of the rated catchment area, with most reserves and conservation areas concentrated around the margins of Te Waihora/Lake Ellesmere at the lower end of the catchment. In comparison, the Ellesmere, Leeston, and Taumutu each have less than 3% of their area protected, typically as small, isolated reserves (Figure 8).

TABLE 6:

Summary of the protected areas present within Greenpark, Ellesmere, Leeston, and Taumutu rated catchments¹.

Data Source	Protected Area Type	Greenpark		Ellesmere		Leeston		Taumutu	
		ha	%	ha	%	ha	%	ha	%
LINZ	Reserve	102	4.9	45	1.3	113	1.1	12	1.3
	Conservation area	51	2.5	–	–	<1	<0.1	6	0.6
	Marine area ²	–	–	–	–	–	–	9	0.9
QEII Trust	Open Space Covenant	–	–	1	<0.1	–	–	–	–

¹ Catchment areas calculated from GIS files that have been used in the preparation of this CMP.

² The inclusion of the ‘marine area’ classification is due to the Taumutu rated catchment boundary extending into the coastal marine area.



Te Waihora Lowlands Protected Areas

PROTECTED AREA TYPE:

Land Information New Zealand

- Reserve
- Conservation area
- Marine area

QEII Trust

- Open space covenant

OTHER:

- Surface water catchment
- Land drainage catchment (rated)
- Rated drain
- Roads



Map © EOS Ecology, 2025 / www.eosecology.co.nz

Layer source: Protected areas (Land Information New Zealand; LINZ), conservation covenant (DOC), open space covenant (Queen Elizabeth II National Trust/Ngā Kairauhi Papa), surface water catchment (River Environment Classification (REC); NIWA), land drainage catchment & rated drains (Selwyn District Council), hill shade (LINZ), roads (Esri vector tile service)

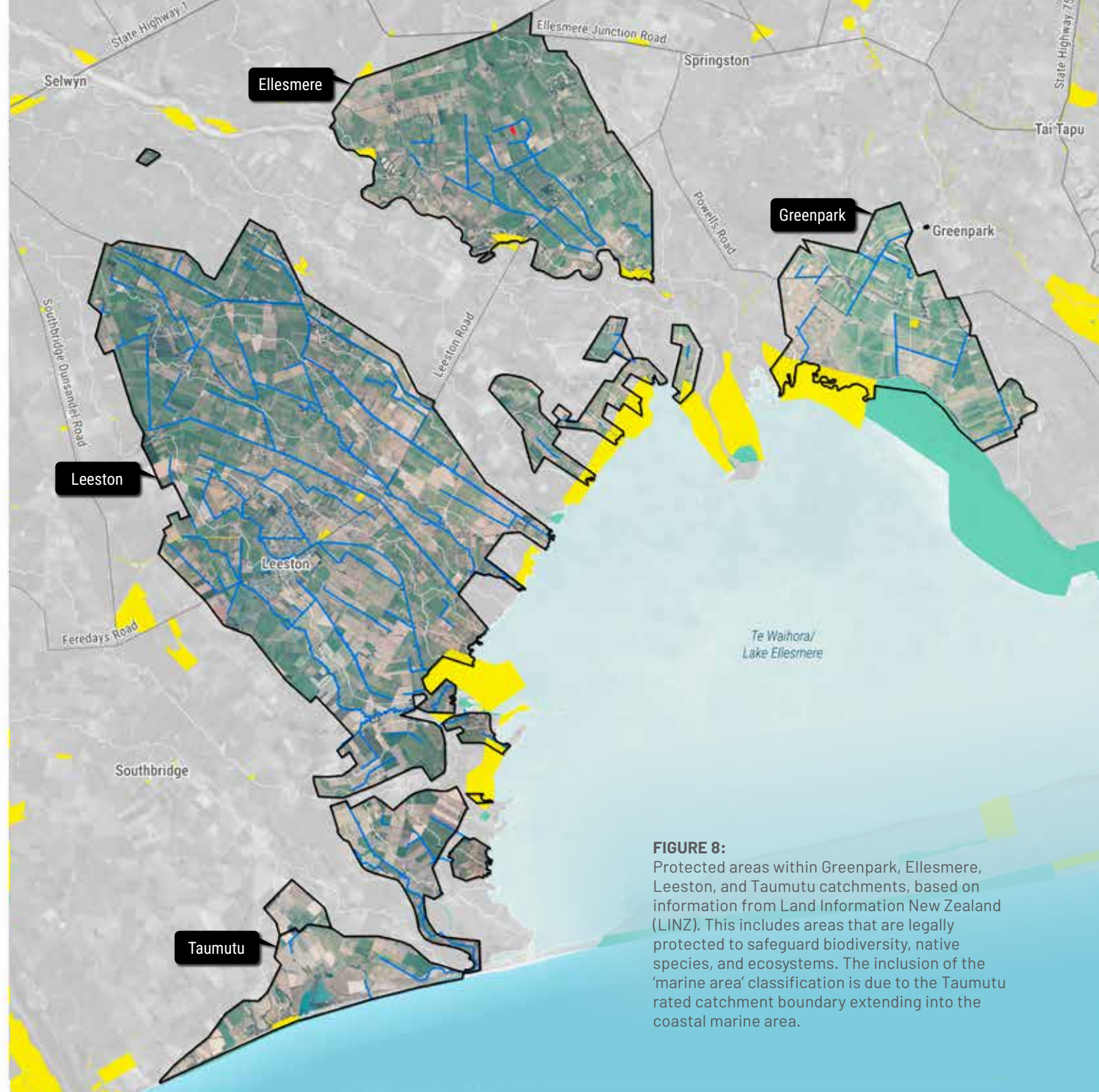


FIGURE 8:

Protected areas within Greenpark, Ellesmere, Leeston, and Taumutu catchments, based on information from Land Information New Zealand (LINZ). This includes areas that are legally protected to safeguard biodiversity, native species, and ecosystems. The inclusion of the 'marine area' classification is due to the Taumutu rated catchment boundary extending into the coastal marine area.

3.2.5 Waterway Types

The Greenpark, Ellesmere, Leeston, and Taumutu catchments comprise a network of both natural waterways and artificial drainage channels. Within each rated catchment, waterways include those that are rated as part of the SDC land drainage schemes and others that are unrated. All waterways in these catchments are classified within the ‘spring-fed plains’ water management unit of the Canterbury Land and Water Regional Plan (LWRP). Collectively, these drains and waterways function to lower the groundwater table for land drainage purposes and to convey surface runoff from the catchment. In some locations, the rated catchments form part of much broader surface water and groundwater catchments. Many of the smaller drains and waterways in these catchments are unrated and a large proportion appear to be intermittent or ephemeral (Figure 9). However, these unrated waterways often feed into rated waterways. The Greenpark, Ellesmere, and Leeston catchments discharge to Te Waihora/Lake Ellesmere, while the Taumutu catchment (and a very small part classified as the Leeston rated catchment at the upstream end of the Taumutu rated catchment) discharge via culverts directly to the coastal marine area.

Aside from the Greenpark rated catchment, several named waterways intersect each of the rated catchments (Table 1). Many of these waterways are natural or have been modified from natural channels rather than being entirely artificially constructed drains. However, over time they have become closely integrated with the rated drainage networks and may be included within the classified or rated drain length for each catchment.

Within the Greenpark, Ellesmere, Leeston, and Taumutu catchments, we have recognised several waterway types, which can be distinguished by their flow and habitat characteristics, including perennial waterways (rated and unrated), intermittent or ephemeral waterways (rated and unrated), and informal or overland flow paths that convey surface runoff during prolonged or heavy rainfall events (Table 7; Figure 9). Further details about the waterway types within these catchments are provided below.

As part of developing this CMP, a more accurate waterway layer was created for the Greenpark, Ellesmere, Leeston, and Taumutu catchments, with ground-truthing playing a key role in the process (Painter & Dow, 2024). Existing waterway layers are often insufficiently detailed for catchment management planning at this scale, particularly where identifying suitable locations for tools, solutions, or interventions is required. Waterway channels were initially derived using digital elevation model (DEM) data and then field-confirmed where possible. Due to the large spatial extent of this CMP, it was not feasible to ground-truth all waterways.

Whilst there are no officially recorded springs in the Greenpark catchment, the Ellesmere, Leeston, and Taumutu catchments include numerous springs (Figure 9). Some of these springs discharge directly into waterways, while others emerge as springheads within paddocks. The location and extent of spring discharge may vary over time in response to weather conditions and irrigation patterns. Springheads are typically visible as persistently wet or muddy areas within otherwise dry land, and the water they discharge often follows informal flow paths before entering the nearest drainage channel.

TABLE 7:
Waterway types present within Greenpark, Ellesmere, Leeston, and Taumutu rated catchments. Classification of perennial versus intermittent/ephemeral flow types may be less accurate in some areas due to limited time for ground-truthing and the inability to access areas not visible from the road. Includes rated and unrated waterways and drainage channels.

PC = Perennial channels
I/EC = Intermittent or ephemeral channels
NA = Not assessed
WR = Water race
I/OFL = Informal/overland flow paths

Waterway Type		Greenpark				Ellesmere					Leeston				Taumutu			
		PC	I/EC	NA	I/OFL	PC	I/EC	NA	WR	I/OFL	PC	I/EC	NA	I/OFL	PC	I/EC	NA	I/OFL
Length ¹	km	1.2	72.7	0.6	113.5	32.2	52.3	0.7	0.8	287.1	75.5	275.3	4.5	887.9	8.5	9.2	0.3	82.7
	% of channel	1.7	97.6	0.7	Not included in calculation	37.5	70.2	0.8	1.0	Not included in calculation	21.5	78.5	1.3	Not included in calculation	47.2	51.1	1.8	Not included in calculation
	% of channel & overland flow path	0.7	38.7	0.3	60.4	8.6	14.0	0.2	0.2	76.9	6.1	22.2	0.4	71.7	8.4	9.1	0.3	82.2

¹ Length calculated from a combination of Geographic Information System (GIS) analysis of 2023 Light Detection and Ranging (LiDAR) data and field data interpretation.



Te Waihora Lowlands Waterway Types

FLOW PERMANENCY:

- Looks ephemeral/intermittent
- Looks perennial
- Not assessed

WATER RACE SCHEME:

- Ellesmere
- Malvern
- Paparua

OTHER:

- Surface water catchment
- Land drainage catchment (rated)
- Rated drain
- Roads
- Springs



Map © EOS Ecology, 2025 / www.eosecology.co.nz

Layer source: Waterways (EOS Ecology), springs (Environment Canterbury via CanterburyMaps), water race (Selwyn District Council (SDC) via Environment Canterbury), land drainage catchment & rated drains (Selwyn District Council), hill shade (Land Information New Zealand; LINZ), roads (Esri vector tile service), imagery (LINZ)

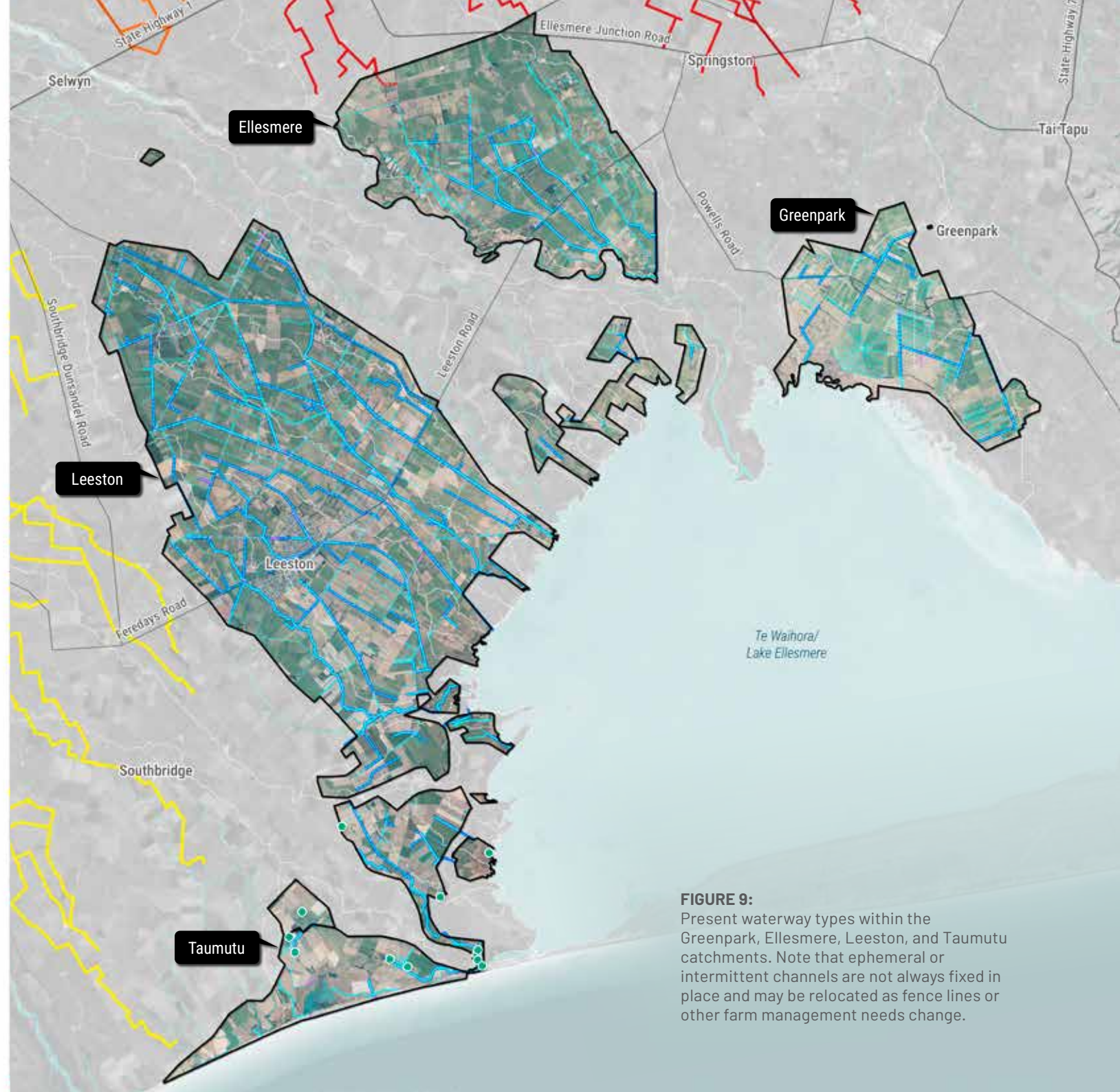


FIGURE 9:

Present waterway types within the Greenpark, Ellesmere, Leeston, and Taumutu catchments. Note that ephemeral or intermittent channels are not always fixed in place and may be relocated as fence lines or other farm management needs change.



Te Waihora Lowlands Flow Paths

Flow paths (incl waterways & overland flow)

WATER RACE SCHEME:

- Ellesmere
- Malvern
- Paparua

OTHER:

- Land drainage catchment (rated)
- Rated drain
- Roads



Map © EOS Ecology, 2025 / www.eosecology.co.nz

Layer source: Informal/overland flow paths (EOS Ecology), water race (Selwyn District Council (SDC) via Environment Canterbury), land drainage catchment & rated drains (SDC), hill shade (Land Information New Zealand; LINZ), roads (Esri vector tile service), imagery (LINZ)



FIGURE 10:

Flow paths (including waterways and overland flow as well as rated drains) present within Greenpark, Ellesmere, Leeston, and Taumutu catchments, generated using LiDAR to identify low points or depressions in the landscape that may act as flow paths during rainfall.

Flow Types

Overland/Informal Flow Paths

These depressions in the landscape are the routes taken by water during and shortly after rainfall. They may be visible as low areas or depressions on the landscape but there is no obvious channel, and they may be difficult to observe during dry weather. Informal or overland flow paths have been identified in the Greenpark, Ellesmere, Leeston, and Taumutu catchments using aerial photos and LiDAR (Figure 10).

ISSUES with informal flow paths include their tendency to act as critical source areas and contribute high levels of fine sediment and nutrients to nearby waterways during wet weather, as well as their widespread distribution within these catchments.



Informal flow paths are low areas or depressions on the landscape and are difficult to observe during dry weather. *Note that this image is from outside the catchment.*



During rainfall, water accumulates in depressions and follows informal flow paths to reach nearby drains (indicative photo, not from the rated catchments). *Note that this image is from outside the catchment.*



Informal flow paths continue to discharge water to drains following rainfall.

Ephemeral/Intermittent Waterways

Ephemeral waterways hold water only during and shortly after rainfall, while intermittent waterways flow for longer periods during the wetter months when soil moisture and groundwater levels are high. Both natural and artificially constructed ephemeral channels occur in these catchments, with natural channels typically having a meandering form, whereas artificial ones are often located along fence lines where they are straight and channelised. Intermittent waterways are generally wider and more deeply incised than ephemeral channels and many have been straightened or modified within the land drainage catchments, where they commonly interconnect with natural waterways.

ISSUES for these waterways include fine sediment accumulation, the potential to act as a source of fine sediment and nutrients during rain events, high requirements for weed and sediment control or removal, and steep banks which may be exacerbated by maintenance activities such as sediment excavation.



Ephemeral waterways occur throughout Greenpark, Ellesmere, Leeston, and Taumutu catchments, contributing surface flow to downstream waterways during rainfall. Ephemeral drainage channels are typically straight and may look like grassed swales if they rarely hold water.



Intermittent waterways flow during the wetter seasons and are typically more channelised than ephemeral waterways. Ephemeral drainage channels are typically straight and may look like grassed swales if they rarely hold water.



Intermittent waterways can experience seasonal growth of emergent macrophytes that spread across the channel as water levels drop, making them harder to control using bankside shading.

Perennial Waterways Rated & Unrated

Channels that hold water for most of the year. Both rated and unrated drainage channels are typically straight and highly modified, but there are also sections of remnant and original waterways that form part of the rated and unrated network that have more natural, meandering forms. Substrates range from coarse gravels in faster flowing sections to fine sediments in low-gradient areas, where slow velocities encourage soft sediment accumulation.

ISSUES for perennial waterways include high sediment input, steep banks, obstruction of channels by willows, and poor water quality. Waterways that have flowed perennially for several years may become intermittent for a time if there is a significant change in climate or groundwater inputs.



There are sections of natural waterway that form part of the rated and unrated network.



Perennial waterways towards the lake and coast can be slow flowing, often with fine sediment on the channel bed and steep banks that are prone to erosion.



Perennial waterways can be fed by spring flow. They can sometimes be identified by the presence of macrophytes that do not tolerate drying, such as *Potamogeton cheesemanii*.

Springs

Two main types of artesian spring are likely present in Ellesmere, Leeston, and Taumutu catchments. These include springs that discharge within the waterways and those that form a springhead on the land. The location of these springs may change over time, in response to weather conditions and irrigation patterns. Springheads are typically visible as wet or muddy areas in otherwise dry land and the water they discharge may follow informal flow paths to the nearest drainage channel.

ISSUES with springs include their potential to contribute fine sediments to downstream waterways, especially when stock are not excluded from accessing springs.



Springs are identified by water bubbles in areas of otherwise still water.



A spring arising within an existing channel.



A planted and fenced springhead.



A large springhead in the Leeston catchment.

Water Race

The water race network only extends into the very upper-most extent of the Ellesmere rated catchment, with one terminal branch of the Paparua Stock Water Race scheme. Whilst there is only one actual water race channel that connects into the upper reaches of the Ellesmere rated catchment, the sheer size of the water race network across land to the north and west of the Ellesmere, Leeston and Taumutu rated catchments means that the surface water flow for some of the waterways in these rated catchments could be bolstered by the supply of water to the water race network which then discharges to ground to the north and west.

ISSUES with the water race network do not relate to any direct interaction but future closure of the water race networks that are upgradient of the rated catchments could have an influence on the flow regime (periodicity and volumes) in the rated catchment, if shallow groundwater mounding caused by the discharge of water race flow to ground currently supports drain flows in the rated catchment.

The Paparua water race scheme takes water from the Waimakriri River at Intake Road and via three main branches, feeds it across the landscape between Christchurch city, Lincoln, Springston and the Ellesmere rated catchment



3.2.6 Freshwater Ecology

Macroinvertebrates

Environment Canterbury has collected macroinvertebrate samples from sites in Ellesmere, Leeston, and Taumutu catchments for more than 20 years (Table 8; Figure 11). Over this period, the 11 Ellesmere sites recorded a median MCI of 94.2 and a QMCI of 4.95, indicating fair water quality. The 20 Leeston sites had a median MCI of 82.9 and a QMCI of 3.55, reflecting fair to poor water quality. In the Taumutu catchment, the three monitoring sites recorded a median MCI of 73.3 and a QMCI of 3.60, indicating poor water quality. There are no Environment Canterbury macroinvertebrate monitoring sites within the Greenpark catchment.

Environmental DNA (eDNA) surveys undertaken in 2024 for this CMP show that waterways within the Ellesmere, Leeston, and Taumutu catchments support numerous cleanwater Ephemeroptera, Plecoptera, and Trichoptera (EPT) taxa, while no EPT taxa were detected in the Greenpark samples (Table 9). Traditional macroinvertebrate sampling recorded a median of six EPT taxa in the Ellesmere catchment (Table 8), while eDNA detected seven taxa at genus level. Similarly, traditional macroinvertebrate sampling recorded a median of four EPT taxa in the Leeston catchment, while eDNA detected 11 EPT taxa at the genus level in this catchment.

Together, the traditional and eDNA results indicate that Ellesmere and Leeston support the highest diversity of cleanwater taxa followed by Taumutu, whereas Greenpark supports the most degraded macroinvertebrate community. Consistent with this, waterways in the Ellesmere, Leeston, and Taumutu catchments recorded eDNA Taxon Independent Community Index (TICI) values within the 'average' interpretation band (Wilkinson *et al.*, 2024), while Greenpark fell within the 'poor' band (Table 9). Kōura/freshwater crayfish were detected by eDNA in Ellesmere, Leeston, and Taumutu catchments, but not in Greenpark.

TABLE 8:

Summary of median aquatic macroinvertebrate community metrics for ecological survey sites in Greenpark, Ellesmere, Leeston, and Taumutu rated catchments. Macroinvertebrate data provided by Environment Canterbury and covering the period between November 1999 and November 2022 (this table includes material sourced from Hilltop Manager database and the SOE stream health dataset stored in the Streamhealth MS Access database, which is licensed under a Creative Commons Attribution 4.0 International licence by Environment Canterbury). The MCI/QMCI interpretation categories of Stark & Maxted (2007) are shown in parentheses.

	Greenpark	Ellesmere	Leeston	Taumutu
Number of ecology survey sites within catchment	0	11	20	3
Number of samples	0	112	157	11
Taxa richness	NA	14	15	12
EPT taxa richness (excl. Hydroptilidae)	NA	6	4	2
%EPT abundance (excl. Hydroptilidae)	NA	42.4	10.78	1.92
Macroinvertebrate Community Index (MCI)	NA	94.2 (Fair)	82.9 (Fair)	73.3 (Poor)
Quantitative Macroinvertebrate Community Index (QMCI)	NA	4.95 (Fair)	3.55 (Poor)	3.60 (Poor)

TABLE 9:
Summary of aquatic invertebrates found in Greenpark, Ellesmere, Leeston, and Taumutu rated catchments, based on eDNA surveys by EOS Ecology (for this CMP). Macroinvertebrate cleanwater taxa (Ephemeroptera, Plecoptera, & Trichoptera) detected to genus level are listed, as are megainvertebrate detections (i.e., kōura and kākahi).

	Greenpark	Ellesmere	Leeston	Taumutu
Number of eDNA sampling sites	2	2	11	3
Taxon Independent Community Index (TICI) median, with Wilkinson <i>et al.</i> , (2024) interpretation bands	85.50 (Poor)	94.19 (Average)	92.85 (Average)	94.59 (Average)
Ephemeroptera (mayfly) genus detected	None recorded	<i>Neozephlebia</i>	<i>Austroclima</i> <i>Coloburiscus</i> <i>Neozephlebia</i>	<i>Neozephlebia</i>
Plecoptera (stonefly) genus detected	None recorded	None recorded	<i>Zelandobius</i>	None recorded
Trichoptera (caddisfly) genus detected	None recorded	<i>Aoteapsyche</i> <i>Hudsonema</i> <i>Oeconesus</i> <i>Psilochorema</i> <i>Pycnocentria</i> <i>Triplectides</i>	<i>Aoteapsyche</i> <i>Hudsonema</i> <i>Hydrobiosis</i> <i>Oeconesus</i> <i>Psilochorema</i> <i>Pycnocentria</i> <i>Triplectides</i>	<i>Oecetis</i> <i>Psilochorema</i> <i>Triplectides</i>
Megainvertebrates detected	None recorded	Kōura/ Freshwater crayfish (<i>Paranephrops</i> <i>zealandicus</i>)	Kōura/ Freshwater crayfish (<i>Paranephrops</i> <i>zealandicus</i>)	Kōura/ Freshwater crayfish (<i>Paranephrops</i> <i>zealandicus</i>)



Te Waihora Lowlands Invertebrate Indices

INVERTEBRATE INDICIES:

MCI Score Band
(conventional data)

- Good
- Fair
- Poor

TICI Score Band
(eDNA data)

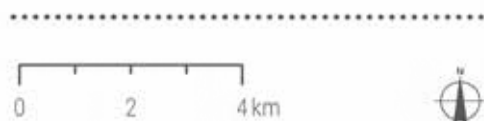
- Good
- Average
- Poor

FLOW PERMANENCY:

- Looks ephemeral/intermittent
- Looks perennial

OTHER:

- Land drainage catchment (rated)
- Rated drain
- Roads



Map © EOS Ecology, 2025 / www.eosecology.co.nz

Layer source: Invertebrate (EOS Ecology, Environment Canterbury),
waterways (EOS Ecology), land drainage catchment & rated drains
(Selwyn District Council), hill shade (Land Information New Zealand;
LINZ), roads (Esri vector tile service), imagery (LINZ)

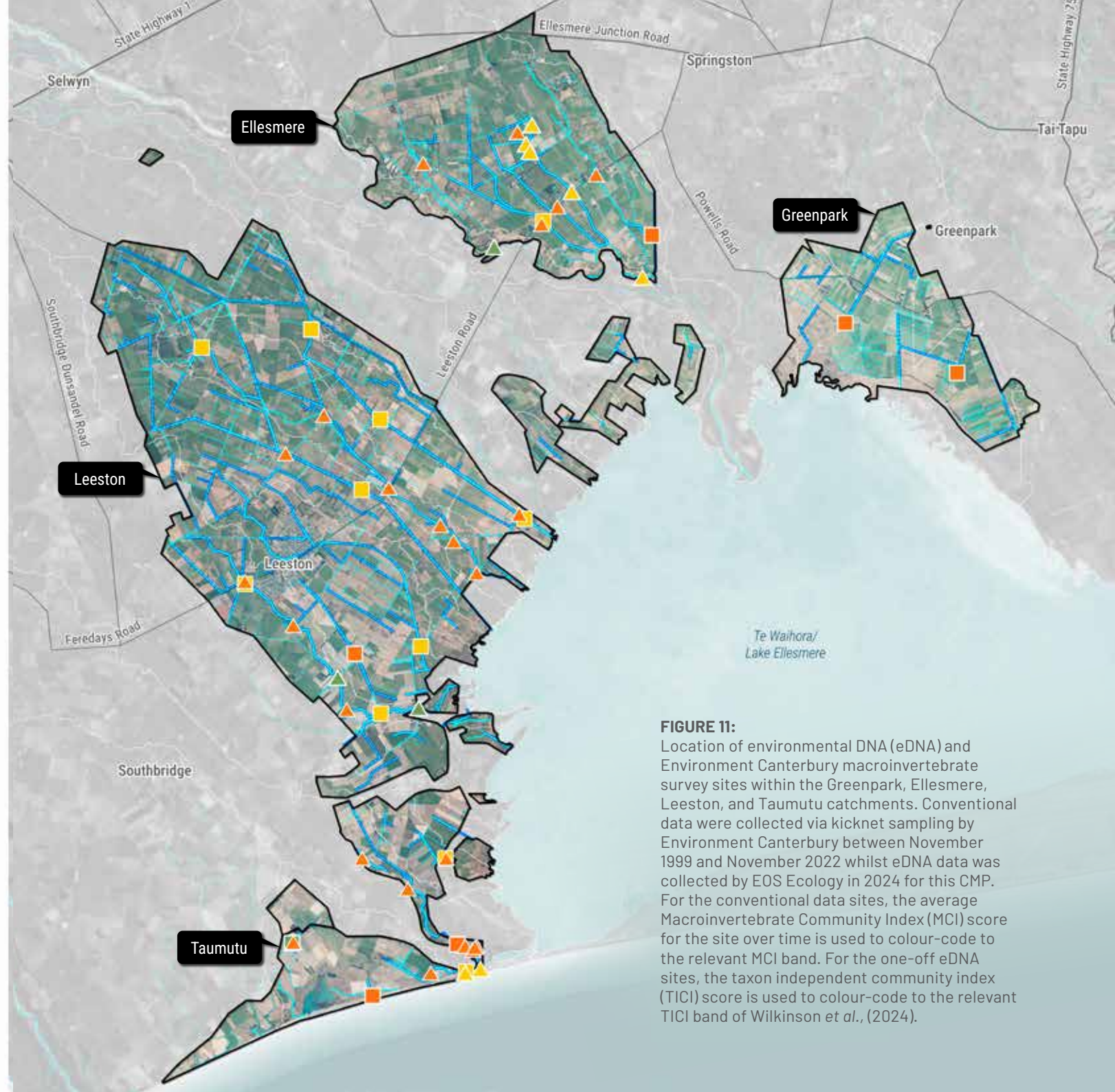


FIGURE 11:

Location of environmental DNA (eDNA) and Environment Canterbury macroinvertebrate survey sites within the Greenpark, Ellesmere, Leeston, and Taumutu catchments. Conventional data were collected via kicknet sampling by Environment Canterbury between November 1999 and November 2022 whilst eDNA data was collected by EOS Ecology in 2024 for this CMP. For the conventional data sites, the average Macroinvertebrate Community Index (MCI) score for the site over time is used to colour-code to the relevant MCI band. For the one-off eDNA sites, the taxon independent community index (TICI) score is used to colour-code to the relevant TICI band of Wilkinson *et al.*, (2024).



Cased caddisfly (*Triplectides obsoletus*)

Image source: EOS Ecology



Kōwaro/Canterbury mudfish (*Neochanna burrowsius*)

Image source: EOS Ecology

Fish

Fish surveys recorded in the New Zealand Freshwater Fish Database (NZFFD) and eDNA surveys undertaken as Fish surveys recorded in the NZFFD, together with eDNA surveys undertaken in 2024 as part of this CMP, indicate that between two and 13 fish species occur across these catchments (Table 10; Figure 12). Greenpark has the most depauperate fish community, with only two species recorded via the eDNA sampling (shortfin eel and goldfish) and no fish records in the NZFFD. In contrast, Leeston supports the highest diversity, with 13 fish species recorded. Of these, 11 were detected in eDNA samples collected for this CMP, while two additional species (black flounder and Chinook salmon) were identified only from pre-existing records in the NZFFD. Ellesmere and Taumutu each support eight fish species.

Shortfin eel occurs in all four catchments, whereas other species are more restricted in their distribution. Ellesmere, Leeston, and Taumutu share a core assemblage comprising shortfin eel, longfin eel, īnanga, upland bully, common bully, and brown trout. Giant bully, bluegill bully, and torrentfish are each recorded in two of the four catchments, while Canterbury mudfish, common smelt, yelloweye mullet, goldfish, black flounder, and Chinook salmon are each confined to a single catchment (Table 10).

Of the fifteen fish species recorded across these catchments, 12 are native, including two classified as threatened and six as At Risk (Dunn *et al.*, 2025). Īnanga are listed as Threatened – Nationally Vulnerable, while Canterbury mudfish are classified as Threatened – Nationally Critical. Longfin eel and common smelt are categorised as At Risk – Declining, while upland bully, giant bully, bluegill bully, and torrentfish are classified as At Risk – Naturally Uncommon (Table 10).

TABLE 10:

Fish species found in Greenpark, Ellesmere, Leeston, and Taumutu catchment waterways. Fish records are based on eDNA samples collected by EOS Ecology between November 2023 and January 2024, or accessed from the Wilderlab public eDNA database, and from species recorded in the New Zealand Freshwater Fish Database (NZFFD; records from 1980 onwards).

Common Name		Shortfin eel	Longfin eel	Īnanga	Upland bully
Species Name		<i>Anguilla australis</i>	<i>Anguilla dieffenbachii</i>	<i>Galaxias maculatus</i>	<i>Gobiomorphus breviceps</i>
Conservation Status		Not Threatened	At Risk – Declining	Threatened – Nationally Vulnerable	At Risk – Naturally Uncommon
Migratory Status		Diadromous–Catadromous	Diadromous–Catadromous	Diadromous–Amphidromous	Non-diadromous
Description		 • Widespread across NZ. • While they can penetrate inland as far as longfin eel, they are more commonly found at low elevation lakes, wetlands and rivers. • Significant taonga species and a very important mahinga kai resource.	 • Widespread throughout NZ in a variety of habitats from sea level to 1,150 m elevation. • Excellent climbers as juveniles. • Significant taonga species and a very important mahinga kai resource.	 • Most common whitebait species, naturally widespread in freshwater systems worldwide. • Highly valued as a food source in its whitebait juvenile stage. • Prefers gentle-flowing lowland rivers, lakes, and streams. • Limited inland penetration due to poor climbing. Habitat degradation is a risk for this species.	 • Thrives in various habitats, often in slow streams along the East Coast of the South Island. • Some populations also inhabit lakes. • Distinctive orange spots covering the entire head, especially on the cheeks.
Catchment	Greenpark – 2 species recorded	✓			
	Ellesmere – 8 species recorded	✓	✓	✓	✓
	Leeston – 13 species recorded	✓	✓	✓	✓
	Taumutu – 8 species recorded	✓	✓	✓	✓

TABLE 10:
...continued...

Common bully	Giant bully	Bluegill bully	Torrentfish	Canterbury mudfish	Common smelt
<i>Gobiomorphus cotidianus</i>	<i>Gobiomorphus gobioides</i>	<i>Gobiomorphus hubbsi</i>	<i>Cheimarrichthys fosteri</i>	<i>Neochanna burrowsius</i>	<i>Retropinna retropinna</i>
Not Threatened	At Risk – Naturally Uncommon	At Risk – Naturally Uncommon	At Risk – Naturally Uncommon	Threatened – Nationally Vulnerable	At Risk – Declining
Diadromous–Amphidromous	Diadromous–Amphidromous	Diadromous–Amphidromous	Diadromous–Amphidromous	Non-diadromous	Diadromous–Anadromous
					
• The most prevalent and widespread native freshwater fish in NZ. • Found in streams and lakes throughout the country. • Typically has seven first dorsal spines, occasionally eight.	• Cryptic nocturnal fish, hiding in daytime under debris and vegetation. • Common at low elevations, mainly in estuaries and nearby waterways, rarely venturing more than 10 km inland. • Resemble common bullies but with only six first dorsal spines.	• Widespread from sea level to 100 km inland. • Capable of overcoming modest barriers for upstream movement. • Thrives in swift, broken rapids, often inhabiting larger braided gravelly rivers. Less commonly found in riffles of smaller streams. • Notable for its distinctive blue gill membrane.	• Widespread from sea level to inland, specialised for life in fast flowing waters. • Most common in rivers flowing directly to the sea rather than through estuaries. • Distinctive diagonal stripes on body. • Solitary and secretive.	• Exclusive to Canterbury, between the Ashley River and Waitaki River. • Original wetland habitats no longer exist. • Found in slow-flowing and weedy streams, springs, drains, and water races. • Restricted range and ongoing habitat loss are risks for this species.	• Widely distributed at low elevations throughout NZ. Capable of inland penetration when stream gradients are low. • Forms land-locked populations in lakes as well.
✓		✓	✓		
✓	✓	✓	✓	✓	✓
✓	✓				

TABLE 10:
...continued...

	Yelloweye mullet	Brown trout	Goldfish	Black funder	Chinook salmon
	<i>Aldrichetta forsteri</i>	<i>Salmo trutta</i>	<i>Carassius auratus</i>	<i>Rhombosolea retiaris</i>	<i>Oncorhynchus tshawytscha</i>
	Not Threatened	Introduced & Naturalised	Introduced & Naturalised	Not Threatened	Introduced & Naturalised
	Non-diadromous	Anadromous-capable	Non-diadromous	Non-diadromous	Diadromous-Anadromous
					
	- Primarily a marine and estuarine species, it will also enter freshwater for foraging at low elevations. - Distinguished by its bright yellow eye. - Widespread in estuaries and rivers, occupying open water.	- Introduced in 1867, brown trout are found in diverse habitats throughout NZ, ranging from estuaries and low elevation tidal lakes to fast-flowing boulder headwater streams and subalpine lakes. - Highly territorial, they out-compete other fish species for available food sources.	- Introduced in the 1860s as ornamental pond fish, goldfish are now widespread in NZ, often descendants of dumped aquarium fish. - They thrive in still waters, consuming aquatic plants and insects.	- Evolved to lie on one side of their bodies for ambushing small prey. - Prefers estuarine environments but also found in low gradient rivers and lowland lakes. - Widespread but exhibits a patchy distribution, with the highest occurrence on the east coast of the South Island.	- First established in the Waitaki River in the early 1900s. - Also known as 'King salmon', these salmon are a significant commercial food source in NZ, farmed in sea cages and diversion canals for hydroelectric dams.
Greenpark – 2 species recorded			✓		
Ellesmere – 8 species recorded		✓			
Leeston – 13 species recorded		✓		✓	✓
Taumutu – 8 species recorded	✓	✓			



Te Waihora Lowlands Fish Diversity

% THREATENED SPECIES:

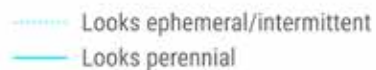


SPECIES DIVERSITY:

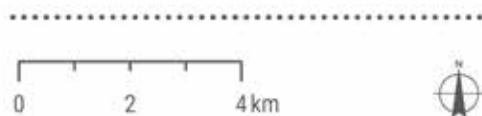
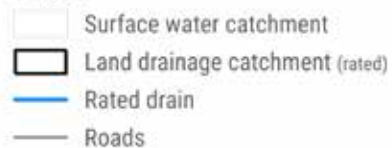
CONVENTIONAL eDNA



FLOW PERMANENCY:



OTHER:



Map © EOS Ecology, 2025 / www.eosecology.co.nz

Layer source: Fish (EOS Ecology, NZFFD), land drainage catchment & rated drains (Selwyn District Council), hill shade (Land Information New Zealand; LINZ), roads (Esri vector tile service), imagery (LINZ)

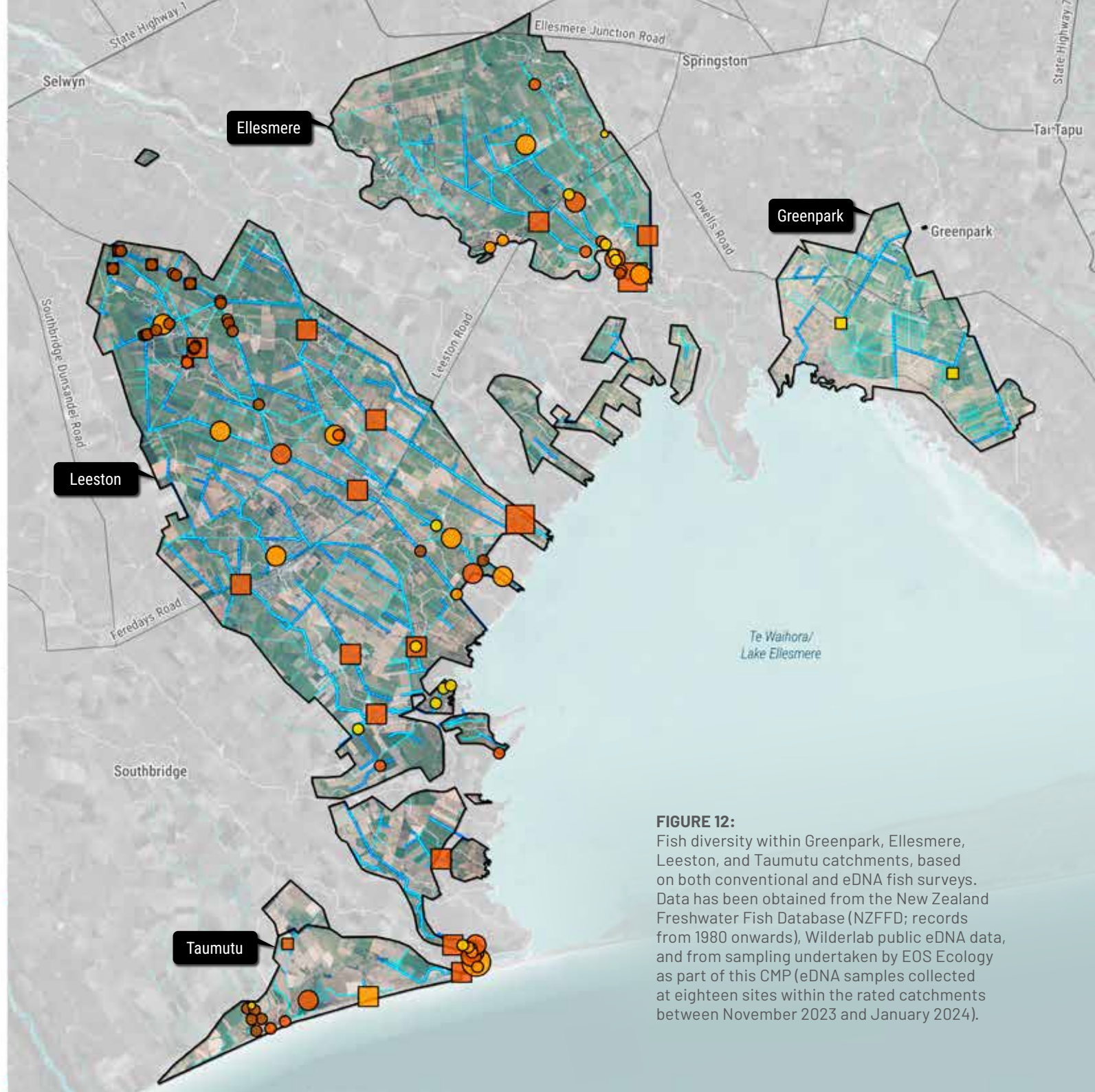


FIGURE 12:

Fish diversity within Greenpark, Ellesmere, Leeston, and Taumutu catchments, based on both conventional and eDNA fish surveys. Data has been obtained from the New Zealand Freshwater Fish Database (NZFFD; records from 1980 onwards), Wilderlab public eDNA data, and from sampling undertaken by EOS Ecology as part of this CMP (eDNA samples collected at eighteen sites within the rated catchments between November 2023 and January 2024).

3.2.7 Water Quality

The water quality of waterways within the rated catchments is regularly measured by SDC at six sites in the Greenpark scheme, two sites in the Ellesmere scheme, 22 sites in the Leeston scheme, and two sites in the Taumutu scheme (Figure 14; Alexander, 2023; Calder-Steele, 2024). Environment Canterbury also has several water quality monitoring sites within these catchments that contribute further long-term water quality information about this area. No new data analysis was undertaken for this summary. Instead, we relied on the summary statistics presented by Alexander (2023) and Calder-Steele (2024).

Overall, the waterways across these catchments show elevated nutrients, high total suspended solids, and frequent *E. coli* exceedances of recreational guideline standards (Figure 13). The Greenpark catchment differs from the other catchments in that it is also affected by low dissolved oxygen and high ammoniacal nitrogen concentrations. While not all measured parameters are covered by the NPS-FM (2020), comparisons with other guidelines, including the Canterbury Land and Water Regional Plan (LWRP) and the Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZG), reinforce these patterns (Table 11).

- **Nitrate-N and ammoniacal nitrogen:** are soluble forms of nitrogen that typically enter waterways via runoff from on-farm drains, shallow groundwater, and informal/overland flow paths during rain events. They may also leach from effluent or fertiliser applied to pastures or enter directly from stock in waterways. In some cases, springs can introduce nitrogen from distant surface water catchments via groundwater. While nitrogen is essential for plant growth, elevated concentrations in waterways can cause excessive plant or algae growth, which may smother streambeds and destroy habitat. At very high levels, nitrate-N and ammoniacal nitrogen can be toxic to sensitive species, reducing survival or causing mortality. Five-year median (2017 to 2022) nitrate-nitrite-N¹ concentrations for waterways within Greenpark (0.079 mg/L), Ellesmere (5.2 mg/L), Leeston (2.5 mg/L), and Taumutu (4.7 mg/L) catchments show that except for Greenpark, nitrates are at levels that would be expected to be having toxic effects on sensitive species (when compared against the NPSFM nitrate-N toxicity bands). Although nitrate-nitrite-N concentrations are variable both within and between catchments, as well as over time, the annual medians and 95th percentiles for sites in these catchments are typically assigning the waterways to the **C attribute band** for nitrate-N toxicity according to the NPS-FM (2020) (Alexander, 2023). The nitrate-N attribute in the NPS-FM (2020) relates to species protection against toxic effects (reduced survival or death of sensitive species), rather than to the sub-lethal (chronic) effects that can occur at much lower concentrations, so as well as having toxic effects on individual species, it is likely that nitrate concentrations in many of these waterways are contributing towards excessive algal and plant growth (Table 11). For Greenpark catchment, annual medians are typically within the **A attribute band** for nitrate toxicity. Five-year median ammoniacal nitrogen concentrations for waterways within Greenpark (0.23 mg/L),

¹ Note that these values have been taken directly from Alexander (2023) and Calder-Steele (2024), who provide data for nitrate-nitrite nitrogen (nitrate-nitrite-N) but compare them against guideline values for nitrate nitrogen (nitrate-N). In the absence of access to the raw data and with no national guideline values for nitrate-nitrite-N, we have taken the same approach, but note that as the nitrite component of nitrate-nitrite-N is typically very low in oxygenated waters, this should not have a material impact on the comparison to nitrate-N guideline values. However, in low oxygen conditions the proportion of nitrite can be higher, which means that the comparison to nitrate-N guideline values for Greenpark (which has low oxygen levels) should be used with caution.

Ellesmere (0.005 mg/L), Leeston (0.01 mg/L), and Taumutu (0.01 mg/L) (Alexander, 2023) show that ammonia concentrations in these waterways are typically better than the NPS-FM (2020) national bottom line of 0.24 mg/L, although annual maximum values of ammoniacal nitrogen recorded in Greenpark often place sites in this catchment within the **C attribute band** on an annual basis. Updated water quality analysis by Calder-Steele (2024) did not change the high-level findings of Alexander (2023) for nitrate-N or ammoniacal nitrogen.

The low nitrate-N but high ammoniacal nitrogen found in the Greenpark catchment could be related to the particularly low dissolved oxygen levels found in that catchment. Under anoxic conditions, dissolved inorganic nitrogen (DIN) and ammonium (NH₄⁺) concentrations would increase due to ammonification and release from sediments. However, such conditions would also cause a reduction in nitrate concentrations (compared to oxic conditions) due to bacterial denitrification decreasing nitrate in the absence of oxygen (Figure 15; Figure 16). The strong influence of oxygen levels on biochemical cycles highlights the importance of monitoring all types of nitrogen in the oxygen-limited Greenpark catchment waterbodies.

- **Dissolved reactive phosphorus (DRP):** is a measure of the phosphorus compounds that are dissolved in water. Sources of DRP include the natural weathering of rocks, agricultural or urban runoff, eroding soils, and sewage discharges. Five-year median DRP concentrations for waterways within Greenpark (0.69 mg/L), Ellesmere (0.025 mg/L), Leeston (0.015 mg/L), and Taumutu (0.02 mg/L) (Alexander, 2023) show that although there is substantial variation within and between the drainage schemes, values for these catchments are typically within the **C or D attribute bands for DRP** according to the NPS-FM (2020) (D band >0.018 mg/L). At these levels, the ecological communities would be expected to be impacted by substantial DRP elevation and in favourable conditions, excessive algae and plant growth is likely. Because phosphorus

readily binds to fine sediment particles, it is often transported into waterways along with sediment during rainfall or runoff events. Certain soil types are also known to be a source of phosphorus. For example, pallic soils (which are present in the Ellesmere rated catchment and parts of the Leeston rated catchment) have low phosphorus absorbency, meaning that they may release phosphorus into receiving environments (Hewitt *et al.*, 2021). However, dissolved oxygen levels also have a part to play in the levels of DRP, with the especially low DO of the Greenpark catchment likely contributing to the higher DRP levels, since low dissolved oxygen levels tend to promote the release of phosphorus from sediments (Figure 16).

- **Dissolved oxygen (DO):** is a measure of how much oxygen is dissolved in the water, which is the oxygen that is available to aquatic organisms living in water. Dissolved oxygen is crucial for the survival of animals living in the water and may drop to harmful levels in warm, slow flowing waterways with excessive plant growth or high organic matter. While the NPS-FM (2020) requires 7-day and 1-day minimum DO data (not available for these catchments), a very low five-year median DO of 2.5 mg/L was reported for Greenpark, while higher medians were recorded for Ellesmere (9.1 mg/L), Leeston (7.6 mg/L), and Taumutu (8.4 mg/L) catchments (Alexander, 2023). Low levels of DO in waterways are stressful for instream life and while Greenpark is the only catchment where the five-year median is below the NPS-FM (2020) national bottom line value of 5 mg/L (7-day mean minimum), each of the catchments have recorded individual measures below this value, suggesting that DO stress can be an issue in some parts of these catchments. The consistently low DO levels in the Greenpark catchment will also be influencing nutrient concentrations within the drain and could help explain the elevated levels of ammoniacal nitrogen and very high phosphorus concentrations. This is because low oxygen (anoxic) conditions can alter the storage of carbon and nutrients within the sediment, with anoxic

conditions causing an increase in carbon, ammoniacal nitrogen, and phosphorous concentrations, with prolonged anoxia causing sediments to become a source of phosphorus and organic carbon rather than a sink (Carey *et al.*, 2022).

- **Dissolved oxygen (DO):** is a measure of how much oxygen is dissolved in the water, which is the oxygen that is available to aquatic organisms living in water. Dissolved oxygen is crucial for the survival of animals living in the water and may drop to harmful levels in warm, slow flowing waterways with excessive plant growth or high organic matter. While the NPS-FM (2020) requires 7-day and 1-day minimum DO data (not available for these catchments), a very low five-year median DO of 2.5 mg/L was reported for Greenpark, while higher medians were recorded for Ellesmere (9.1 mg/L), Leeston (7.6 mg/L), and Taumutu (8.4 mg/L) catchments (Alexander, 2023). Low levels of DO in waterways are stressful for instream life and while Greenpark is the only catchment where the five-year median is below the NPS-FM (2020) national bottom line value of 5 mg/L (7-day mean minimum), each of the catchments have recorded individual measures below this value, suggesting that DO stress can be an issue in some parts of these catchments. The consistently low DO levels in the Greenpark catchment will also be influencing nutrient concentrations within the drain and could help explain the elevated levels of ammoniacal nitrogen and very high phosphorus concentrations. This is because low oxygen (anoxic) conditions can alter the storage of carbon and nutrients within the sediment, with anoxic conditions causing an increase in carbon, ammoniacal nitrogen, and phosphorous concentrations, with prolonged anoxia causing sediments to become a source of phosphorus and organic carbon rather than a sink (Carey *et al.*, 2022).
- **Escherichia coli (E. coli):** is an indicator of faecal contamination and the potential presence of disease-causing organisms. High levels pose health risks for humans and animals and affect suitability of the waterways for mahinga kai, swimming, and other recreational uses. Five-year median results for the Greenpark (220 cfu/100 mL), Ellesmere (250 cfu/100 mL), Leeston (160 cfu/100 mL), and Taumutu (50 cfu/100 mL) summarise the general state of *E. coli* across these catchments

(Alexander, 2023). While Greenpark, Ellesmere, and Leeston all reported extremely high *E. coli* concentrations on some occasions and frequently exceeded Ministry for the Environment & Ministry of Health (2003) recreational alert (260 *E. coli*/100 mL) and action (550 *E. coli*/100 mL) levels for freshwater, Taumutu catchment reported relatively low *E. coli* concentrations in comparison and less frequently exceeded the recreational guidelines.

- **Total suspended solids (TSS):** is a measure of the amount of fine particulate matter, such as silt, clay, and organic material, suspended in the water column. Five-year median results for the Greenpark (20 mg/L), Ellesmere (2.5 mg/L), Leeston (4 mg/L), and Taumutu (5.5 mg/L) summarise the general state of TSS across these catchments (Alexander, 2023). Although TSS is not an attribute under the NPS-FM (2020), the Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZG) provide a default guideline value of 2.1 mg/L for suspended sediments in catchments classified as Cool Dry Low-elevation under the River Environment Classification (REC). This comparison indicates that TSS levels in Greenpark, Ellesmere, Leeston, and Taumutu are all elevated above the recommended guideline.

FIGURE 13: Water quality issues in the Greenpark, Ellesmere, Leeston, and Taumutu catchments.



Total suspended solids are often elevated during and after rainfall, giving waterways a noticeably murky appearance.



Elevated nitrogen and phosphorus concentrations in these catchments contribute to excessive algal and macrophyte growth.



The very low dissolved oxygen levels in the Greenpark rated catchment waterbodies will also be affecting other water quality attributes, with anoxic conditions causing carbon, ammoniacal nitrogen, and phosphorous to be released from sediments

TABLE 11:

Five-year summary of measured water quality for Greenpark, Ellesmere, Leeston, and Taumutu catchment water quality monitoring sites sampled by Selwyn District Council. Sites sampled approximately quarterly between 2018 and 2022. Median and 90th percentile ranges calculated by Alexander (2023). Relevant guidelines from ANZG (2018) and the Canterbury Land and Water Regional Plan (LWRP) are included for comparison. Where a water quality parameter meets all of the listed guidelines for the catchment it is shaded green, orange indicates that it meets some but not all listed guidelines, and red indicates that it meets none of the listed guidelines.

	Meets consent conditions and/or other listed guidelines
	Meets some but not all of the consent conditions and other listed guidelines
	Does not meet consent conditions and/or other listed guidelines

Water Quality Parameters	Greenpark		Ellesmere		Leeston		Taumutu		Assessment against relevant guidelines
	Median	90 th Percentile	Median	90 th Percentile	Median	90 th Percentile	Median	90 th Percentile	
Nitrate + Nitrite Nitrogen¹ (mg/L)	0.079	0.003–1.5	5.2	0.025–8.6	2.5	0.005–7.6	4.7	0.43–5.6	0.265 mg/L (80 th percentile – ANZG – cool dry low-elevation) for nitrate-N 3.8 mg/L (annual median – LWRP Schedule 8 water quality limits – spring-fed plains) for nitrate-N
Ammoniacal nitrogen (mg/L)	0.23	0.005–1.6	0.005	0.005–0.1	0.01	0.005–0.16	0.01	0.05–0.088	0.01 mg/L (80 th percentile – ANZG – cool dry low-elevation) 0.24 mg/L (maximum annual median – LWRP Schedule 8 water quality limits – spring-fed plains)
Total inorganic nitrogen (mg/L)	0.6	0.01–3.1	5.2	0.14–8.6	2.7	0.02–7.7	4.7	0.44–5.7	NA
Total nitrogen (mg/L)	3.1	1.1–7.5	5.9	0.8–8.7	3.5	0.5–8.2	5.0	1.4–7.5	0.913 mg/L (80 th percentile – ANZG – cool dry low-elevation)
Total phosphorus (mg/L)	1.3	0.13–5.6	0.05	0.012–0.41	0.035	0.008–0.83	0.036	0.006–0.29	0.014 mg/L (80 th percentile – ANZG – cool dry low-elevation)
Dissolved reactive phosphorus (mg/L)	0.69	0.02–4.2	0.025	0.006–0.21	0.015	0.005–0.24	0.02	0.006–0.11	0.016 mg/L (LWRP Table S5A receiving water standards – spring fed plains) 0.008 mg/L (80 th percentile – ANZG – cool dry low-elevation)
Dissolved oxygen (mg/L)	2.5	0.16–7.7	9.1	2.5–13.0	7.6	0.9–12.0	8.4	2.6–11.0	7.0 mg/L (7-day minimum – LWRP Schedule 8 water quality limits – spring-fed plains)
<i>E. coli</i> (cfu/100mL)	220	5–28,300	250	30–1,500	160	10–2,600	50	5–538	550 <i>E. coli</i> /100mL (LWRP Table S5A receiving water standards – spring-fed plains) ≤130 <i>E. coli</i> /100mL (median – LWRP Table 1a freshwater outcomes – spring-fed plains)
Conductivity (µS/cm)	1,900	300–9,500	290	130–470	340	210–520	260	210–920	116 µS/cm (80 th percentile – ANZG – cool dry low-elevation)
pH	7.0	6.3–7.7	7.2	6.8–7.7	7.0	6.5–7.8	7.0	6.6–7.4	6.5–8.5 (LWRP Table S5A receiving water standards – spring-fed plains) 7.23–7.8 (20 th –80 th percentile – ANZG – cool dry low-elevation)
Temperature (°C)	12.0	5.7–19.0	13.0	7.4–20.0	12.0	7.7–18.0	12.0	6.4–13.0	20°C (maximum – LWRP Table 1a freshwater outcomes – spring-fed plains)
Total suspended solids (mg/L)	20.0	2.5–870.0	2.5	1.5–46.0	4.0	1.5–100.0	5.5	1.5–86.0	2.1 mg/L (80 th percentile – ANZG – cool dry low-elevation)

¹ Note that these values have been taken directly from Alexander (2023) and Calder-Steele (2024), which is for nitrate-nitrite nitrogen (nitrate-nitrite-N), not nitrate-N. With no national guideline values for nitrate-nitrite-N, we have taken the same approach as that of Alexander (2023) and Calder-Steele (2024), where the results are compared to guideline values for nitrate-N. However, as the nitrite component of nitrate-nitrite-N is typically very low in oxygenated waters, this should not have a material impact on the comparison to nitrate-N guideline values. In low oxygen conditions, the proportion of nitrite can be higher, which means that the comparison to nitrate-N guideline values for Greenpark (which has low oxygen levels) should be used with caution.



Te Waihora Lowlands Water Quality Monitoring Sites

WATER QUALITY MONITORING SITE:

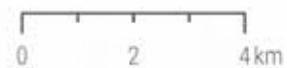
- SDC monitoring site

FLOW PERMANENCY:

- Looks ephemeral/intermittent
- Looks perennial

OTHER:

- Land drainage catchment (rated)
- Rated drain
- Roads



Map © EOS Ecology, 2025 / www.eosecology.co.nz

Layer source: SDC monitoring site (Selwyn District Council), waterways (EOS Ecology), land drainage catchment & rated drains (Selwyn District Council), hill shade (Land Information New Zealand; LINZ), roads (Esri vector tile service), imagery (LINZ)

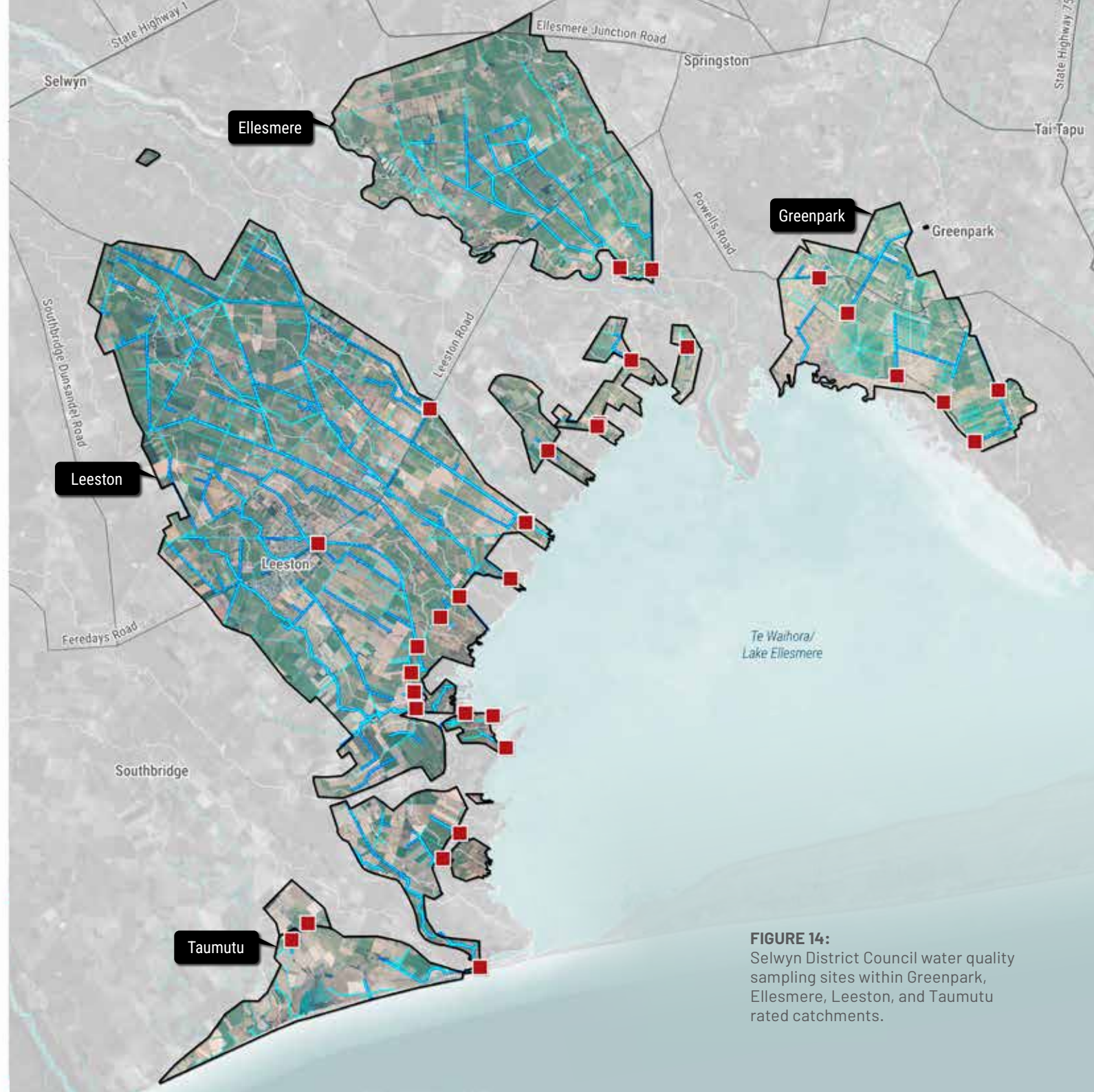


FIGURE 14:
Selwyn District Council water quality
sampling sites within Greenpark,
Ellesmere, Leeston, and Taumutu
rated catchments.

Denitrification Process

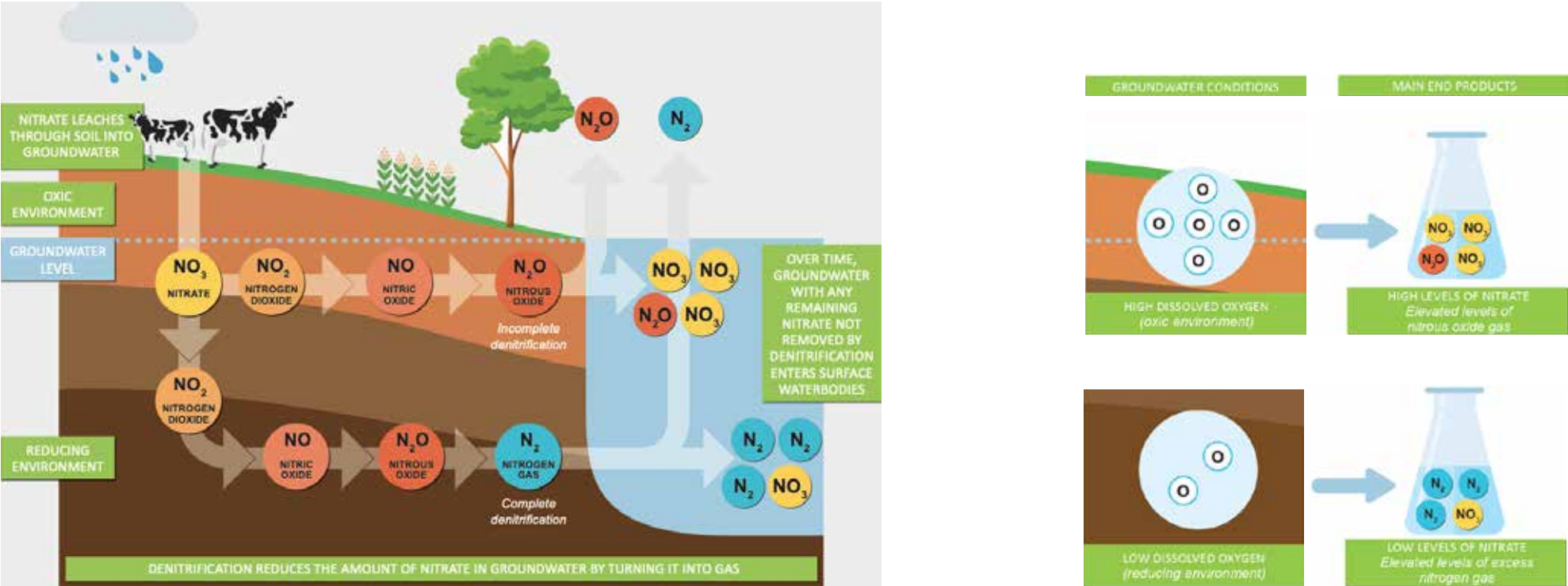
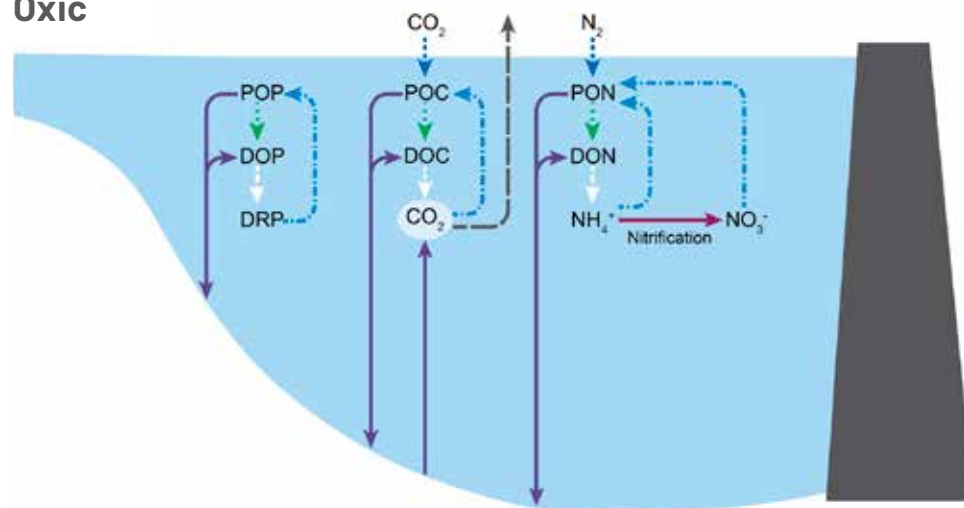


FIGURE 15: A simplified diagram that shows the denitrification process that occurs in groundwater under oxic (high dissolved oxygen) and anoxic (low dissolved oxygen) conditions, and how the level of oxygen available affects the amount of nitrate reaching surface water environments

Source: From Our Land & Water Science Challenge. <https://ourlandandwater.nz/outputs/revealing-groundwaters-denitrification-capacity>

Oxic



Anoxic

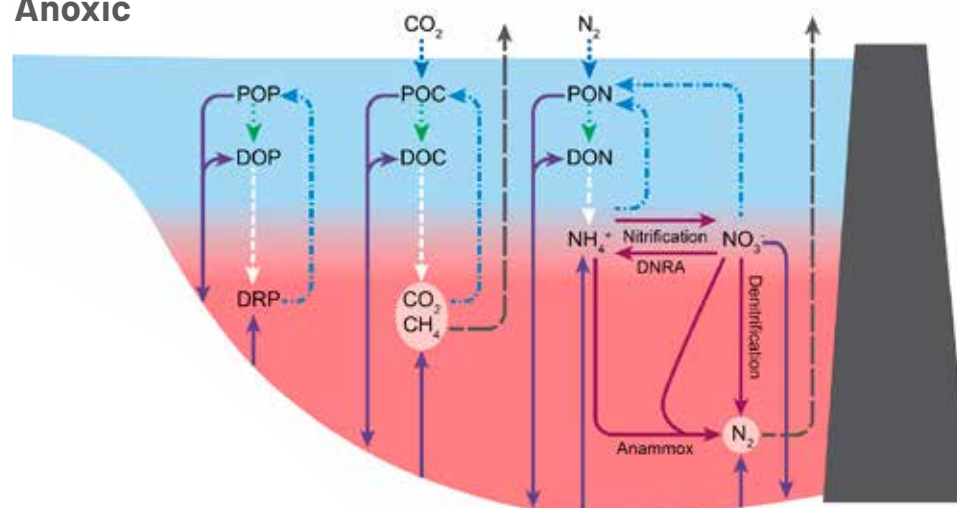


FIGURE 16:

A conceptual diagram from Carey *et al.*, (2022) showing the dominant carbon, nitrogen, and phosphorus cycling processes in oxic (top) and anoxic (bottom) conditions in the water column.

Carbon processes include cycling of carbon dioxide (CO_2), dissolved organic carbon (DOC), methane (CH_4), and particulate organic carbon (POC).

Nitrogen processes include cycling of dissolved organic nitrogen (DON), nitrogen gas (N_2), ammonium (NH_4^+), nitrate (NO_3^-), and particulate organic nitrogen (PON).

Phosphorus processes include cycling of dissolved organic phosphorus (DOP), dissolved reactive phosphorus (DRP), and particulate organic phosphorus (POP).

Processes are denoted by arrows. Source: modified from Carey *et al.*, (2022)

- Emission
- Fixation
- ... Hydrolysis
- ==== Mineralisation
- Immobilisation
- Sediment flux
- N-specific processes

DOC = dissolved organic carbon
 POC = particulate organic carbon
 DON = dissolved organic nitrogen
 PON = particulate organic nitrogen
 DOP = dissolved organic phosphorus
 DRP = dissolved reactive phosphorus
 POP = particulate organic phosphorus

3.3 Cultural Values

Te Waihora Combined Catchment Management Plan covers four large areas around Te Waihora/Lake Ellesmere: Greenpark, Ellesmere, Leeston, and Taumutu.

The identified areas under Te Waihora Combined Catchment Management Plan are areas of shared interest between Te Taumutu Rūnanga and Te Ngāi Tūāhuriri Rūnanga. Both rūnanga hold and exercise rangatiratanga over the area. The health of the whenua and water resources across the takiwā is strongly connected to the health of the people. The catchments identified under this plan are crucial to mana whenua for their connection to Te Waihora cultural landscape, which contains significant mahinga kai resources, specific cultural features, traditions, and historical associations that connect people to place. Protecting and restoring these resources across Waitaha is of the utmost importance to mana whenua.

Within the four catchments there are multiple wāhi tapu and wāhi taonga sites, such as Ōrariki – the pā of Te Ruahikihiki – and Te Pā o Moki (named after Moki II, the son of Ruahikihiki). These sites fall within the Taumutu takiwā. Together these sites provide evidence of the high presence of Ngāi Tahu settlement and values within the catchment.

Ngāi Tahu oral traditions tell of Rākaihautū, who beached his waka Uruao at Whakatū (Nelson). The new arrivals divided in two, with Rākaihautū taking one party southwards via an inland route over Kā Tiritiri o te Moana, and his son, Te Rakihouia, taking the other party on board the waka to explore the east coastline. On his inland journey southwards, Rākaihautū used his kō to dig the main lakes around Te Wai Pounamu, while Te Rakihouia discovered the coastal lake (now Te Waihora/Lake Ellesmere) on his coastal journey south. In doing so, he claimed the abundant resources of the area for his father, and hence he named the lake Te Kete Ika a Rākaihautū – the fish basket of Rākaihautū. Te Waihora, Te Kete-ika-a-Rākaihautū, and Te Kete-ika-a-Tūtekawa are all traditional names for Lake Ellesmere.

Te Waihora is a large, shallow, brackish coastal lake, spreading from the western shores of Horomaka/Te Pātaka-a-Rākaihautū (Banks Peninsula) down to the settlement of Taumutu. All four catchments in this plan are contiguous with Te Waihora. The Te Waihora Catchment is a significant cultural landscape because of its strong ties with Ngāi Tahu history and settlement; it was one of the most substantial mahinga kai resources for Ngāi Tahu historically. Mahinga kai is the cornerstone of Ngāi Tahu cultural wellbeing and, as such, mahinga kai activities are a way for mana whenua to express their identity.

The margins, tributaries, and drains of Te Waihora are home to many taonga species including, but not limited to, pūtakitaki/paradise duck, pātiki/flounder, tuna/eel, īnanga/whitebait, kanakana/lamprey, and kōura/freshwater crayfish. The lake, as a mahinga kai source, has always been a defining aspect of marae life at Taumutu. Ongoing concerns about adverse environmental effects such as nutrient and sediment loadings, and other pollutant inputs are counterproductive to whānau aspirations to harvest and gather kai and show respect to the values of this tribally significant hāpua. These concerns are central to, and form the basis of, work for Te Taumutu Rūnanga today.

Te Waihora has little protection from the effects of land use in the upper catchment. Activities such as grazing, sewage discharge, and runoff affect lake health when the resultant pollutants flow down the catchment and into the hāpua. When the mauri of the water is degraded, the connection mana whenua has to the cultural landscape is put at risk. For instance, it limits the ability for mana whenua to participate in, and have access to, high-quality mahinga kai. Currently, the customary harvest for mana whenua of tuna in Te Waihora is unattainable. Restoring the ecological health of Te Waihora may re-establish this important aspect of Ngāi Tahu cultural identity. As Kaitiaki, mana whenua need effective engagement in resource management decision-making to protect the environment and uphold Ngāi Tahu values.

While applicable resource management legislation enables the Rūnanga to participate effectively in resource management decision-making, the pathways to decision-making are not always enabled by local government. The Joint Officials Group (JOG) is a collaborative governance group that sets the strategic direction for the management of, and improving the values of, Te Waihora. Both the Rūnanga and Ngāi Tahu are members of this governance group, who support and are responsible for implementing the Cultural Landscape Values Management Area (CLVMA).

The CLVMA is a specific management regime within the Selwyn/Waihora Subregional Plan and circles the entire circumference of the lake. The CLVMA is a geographically defined planning zone in the Canterbury region established to protect indigenous cultural heritage and ecological health. These areas require specific land management and environmental protection targets to safeguard traditional food gathering (mahinga kai) and sacred sites (wāhi tapu). The zone overall has three intended directions:

- The CLVMA directs Farm Environment Plans to protect mahinga kai and limit nutrient runoff to 15 kg per farm site.
- Collaboration with mana whenua – Ngāi Tahu values need to be explicitly ‘taken into account’ when applying for a resource consent. This includes meeting cultural and ecological targets.
- Protection of waterways – damming rivers, draining wetlands, or discharging runoff are heavily monitored or restricted to preserve water.

Te Taumutu Rūnanga consistently advocate for the improvement of water quality and quantity across the takiwā, which has been adversely affected by the inappropriate control of land use activities. For example, inappropriate land use has resulted in the degradation of mahinga kai resources, and the mauri of Te Waihora. It is therefore a key priority for Rūnanga that improved

resource management is undertaken and better land use practices are used in the catchments close by or adjacent to Te Waihora. The CLVMA contains provisions to achieve these aspirations. Taumutu Rūnanga, Ngāi Tahu, local government, and the local community share the responsibility to implement these provisions in order to benefit from the anticipated improved health of Te Waihora, mō tātou, ā, mō kā uri ā muri ake nei.

This Cultural Values section was written by Mahaanui Kurataiao Ltd (Mahaanui) on behalf of Te Taumutu Rūnanga. Mahaanui has been endorsed by Te Taumutu Rūnanga to write this on their behalf and the copy presented here has been approved by the Rūnanga.



Coastline along Taumutu
rated catchment

Image source: EOS Ecology

4 Large-Scale Constraints

4.1 Climate Change

Lake levels for Te Waihora/Lake Ellesmere are governed by a National Water Conservation Order (National Water Conservation (Te Waihora/Lake Ellesmere) Order, 1990), which places restrictions on lake openings based on the lake level and the time of year, with the intention of protecting the outstanding features of the lake. Currently, Te Rūnanga o Ngāi Tahu and Canterbury Regional Council jointly hold resource consents to artificially open and close the lake (CRC140366, CRC140367, CRC140368). As part of these consents, they must operate under a protocol which includes a consideration of aspects such as the protection of habitat, values associated with tikanga Māori, summer lake level management, management of land inundation, managing the effects of high lake levels on waterway networks and infrastructure, and tuna/eel migration timing. However, climate change will impact the physical processes and conditions that influence the ability to open the lake. The level of Te Waihora/Lake Ellesmere is managed relative to mean sea level, with a higher lake level relative to sea level needed to provide a differential head to help with the opening process (i.e., using the outflowing lake water to help scour a channel after excavating a pilot channel). Sea level rise because of climate change will make it more difficult to achieve a successful opening at lower lake levels and may result in higher mean lake levels that would potentially reduce the effectiveness and flood capacity of the land drainage networks within the Te Waihora/Lake Ellesmere catchment.

Low-lying coastal areas are particularly vulnerable to the effects of climate change. As such, Te Waihora/Lake Ellesmere and its low-lying catchment are likely to be impacted by physical changes that will result from anthropogenic climate change, such as sea level rise, coastal erosion, salinisation of freshwaters (including groundwater), and an increase in the frequency and/or intensity of rainfall events and droughts. There is potential for climate change to place increased pressure on the drainage function of the Greenpark, Ellesmere, Leeston, and Taumutu catchments in the future.

National climate projections for Aotearoa New Zealand were updated by NIWA (now Earth Sciences New Zealand) during 2024 and provide higher resolution projections than were previously available (<https://environment.govt.nz/facts-and-science/climate-change/climate-change-projections>). These show that future rainfall is expected to be more variable for the Canterbury region, with an increase in both the intensity and frequency of extreme rainfall events and a corresponding increase in the frequency and intensity of flood events (Dudley Ward *et al.*, 2024). Sea level rise is already occurring and is certain to continue. Emission reductions do not stop sea level rise, they simply influence the extent and trajectory of the changes that will occur, so it is crucial that this CMP considers the large-scale constraint of future sea level rise.

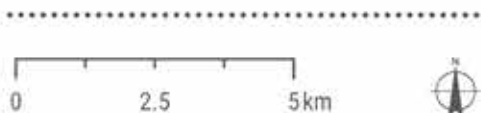
Selwyn District Council recognises the risks posed by climate change within the district and is actively working on identifying and planning for these risks (www.selwyn.govt.nz/community/our-natural-environment/climate-change). The Council is also a signatory to the New Zealand Local Government Leaders' Climate Change Declaration 2017, which makes a series of commitments to develop and implement actions to reduce greenhouse gas emissions and support resilience within local communities, as well as helping local communities to understand and prepare for the effects of climate change (<https://d1pepq1a2249p5.cloudfront.net/media/documents/Climate-Change-Declaration.pdf>).

To this end, historic climate cycles and trends and projected future changes have been used in a high-level risk assessment of SDC's assets to predict which are most likely to be affected by climate change (Dudley Ward *et al.*, 2023). This study found that increases in sea level are likely to cause issues for land drainage areas close to Te Waihora/Lake Ellesmere (such as Greenpark and Leeston). An increase in sea level would either increase the lake levels and so reduce the effectiveness of the land drainage network around the lake or would result in the lake needing to be opened more frequently (if this is possible to do) to maintain the lower lake levels (Dudley Ward *et al.*, 2023). Higher lake levels would influence the drainage network by flooding of land adjacent to the lake and by causing backwater effects that would propagate further up the land drainage waterways (Dudley Ward *et al.*, 2023). There are strong links between the shallow groundwater system, lake levels, and the drainage network: higher lake levels result in higher groundwater levels propagating further inland, which places further pressure on land drainage. Widespread flooding, such as that which occurred in June/July 2013, has demonstrated the risk of inundation that exists for low-lying land within the Selwyn District land drainage schemes, and it is evident that this low-lying area has limited capacity to cope with this during extreme events (Figure 17).



Te Waihora/ Lake Ellesmere Sea Level Rise

- June/July 2013 flood extent
- Median projection of sea level rise at 2050
(under SSPS-8.5)
- Land drainage catchment (rated)



Map © EOS Ecology, 2025 / www.eosecology.co.nz

Layer source: June/July 2013 flood extent, sea level rise projection (Aqualinc), hill shade (Land Information New Zealand; LINZ), land drainage catchment (Selwyn District Council), Te Waihora/Lake Ellesmere (LINZ), roads (Esri vector tile service)

Basemap: LCDB v6 (Manaaki Whenua; Landcare Research)

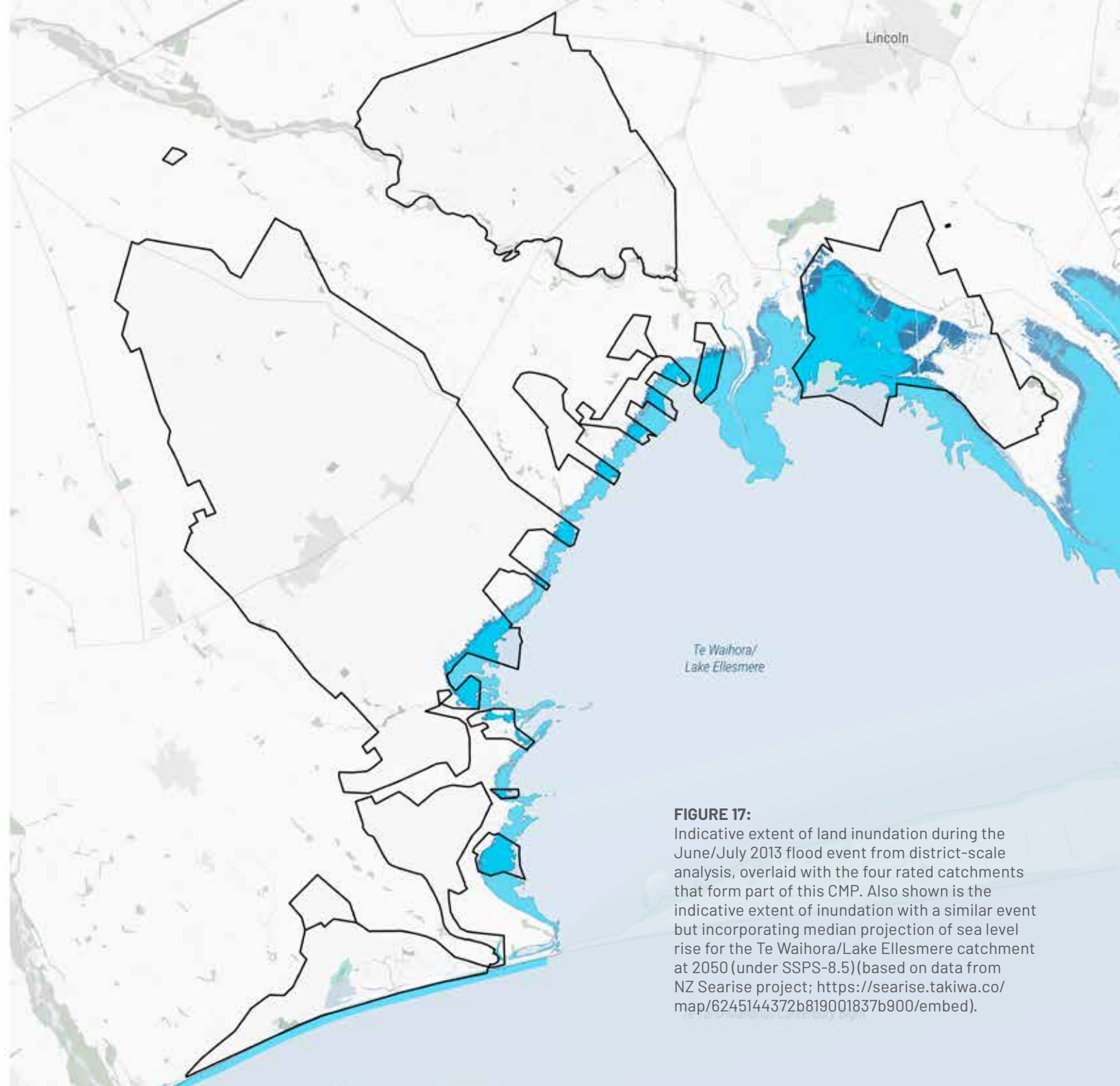


FIGURE 17:

Indicative extent of land inundation during the June/July 2013 flood event from district-scale analysis, overlaid with the four rated catchments that form part of this CMP. Also shown is the indicative extent of inundation with a similar event but incorporating median projection of sea level rise for the Te Waihora/Lake Ellesmere catchment at 2050 (under SSPS-8.5) (based on data from NZ Searise project; <https://searise.takiwa.co/map/6245144372b819001837b900/embed>).

4.2 Hydrological Context

Below the Canterbury Plains are a series of aquifers and aquitards which vary in thickness, extent, and depth below ground level (Dudley Ward *et al.*, 2024). The groundwater in these layers is recharged from river leakage, rainfall, and irrigation on the Plains and tends to flow in a south-east direction from the foothills of the Southern Alps to the coast (Figure 18). While the aquifers are highly permeable and water bearing, the aquitards have lower permeability and act as confining layers, although they may transmit water slowly between aquifers. Towards the coast, the geology of Banks Peninsula acts as a barrier to groundwater flow, with its low permeability causing groundwater flow to diverge and flow either side of the Peninsula (Figure 18). Artesian aquifers underlie most of the lowland drainage schemes within the Selwyn District (Dudley Ward *et al.*, 2024) and result in numerous springs. The Greenpark catchment differs from the other drainage catchments as it is largely overlain by a continuous aquitard and so has no recorded springs receiving water from the deeper confined aquifers (<https://gis.ecan.govt.nz/arcgis/rest/services/Public/Groundwater/MapServer/6>). Groundwater levels in the Greenpark catchment show that the shallow unconfined aquifer is closely linked to the level of Te Waihora/Lake Ellesmere.

While the surface water and rated drainage catchments are a similar size and shape for the Greenpark catchment, the surface water catchments are much larger than the rated catchments for the Ellesmere, Leeston and Taumutu catchments (Figure 2; Figure 19). While the rated catchments are focused on the low-lying margins of Te Waihora/Lake Ellesmere, the theoretical surface water catchments for Ellesmere, Leeston and Taumutu extend much further inland onto the Canterbury Plains, although in reality there is not full surface connectivity to the lowland streams.

Water is also fed into some of the rated catchments by other means. Selwyn District Council's water race networks, which exist primarily to provide drinking water for livestock, feed water from the Rakaia and Waimakariri rivers onto land around the lowland Selwyn district, contributing recharge to the groundwater system via race losses and bywash at the end of races (Figure 19). Whilst there is only one actual water race channel that directly connects into the upper reaches of the Ellesmere rated catchment, the sheer size of the water race network across land to the north and west of the Ellesmere, Leeston, and Taumutu rated catchments means that the surface water flow for some of the waterways in these rated catchments could be bolstered by the supply of water to the water race network which then discharges to ground to the north and west. If water race networks are closed in the future, then the groundwater system will rebalance in response to lower recharge and flows in the rated catchment waterbodies could subsequently change over time.

Interactions between the wider Canterbury Plains groundwater system (and its drivers and pressures) and the rated catchments (particularly Ellesmere, Leeston, and Taumutu) influence both surface water flows and surface water quality (Figure 18). Concerns were raised during the early planning stages of the Central Plains Water (CPW) irrigation scheme that the application of more river-sourced irrigation water to the upper and mid Plains could influence groundwater levels and lowland waterway flows. This has not occurred to the extent predicted, due to changes in how the CPW scheme was constructed relative to what was originally planned. Concerns have also been raised regarding the influence of urban stormwater disposal on groundwater levels and drain flow regimes. It remains challenging, however, to distinguish between changes in flows and water levels that may be caused by CPW, other irrigation, or urban development, and changes caused by climate variability.

The larger scale of the surface water and potential groundwater catchments compared to the rated catchment, particularly for Ellesmere, Leeston, and Taumutu, adds an additional layer of complexity to the management of surface waterways in the rated catchments. It means that flow permanency may change due to factors occurring at a larger landscape scale beyond the control of the rated catchment, and influenced by climate drivers outside of the rated catchment boundary, which could mean that some interventions will function better in some years compared to others based on the amount of surface water flow. Similarly, surface water quality is influenced not only by activities within the rated catchment, but also by activities well outside it that affect groundwater quality across the broader groundwater catchment to which waterways in the rated catchments are connected. It will therefore be challenging for the tools and solutions proposed here to manage effects from a much larger area than that covered by the interventions. Since groundwater quality affects surface water quality, some aspects of surface water quality within the drainage catchment are outside of the scope of this CMP, which focuses on tools and solutions at the rated catchment level.

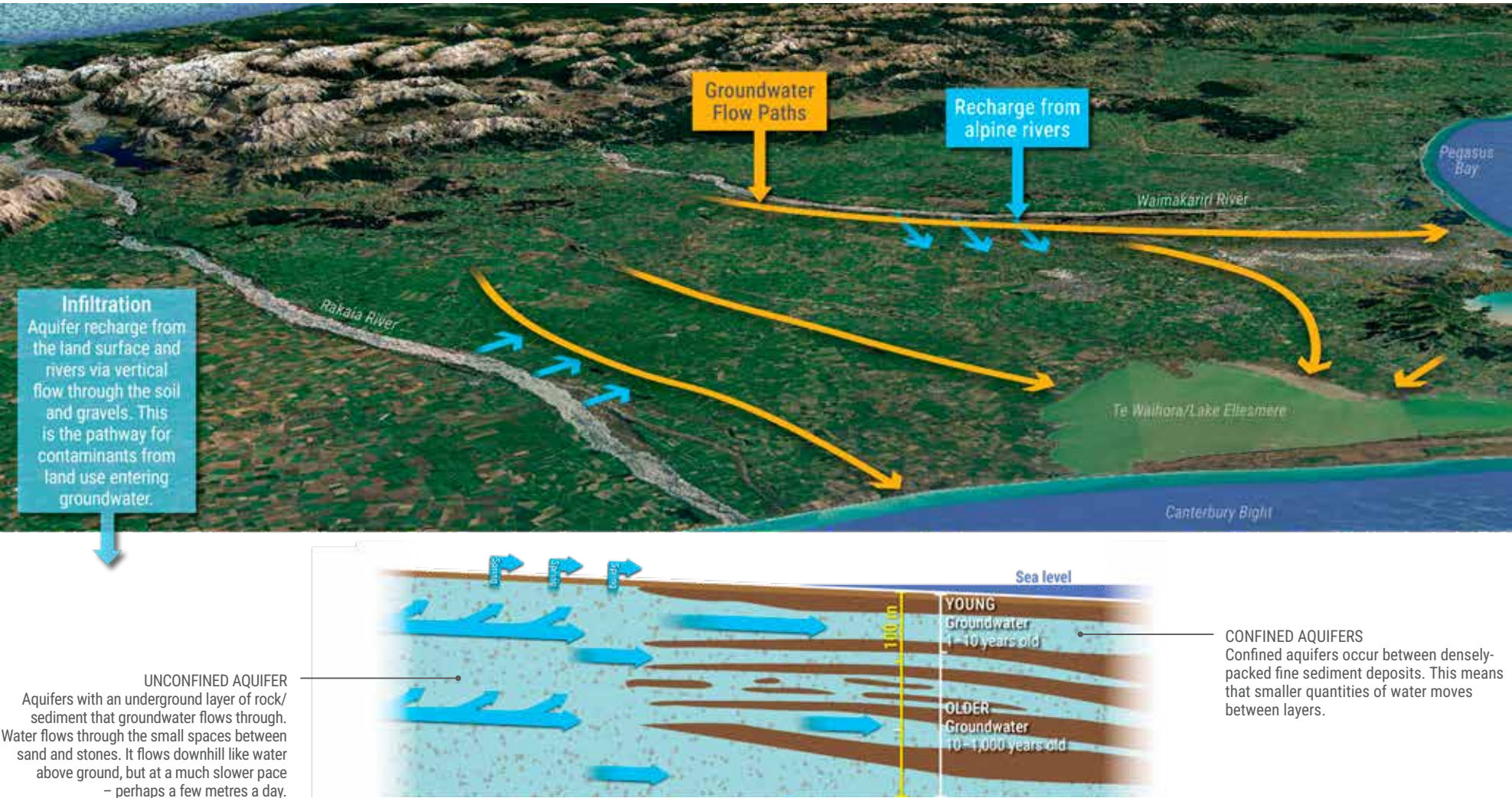


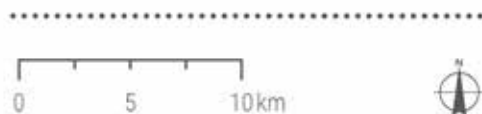
FIGURE 18:
Hydrological context of the Te Waihora/Lake Ellesmere catchment. © EOS Ecology

WATER RACE SCHEME:

- Ellesmere
- Malvern
- Paparua

OTHER:

- Surface water catchment (REC)
- Land drainage catchment (rated)
- Rated drain



Map © EOS Ecology, 2025 / www.eosecology.co.nz

Layer source: Water race scheme (Environment Canterbury), surface water catchment ((River Environment Classification (REC); NIWA), land drainage catchment & rated drains (Selwyn District Council), hill shade (LINZ), roads (Esri vector tile service)

Basemap: LCDB v6 (Manaaki Whenua, Landcare Research)

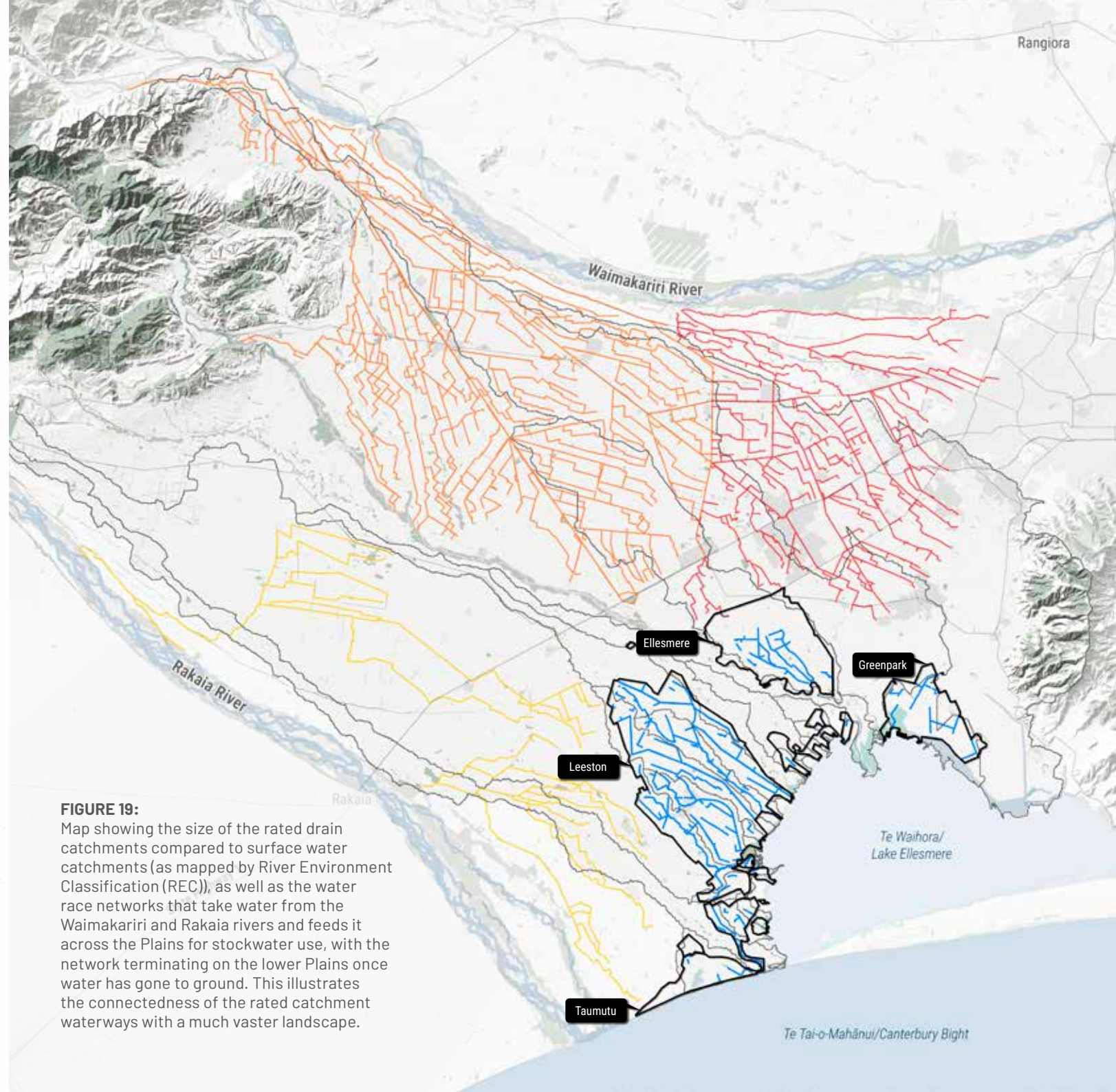


FIGURE 19:

Map showing the size of the rated drain catchments compared to surface water catchments (as mapped by River Environment Classification (REC)), as well as the water race networks that take water from the Waimakariri and Rakaia rivers and feeds it across the Plains for stockwater use, with the network terminating on the lower Plains once water has gone to ground. This illustrates the connectedness of the rated catchment waterways with a much vaster landscape.

4.3 Land Use Change & Intensification

Rural land use dominates the Greenpark, Ellesmere, Leeston, and Taumutu catchments and, as in the wider Canterbury region, there has been substantial agricultural intensification over the past three decades. Within Canterbury, the number of dairy cattle increased ten-fold between 1990 and 2022 (Stats NZ, 2024a), with dairy conversions and on-farm intensification accommodating this growth. These changes in land use have been accompanied by shifts in land management practices, including increased reliance on irrigation and the use of synthetic fertilisers.

To enable productive farming within these catchments, there has historically been a need to protect land from flooding, ponding, and waterlogged ground. As farmland has developed, many natural springs, wetlands, and small streams have been modified or replaced with networks of artificial drainage channels. More recently, farm intensification has also increased the need to actively maintain soil moisture levels to support agricultural production. Across Canterbury, the total irrigated area for dairy farms doubled between 2002 and 2019 (Stats NZ, 2024b). Much of the land within these catchments is irrigated to some extent (Dark, 2020; <https://opendata.canterburymaps.govt.nz/datasets/ecan::irrigated-areas/explore>), reflecting the wider regional trend toward increased irrigation and more intensive farming systems.

Acknowledging that most catchments contain a mix of activities and land cover types, MfE & Stats NZ (2020) classify catchments based on their dominant land cover. Under this system, the Greenpark, Ellesmere, Leeston, and Taumutu catchments are all classified as pastoral. Across New Zealand, most waterways in pastoral catchments are affected by elevated concentrations of nutrients, suspended sediments, and pathogens (MfE & Stats NZ, 2020). While water quality trends are improving in some pastoral areas, water quality remains stable or continues to decline in many other pastoral catchments, indicating ongoing pressures from land use and land management practices. Groundwater quality in the central Canterbury Plains shows the impacts of land use intensification, with nitrate-N concentrations in monitoring bores in the Selwyn District plains predominantly likely or very likely to be degrading based on 10-, 15-, and 20-year trend analyses (www.lawa.org.nz/explore-data/groundwater-quality). There is some recent evidence of improving trends based on the last five years of data (cpwl.co.nz/wp-content/uploads/2026/03/2024-2025-CPWL-Ground-and-Surface-Water-Report.pdf), however the influence of climate events such as recharge ‘pulses’ caused by ex-tropical cyclones in 2017 is difficult to disentangle. The effects of upgradient land use on nitrate-N in surface water within the rated catchments is most evident in the Ellesmere, Leeston and Taumutu catchments (Calder-Steele, 2024). Monitoring in the Greenpark

catchment shows lower nitrate-N values, which is interpreted as being due to the smaller upstream groundwater catchment with less exposure to land use outside of the rated catchment boundary.

Leeston contains the only substantial urban area within these catchments, but even here urban land cover currently accounts for less than 2% of the total catchment area (Table 3). Although rural land uses remain dominant, urban areas within these catchments have increased in recent years, which will not be reflected in the latest available land cover databases as they date back to the summer of 2023/2024. The population of Leeston was 2,470 as at June 2025 (Stats NZ, n.d.), and the population of Selwyn District increased by 29% between the 2018 and 2023 Census (Selwyn District Council, 2024). The Ellesmere Area Plan 2031 (SDC, 2016) identifies an expanded residential boundary for Leeston intended to accommodate projected population growth to 2031 without requiring additional greenfield development. However, SDC has identified high groundwater levels, flooding risk, limitations in existing stormwater infrastructure, and reverse sensitivity effects associated with the wastewater treatment plant as constraints on future land rezoning around the township.

The transition from rural to urban land use has the potential to degrade the freshwater environment, although mitigation measures associated with urban development can, in some cases, reduce catchment pressures. Where urban expansion occurs in areas containing springs, land use change may alter spring contributions to the catchment. Increasing urban land cover also results in a greater proportion of impervious surfaces and higher volumes of stormwater runoff which, if not adequately managed, could put additional flooding pressure on downstream low-lying areas. Urban stormwater typically contains a different suite of contaminants than rural runoff, including higher concentrations of heavy metals, which changes the pressures on local waterways. While good urban design can mitigate some effects of urbanisation, urban catchments generally exhibit flashier streamflows, higher contaminant and nutrient concentrations, simplified channel morphology, and increased dominance of pollution-tolerant aquatic species (Walsh *et al.*, 2005).



Intermittent channel in
Greenpark rated catchment

Image source: EOS Ecology

5 Pressures & Current Challenges/Issues

The following sections outline the pressures and current challenges/issues faced in the four rated catchments that are covered by this CMP (i.e., Greenpark, Ellesmere, Leeston, and Taumutu land drainage schemes; Table 12). These were identified based on discussions with members of Te Komiti Waiora District Land Drainage and Waterway Committee (including representatives from Te Taumutu Rūnanga, Wairiri Valley District Committee chair, Te Rūnanga o Ngāi Tahu, Department of Conservation, Canterbury Regional Council, and Selwyn District Council), knowledge gained from determining the past and present state of the catchments, and discussions with landowners and those with a foundational knowledge of the catchment.



Springfed system in Ellesmere rated catchment.

TABLE 12:

An overview of the pressures and current challenges/issues faced in the four rated catchments that are covered by this CMP (i.e., Greenpark, Ellesmere, Leeston, and Taumutu land drainage schemes).

Pressure/Challenge/Issue	Further Pressure/Challenge/Issue Breakdown	Greenpark	Ellesmere	Leeston	Taumutu
Flooding exacerbation	Soils, water table & landform	✓	✓	✓	✓
	Irregular maintenance	✓	✓	✓	
	Channel margins exacerbate flooding issues	✓	✓	✓	✓
	Urban expansion creates concerns around increased flooding			✓	
Maintenance practices	Maintenance in rated vs unrated network	✓	✓	✓	✓
	Bank instability	✓	✓	✓	✓
	Sediment accumulation& removal	✓	✓	✓	✓
Water quality	Relative influence of issues from outside vs inside the catchment		✓	✓	✓
	Water quality issues related to standing water	✓			
Macrophytes			✓	✓	✓
Lack of space around drains		✓	✓	✓	✓
Temporary location of waterways		✓		✓	
Fish passage	Weirs, pipes & urbanisation	✓		✓	✓
	Using fish passage exclusion to protect species			✓	
Communication		✓	✓	✓	✓



Perennial channel in
Leeston rated catchment

Image source: EOS Ecology

5.1 Flooding

5.1.1 Flooding Exacerbation: Soils, Water Table & Landform

The low-elevation Greenpark catchment has persistent issues with localised flooding and prolonged wet ground conditions (Figure 20). The catchment is dominated by heavy, poorly drained gley soils, with more than 80% of the mapped soils classified as poorly or very poorly drained (Table 5; Figure 7). Combined with the catchment's low elevation and proximity to Te Waihora/Lake Ellesmere, these soil characteristics make the area highly susceptible to waterlogging, particularly in winter, but often throughout the year. This susceptibility is the primary reason land drainage is required in the Greenpark catchment, and the drainage network is therefore essential for maintaining the productive capacity of farmland. However, this comes with its own challenges, as the deep drainage channels are influenced by water levels in Te Waihora/Lake Ellesmere: when lake levels are high, water can back up through the network and reduce both flood flow capacity and overall effectiveness of the narrow, confined drains.

The Ellesmere, Leeston, and Taumutu catchments are similarly dominated by poorly drained gley soils and are also characterised by seasonally high groundwater tables and abundant springs, factors that have historically driven the development of the land drainage schemes. In addition, the Leeston and Taumutu catchments receive runoff from much larger surface water catchments, meaning the rated drainage network must convey not only rainfall falling within the catchment, but also inflows originating from outside the rated area. Expanding urban areas within Leeston have also raised community concern about the potential for increased flood volumes and flashier flood flows related to a reduction in permeable land surface area, with associated implications for flood risk downstream of the expanding town.

FIGURE 20:  Images illustrating flooding of low-lying ground in the Ellesmere rated catchment.



5.1.2 Flooding Exacerbation: Irregular Maintenance

Shallow, ephemeral, informal channels within the rated catchment often have lower flow capacity (relative to permanently flowing channels), and localised blockages or channel constrictions resulting from irregular maintenance can lead to flooding when rainfall exceeds their ability to convey flow (Figure 21). These types of channels typically receive little to no routine or preventative maintenance, and blockages can be difficult to detect during dry conditions. In addition, many smaller waterways within the rated catchment are not defined as rated drains and are therefore not maintained to the same standard as the rated drains.

Improving understanding of both formal drainage channels and informal flow paths, together with clear maintenance guidance for temporary and ephemeral flowing channels, would help address these issues. Maintaining fence lines free of obstructions is particularly important, as fences frequently cross waterways and can trap debris which then impedes flow during rain events if it is not cleared away. Similarly, undersized or poorly maintained culverts, whether on ephemeral/intermittent or perennial waterways, can create bottlenecks that restrict conveyance during high-flow periods, leading to upstream ponding and localised flooding.

In some locations, a lack of downstream vegetation management, particularly the presence and growth of willows, can contribute to flow constrictions and elevated upstream water levels due to the low gradient of the catchments. Willows can cause significant channel-choking by narrowing waterways, trapping debris, and increasing hydraulic resistance. A lack of willow management and related flooding exacerbation has previously been identified as an issue for some waterways within the Leeston catchment; however, targeted management efforts have largely controlled the issue in this area. Crack willow (*Salix fragilis*) and grey willow (*Salix cinerea*) are listed as unwanted organisms under the Ministry for Primary Industries' National Plant Pest Accord (NPPA)¹, although these may not be the primary species of concern in this particular catchment. Reinvasion following control is a widespread issue, as upstream areas can continually supply seedlings and stems that readily re-establish and undermine downstream control efforts – meaning that a coordinated, catchment-wide approach is needed. Willow spread is influenced by factors such as wind direction, location, and species-specific traits, highlighting the importance of effective upstream or upwind management to support successful and sustained downstream control. Ongoing monitoring and maintenance will remain important to ensure downstream vegetation does not re-establish in a manner that compromises drainage performance or increases localised flooding risk.

¹ www.mpi.govt.nz/biosecurity/how-to-find-report-and-prevent-pests-and-diseases/partnerships-programmes-and-accords/national-pest-plant-accord-for-preventing-the-sale-of-invasive-weeds-in-nz

Irregular Maintenance



Infrequent or insufficient maintenance of drainage waterways can exacerbate flooding by constricting channels and impeding the free flow of water. Two-stage channels will increase flood flow capacity, along with a bank maintenance programme.



Keeping culverts and bridge openings free of obstructions is essential for effective drainage, especially during rain events.



Fences across waterways can trap debris, constrict flow, and cause localised flooding during high flow events.



Undersized culverts or low crossings can create blockages during elevated flow.

FIGURE 21:

Images illustrating how irregular maintenance of ephemeral channels and culverts, along with fences crossing waterways, may contribute to increased flooding in the Greenpack, Ellesmere, Leeston, and Taumutu drainage catchments.

5.1.3 Flooding Exacerbation: Channel Margins Exacerbate Flooding Issues

Over time, routine maintenance of land drainage waterways can result in the margins and banks becoming elevated above the surrounding land, as channels are frequently excavated to remove macrophytes and fine sediment and the material is then deposited adjacent to the channel (Figure 22). This channel morphology can create additional challenges during flood events because once stream banks are overtopped, water may struggle to return to the channel and drain away efficiently. In areas with better drained soils (which is limited to the upper reaches of the Ellesmere rated catchment and parts of the Greenpark rated catchment adjacent to Davidsons Road, Figure 7), this effect may be less pronounced, as a greater proportion of floodwater can infiltrate into the ground. In areas with poorly drained soils, particularly in the Greenpark catchment, limited infiltration means overland flow may be the primary pathway for floodwaters to re-enter the channel. Raised banks can impede this process, prolonging surface ponding and inundation of adjacent land. Similar effects can arise from riparian planting, where densely planted margins may form physical barriers that slow or block the return of floodwaters to the channel. In some cases, riparian margins can effectively function like raised banks, reducing drainage effectiveness during rain events and extending the duration of inundation. Creating intentional breaks at key locations within riparian margins, and ensuring planting is appropriately located and integrated with channel reshaping, can help maintain floodwater return pathways while still delivering ecological and water quality benefits across the rated catchments.

Bunded Margins



FIGURE 22:

Images illustrating how sediment spoil left adjacent to drainage channels could exacerbate flooding issues by reducing flood flow capacity of the drain and preventing surface water flooding from entering drainage channels.

Raised waterway margins can prevent floodwater from re-entering the channel, prolonging the inundation of surrounding land.

5.1.4 Flooding Exacerbation: Urban Expansion Creates Concerns Around Increased Flooding

Expansion of urban areas within these catchments has raised growing concern among local stakeholders about changes to surface water discharge and the potential for increased flooding pressure downstream (Figure 23). Rural landowners have expressed concern that the transition from predominantly rural land uses to more intensive urban development could be altering hydrological processes, with implications for flood risk beyond the immediate areas of development.

Although rural land uses remain dominant in these catchments, urban areas have expanded in recent years. The wider Selwyn District has experienced rapid growth in recent years, with a 29% increase in population between the 2018 and 2023 Census periods. In response to further projected growth, the Ellesmere Area Plan 2031 (SDC, 2016) identifies an expanded residential boundary for Leeston, intended to accommodate future population demand without the need for additional greenfield development (Section 4.3). However, there are significant constraints on further land rezoning around the township, including high groundwater levels, existing flooding risk, and limitations in stormwater infrastructure.

Urban expansion alters catchment hydrology primarily through an increase in impervious surfaces such as roofs, roads, and paved areas. These changes reduce infiltration and increase the volume and intensity of stormwater runoff. Stakeholders are concerned that these changes may exacerbate flooding downstream, particularly given the low-lying land and thus reduced flood flow capacity from channels during higher lake levels due to backwater effects. In some areas, urban development may also affect spring-fed systems, potentially altering baseflows and changing the timing and volume of water entering the catchment.

Beyond flooding, the transition from rural to urban land use has broader implications for freshwater systems. Urban stormwater typically contains a different suite of contaminants than rural runoff, including elevated concentrations of heavy metals and other pollutants. While good urban design and stormwater management practices can reduce some adverse effects, urban catchments commonly exhibit flashier streamflows, higher contaminant and nutrient concentrations, simplified channel morphology, and a greater dominance of pollution-tolerant aquatic species (Walsh *et al.*, 2005). Collectively, these changes heighten concern that continued urban expansion, if not carefully managed, will increase flood risk while also placing additional pressure on downstream freshwater environments, including Te Waihora/Lake Ellesmere.

FIGURE 23:  Images illustrating urban development within the Leeston rated catchment.



5.2 Maintenance Practices

5.2.1 Maintenance in Rated vs Unrated Network

The purpose of the SDC maintenance programme is to maintain the drainage function of waterways¹. Across the four rated catchments covered in this CMP, rated drains make up a smaller proportion of total waterway length than unrated waterways (Table 13). This creates a significant challenge for achieving consistency and appropriate maintenance across the rated catchment, as individual landowners are responsible for funding and managing a large proportion of the drainage network. To achieve the vision of the CMP, many of the tools and solutions proposed will need to be implemented on unrated drains within the rated catchments, as well as on waterways and informal/overland flow paths beyond the rated network. Collaboration with landowners will be essential to ensure these interventions are effective and sustainable. By considering maintenance requirements during the design phase and working closely with landowners, solutions can be successfully integrated into existing drainage management practices. Developing maintenance plans for unrated drains in partnership with landowners will support long-term success, with landowners playing a key role in ongoing maintenance and record keeping. This reinforces the importance of establishing smart systems for scheduling and recording maintenance, as this information is likely to be critical for assessing CMP outcomes and meeting the requirements of potential future discharge consents for these catchments.

Within the rated waterways of the Greenpark, Ellesmere, Leeston, and Taumutu rated catchments, routine maintenance is funded by SDC and carried out by contractors. Selwyn District Council is currently transitioning the delivery of land drainage maintenance from land drainage committees to CORDE, a process that will be fully implemented over a three-year period. Maintenance activities undertaken by CORDE are already scheduled through contract documentation and tracked within SDC's Asset Management System (AMS) for other service areas, such as water races and land drainage. Once the transition is complete, land drainage maintenance across these catchments will be consistently captured through the AMS. The AMS includes a GIS interface, providing a strong foundation for spatially enabled maintenance records and supporting the application of smart, catchment-wide asset management practices.

¹ For parts of the Leeston catchment where there are habitats sustaining kōwaro/Canterbury mudfish, a more conservative approach to maintenance is undertaken to protect this endangered fish.

TABLE 13:
Length of rated drain compared to total channel (any defined channel that has either perennial or intermittent/ephemeral flow) length within Greenpark, Ellesmere, Leeston, and Taumutu rated catchments. Classification of channel length may be less accurate in some areas due to limited time for ground-truthing and the inability to access areas not visible from the road.

	Greenpark		Ellesmere		Leeston		Taumutu	
	Rated Drain	All Channels (Rated & Unrated)	Rated Drain	All Channels (Rated ³ & Unrated)	Rated Drain	All Channels (Rated & Unrated)	Rated Drain	All Channels (Rated & Unrated)
Length ^{1,2} (km)	20.6	74.4	25.3	86.0	200.5	350.8	9.7	17.9
% of channel length	27.7%		29.4%		57.1%		54.1%	

¹ Length calculated from a combination of Geographic Information System (GIS) analysis of 2023 Light Detection and Ranging (LiDAR) data and field data interpretation; as such, this is an estimate only.
² Length of rated drain based on GIS-provided layers, and may differ from that provided in Table 1, which were taken from Selwyn District Council reports.
³ The water race at the top/west end of the Ellesmere catchment is also a rated drain.

5.2.2 Bank Instability

Bank instability has been identified as a key challenge across the rated drainage networks, arising from a combination of underlying physical characteristics and channel management practices. Across many parts of the catchments, banks have become over-steepened, a condition exacerbated by channel sediment removal, which reduces vegetation cover and increases susceptibility to erosion (Figure 24). The issue is further compounded by over-spraying of bank margins, resulting in additional loss of stabilising vegetation and increased erosion risk. This is a very common maintenance practice, particularly for roadside drains. In addition, erosion associated with weirs (within the Leeston catchment) or undersized culverts has led to localised scour and bank instability that can risk other infrastructure such as power poles. In some locations, bank reinforcement measures, such as gabion baskets, have been required to prevent further erosion. In several cases, ongoing bank instability is placing adjacent infrastructure at risk, including power poles.

Bank Instability



Steep banks are vulnerable to slumping and erosion, introducing fine sediment into waterways.



Bank reinforcement using gabion baskets to stabilise eroding channel banks, Leeston catchment.



The coastal channel at Taumutu has formed through the gravel sandbank, and so bank stability is a challenge here.



Although spraying is a common maintenance practice along waterway margins, repeated spraying removes bank vegetation, increasing the risk of sediment entering the channel.



Bank erosion can risk infrastructure such as power poles.

FIGURE 24:

Images illustrating bank instability in the Greenpark, Ellesmere, Leeston, and Taumutu land drainage catchments.

5.2.3 Sediment Accumulation & Removal

Fine sediments accumulate on the beds of drainage channels, with ongoing inputs arising from erosion of steep or slumping banks, runoff from farms via informal flow paths (also referred to as critical source areas) or runoff from gravel roads, sediment stockpiles from sediment removal, and stock access to drainage waterways (Figure 25). Fine sediment includes both organic matter (such as decaying vegetation, algae, and animal waste), and inorganic particles like silt and clay. As a result of the continual supply of fine sediment, combined with low channel gradients and slow flowing or standing water in parts of these catchments, channel substrates can contain deep and highly variable accumulations of fine sediment. These accumulated sediments adversely affect both water quality and aquatic habitat within the drainage waterways.

The sediment that accumulates in the rated network is mechanically removed as effectively as possible to maintain the drainage function of the waterways, and to prevent this accumulated sediment from being redistributed through the network at times of high flow. However, the regular mechanical removal of sediment and over-spraying of banks to maintain channel capacity has the potential to destabilise banks and cause further sediment input to the channel, which in turn will require more regular removal, creating a self-perpetuating cycle of sediment removal and sediment generation. To avoid maintenance activities exacerbating existing issues within their land drainage catchments, SDC has recently developed standard operating procedures (SOPs) for several land drainage catchments (e.g., Wilson, 2024). The SOPs recommend, where possible, undertaking drain cleaning when waterways are dry, removing cut weed from the channel, maintaining the channel profile, retaining bank vegetation, using a slotted bucket for silt removal, and avoiding the placement of excavated sediment within 1 m of the top of the bank (Wilson, 2024). Looking at options for creating more space for channels (see Section 7.2) will be needed, along with catchment-specific guidance that recognises the limitations of the gley and pallic soils of the rated catchments.

Sediment Inputs



While maintenance is essential to maintain drainage function, exposed soil adjacent to waterways can be a significant source of sediment input.



Ephemeral drainage waterways with bare soil become sources of sediment during rainfall as they channel overland runoff to downstream waterways.

FIGURE 25:
Images illustrating sources of sediment to waterways in the Greenpark, Ellesmere, Leeston, and Taumutu land drainage catchments.

5.3 Water Quality

Water quality monitoring indicates distinct but related pressures across the Ellesmere, Leeston, and Taumutu catchments. These three rated catchments are primarily affected by very high concentrations of nitrate-nitrite-N, total nitrogen, total phosphorus, dissolved reactive phosphorus (DRP), and total suspended solids (TSS). In comparison, whilst *E. coli* concentrations are elevated in Ellesmere and Leeston, they are very low in the Taumutu rated catchment. These three spring-fed catchments are also strongly influenced by groundwater contributions from beyond the surface water catchment, as discussed in Section 5.3.1. Greenpark catchment also exhibits pronounced water quality challenges, including elevated DRP, total phosphorus, ammoniacal-N, high TSS, and very low dissolved oxygen. However, unlike the other three catchments, Greenpark has little or no spring flow inputs and is instead strongly influenced by a prevalence of standing water and trapped organic matter.

5.3.1 Relative Influence of Issues from Outside vs Inside the Catchment

Rural land use dominates the catchments draining into Te Waihora/Lake Ellesmere, and there has been substantial land use intensification and expansion of irrigated area over the past three decades. Across Aotearoa New Zealand, the national dairy herd increased by approximately 70% between 1994 and 2017 (MfE & Stats NZ, 2020), driven by dairy conversions and farm intensification. Increased stocking rates have in turn required more active management of soil moisture to maintain agricultural productivity. In the Canterbury region, this has resulted in a doubling of the total irrigated area of dairy farms between 2002 and 2022 (Stats NZ, 2024b). Farm intensification has also been accompanied by increased use of synthetic fertilisers, which has contributed to declining water quality in many catchments.

Land use change and intensification across the wider Te Waihora/Lake Ellesmere catchment can influence groundwater quality in ways that extend beyond individual surface water drainage boundaries. While monitoring of shallow groundwater and springs within the wider catchment shows elevated nitrate-N concentrations (Alexander, 2023; Calder-Steele, 2024), the limited presence of springs and the hydrological setting of the Greenpark catchment suggest it functions largely independently of the broader system (see Section 4.2). Water quality data indicate that, in contrast to the Ellesmere, Leeston, and Taumutu catchments, nitrate-N concentrations in the Greenpark catchment remain below relevant guideline values (Table 11). This supports the conclusion that external influences on water quality are less pronounced in Greenpark than in the Ellesmere, Leeston, and Taumutu catchments. In this respect, the Greenpark catchment behaves similarly to the neighbouring Osbornes catchment (EOS Ecology & Aqualinc Research, 2026a). Despite this, there is a perception within the Greenpark community that external land use pressures and water quality issues are affecting local waterways. Addressing this concern through ongoing engagement with the local community is therefore important (see Section 5.9).



Macrophyte growth in
Ellesmere rated catchment

Image source: EOS Ecology

5.3.2 Water Quality Issues Related to Standing Water

In pre-European times, much of the Greenpark catchment was covered by water. Wetlands and the shallow margins of Te Waihora/Lake Ellesmere occupied a substantial proportion of the catchment, while a sandhill extending across the mid-catchment formed the only higher and drier land area (Environment Canterbury, 2026). Regular openings of Te Waihora/Lake Ellesmere from 1868 onwards (Maw & Main, 1989) have substantially altered both the duration of inundation and the hydrological regime of the Greenpark catchment. While these lake openings largely protect this very low-lying and low slope land from inundation by the lake, drainage of rainfall and groundwater is still required to enable productive land use. As a result, many waterways in the Greenpark catchment are ephemeral (flowing only temporarily during, and shortly after, rainfall) or intermittent (flow during wetter seasons when groundwater levels are higher and tending to be dry over summer). Although the larger rated drains may retain water year round (i.e., exhibit a perennial ‘flow’), even these waterways are characterised by very low gradients, low water velocities, and long reaches of standing water (Figure 26).

Extended periods of dry weather and low groundwater levels in recent years have highlighted how dry these waterways can become, and newer residents in the catchment may perceive these conditions as typical for the catchment. In contrast, longer-term residents will have experienced periods of much higher groundwater levels and recognise the importance of the drainage network during wetter years. These changing conditions are expected to become increasingly challenging as climate change drives greater extremes in both wet and dry periods across the region.

The predominance of standing, rather than flowing, water in the perennial reaches of the Greenpark catchment is also a key contributor to poor water quality (Table 11). In this low-lying and relatively flat catchment, standing water combined with high organic sediment loads contributes to low dissolved oxygen levels. As discussed in Section 3.2.7, the standing water and very low dissolved oxygen conditions are controlling the storage of carbon and nutrients within the sediment, with bacterial denitrification decreasing nitrate in the absence of oxygen (i.e., anoxic conditions) and the lack of oxygen causing an increase in carbon, ammoniacal nitrogen, and phosphorous concentrations. In this regard, Greenpark is more like Osbornes Drain in terms of its water quality issues and challenges (see EOS Ecology & Aqualinc Research, 2026a).

FIGURE 26:

Images illustrating the predominance of standing water within waterways of the Greenpark catchment. The standing water and low dissolved oxygen will be controlling the release of nutrients.



5.4 Macrophytes

Many reaches within the Greenpark, Ellesmere, Leeston, and Taumutu catchments experience excessive macrophyte growth (Figure 27). In some areas, drainage channels are seasonally obscured by emergent macrophytes. Commonly observed macrophytes in these catchments include monkey musk (*Mimulus* sp.), watercress (*Nasturtium* sp.), Callitriche, and floating grasses that can obscure the water surface. Free-floating duckweed (*Lemna* sp.) is also common in areas of standing water in the Greenpark rated catchment. Partial shading alone is insufficient to limit macrophyte growth in these systems, as high nutrient concentrations and slow flowing conditions provide ideal growth conditions. Emergent species such as monkey musk and water cress are routinely removed by a contractor on behalf of SDC to maintain the drainage function of the waterways.

While the current macrophyte maintenance regime is required to preserve drainage capacity, it has several recognised environmental impacts and represents an ongoing operational cost, as it does not offer a permanent solution. A review by James (2011) identified a range of potential environmental effects associated with mechanical macrophyte clearance, including the mobilisation of fine sediments, changes in water chemistry, physical removal of aquatic fauna, and the alteration or loss of instream habitat. Chemical control methods also have environmental implications, such as reduced dissolved oxygen levels from decaying plant material, nutrient release, potential herbicide toxicity, and loss or modification of instream habitat (James, 2011). Stockpiling removed macrophytes and sediments along drain margins can further exacerbate existing bank instability issues by smothering vegetation and increasing bank height.

Although macrophytes can reduce drainage capacity in some reaches, they can also provide water quality benefits by removing nutrients from the water column. The potential to harness this function, by supporting macrophyte growth within drainage channels as lineal wetlands, alongside increased channel capacity, is explored further in Section 7 of this CMP.

Excessive Macrophyte Growth



Greenpark



Ellesmere



Leeston



Taumutu

FIGURE 27:
Images illustrating excessive
macrophyte growth in the
Greenpark, Ellesmere, Leeston,
and Taumutu catchments.

5.5 Lack of Space Around Drains

Within the Greenpark, Ellesmere, Leeston, and Taumutu catchments, drainage waterways have been developed alongside and through farmland, along road margins and access ways, and through urban areas. Some waterways are deeply incised with steep, erosion-prone banks, making interventions more challenging to implement. Undertaking interventions within these waterways may require additional adjacent land, which may encroach on farmland. In many cases, little space is available for altering the existing layout. On-farm drains typically have minimal setbacks because of the high value of productive land, while roadside drains may be constrained by narrow roadside corridors, roadways, and power poles (Figure 28). Steep banks on over-deepened drainage channels may require substantial corridor widths for modification and where space is limited, opportunities for bank reshaping and channel improvement are reduced. Substantial vegetation, power poles, and the width of roading corridors will all be space limiting factors within these catchments.

Lack of Space



Powerlines and roads are often located close to drainage waterways, making bank reshaping and planting a challenge.



Over-deep channels require substantial room to reshape them and improve flood flow capacity, which may be challenging when located by roads.



Large vegetation and trees can limit access and make it more challenging to implement interventions.

FIGURE 28:
Images illustrating the
challenge of lack of space
within the drainage network

5.6 Temporary Location of Waterways

Across the Greenpark, Ellesmere, Leeston, and Taumutu catchments, there are many ephemeral or intermittent non-rated drains that are not in a permanent location (Figure 29). These temporarily located waterways tend to be relocated as required, to align with changes in fence layout or for other farm management reasons. It is recognised by land users that while drainage waterways are necessary to reduce waterlogged soils in this area, the locations where these are needed can vary over time. The perception of these temporary waterways may be that they have lower value compared to permanently located land drainage waterways, but they may play an important role in achieving a more holistic approach to catchment management.

This provides an additional challenge when working towards a catchment-based approach to waterway management. This CMP represents waterways as they are now, but there needs to be a recognition that some of these locations are temporary and the mapped waterway layers will become out of date over time. This challenge will need careful consideration in terms of locating the interventions that are designed to improve these catchments, and the general approach will be to locate interventions only on waterways that are permanently located.

Temporary Waterways



FIGURE 29:
Images illustrating the challenge
of temporary waterways in the
Greenpark, Ellesmere, Leeston,
and Taumutu catchments.

Temporary waterways tend to follow fence lines within the rated catchments.

5.7 Fish Passage

Managing fish passage, particularly in the Leeston and Taumutu catchments, presents several challenges, particularly where infrastructure, urban development, and conservation objectives interact. Physical barriers such as weirs and pipes can restrict fish movement, and there may be opportunities to improve catchment connectivity as these structures are upgraded (Section 5.7.1), while in some locations maintaining barriers remains necessary to protect threatened species (Section 5.8). SDC have commissioned a fish passage assessment for all in-stream structures across the district, where barriers to fish passage will be identified and prioritised, and fish passage will be progressively improved through SDC's asset renewal programme.

5.7.1 Weirs, Pipes & Urbanisation

Infrastructure such as weirs and pipes can present ongoing challenges for fish movement, particularly within the Leeston and Taumutu catchments (Figure 30). The Leeston catchment contains numerous weirs along the Hanmer Road drain, which include downstream drops that create abrupt barriers to upstream fish movement. Undersized culverts are another common issue, and where there is sufficient gradient, they can create elevated water velocities and vertical drops at their downstream end, disrupting natural flow patterns, altering habitat conditions, and limiting fish passage. In rapidly expanding urban areas such as Leeston, the piping of long sections of waterways further exacerbates fish passage issues by creating extended barriers to connectivity and permanently reducing instream habitat availability. Most of the waterways in the Taumutu rated catchment discharge directly to the coast. Because of the highly exposed nature of the gravel shoreline, the outlets are all piped, which creates significant impediments to upstream fish migration. However, the ability to rectify this is limited given the highly dynamic nature of the coastline, meaning that any open channel would soon become blocked from the sea with the constant movement and buildup of coastal gravels.

Weirs & Pipes



Some smaller culverts may have drops at the downstream end that can create fish passage barriers, although these are usually rare in the rated catchments due to the low gradient of most waterways.



Formal weirs along Hanmer Road drain help to manage water level and velocity in a deepening drainage channel, but they also create barriers for fish passage.

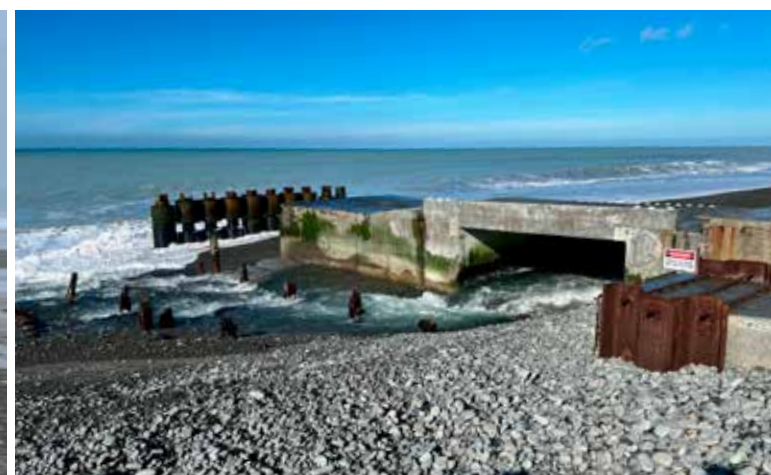


FIGURE 30:

Fish passage issues in the Leeston and Taumutu rated drain catchments.

For the Taumutu rated catchment, most of the waterways discharge via long pipes due to the dynamic and exposed nature of the coastline. Fish passage will be very difficult to manage here.

5.8 Using Fish Passage Exclusion to Protect Species

Kōwaro/Canterbury mudfish (*Neochanna burrowsius*) are known to be present in parts of the Leeston rated drain catchment (Figure 31). Kōwaro are classified as *Threatened – Nationally Critical*, which is the highest threat level that an extant species in Aotearoa New Zealand can be classified as. As one of Aotearoa New Zealand's most endangered fish, it faces a very real risk of extinction due to severe habitat loss, restricted range, fish predation, and land use pressures. A key challenge of managing for kōwaro/Canterbury mudfish in the Leeston catchment is that a blanket rule of providing fish passage everywhere can unintentionally undermine their protection. While channel connectivity and fish passage is essential for migratory native fish, kōwaro/Canterbury mudfish often rely on natural or artificial barriers to remain isolated from predators and competitors. This creates a conflict between typical fish passage objectives and species-specific conservation needs. Addressing this challenge requires moving beyond a generic solution and instead identifying where mudfish populations occur and where exclusion remains ecologically appropriate. With accurate spatial information, ecological surveys, and local knowledge, fish passage exclusion can be deliberately applied in key habitats to retain protective barriers, while allowing passage in other parts of the network to support wider freshwater ecosystem health.

Fish Passage vs Fish Protection

Kōwaro/Canterbury mudfish have a threat classification of *Threatened – Nationally Critical*.



Informal weirs are often used to provide for water takes but they can create fish passage barriers. In this case, this is in an area with kōwaro/Canterbury mudfish upstream, so this additional fish passage impediment can help add an additional layer of protection for kōwaro.



A Department of Conservation sign indicating the presence of kōwaro/Canterbury mudfish at a site in the Leeston rated drain catchment.



FIGURE 31: Kōwaro/Canterbury mudfish (*Neochanna burrowsius*) are known to be present in parts of the Leeston rated drain catchment.

5.9 Communication

Among the rated properties within the Greenpark, Ellesmere, Leeston, and Taumutu catchments there are a wide range of land uses (see Section 3.2.1), from large-scale irrigated dairy farming to smaller lifestyle blocks and contract-farmed land. Landowner experience and familiarity with the local drainage systems and environmental responsibilities are equally variable, reflecting ongoing changes from generational farming to newer ownership and management models. This variability contributes to inconsistent understanding of rights, responsibilities, and permitted activities within waterways, including uncertainty around vegetation management practices, where and how spraying may be undertaken, and what work can or should occur both within and outside the rated drainage network. These challenges can be particularly pronounced when land ownership or land management arrangements change, as new owners or contractors take time to become familiar with local requirements.

Although those within the rated catchments bear the cost of these schemes and benefit directly from their operation, substantial influences from outside the rated area, including the contribution of sediment and contaminants from land not subject to targeted rates, highlight the need for clearer communication across the wider surface water catchment. There is also limited awareness that discharges to the drainage network become part of SDC's discharge to Te Waihora/Lake Ellesmere and will be required to meet the requirements of any future discharge consents, as well as the requirements of the Stormwater and Drainage Bylaw 2025 (SDC, 2025).

Further complexity arises from uncertainty around the intended function of different channels (for example, not knowing whether channels should be permanently flowing or intermittently dry) and around attributing changes in flow to specific causes such as upgradient irrigation, stormwater inputs, land development, changes in water race operation, or climate-driven variability. In addition, a lack of coordination between roading activities and consenting processes can result in poorly performing culverts, contributing to blockages, erosion, reduced fish passage, and localised flooding.

Strengthening communication with landowners therefore presents a significant opportunity to improve shared understanding of environmental responsibilities and support a more coordinated approach to drainage management across all catchments. Actions such as wider community sharing of this CMP, alongside clear standard operating procedures (SOPs) and codes of practice (COPs), would provide practical guidance for private landowners and contractors while reinforcing the shared responsibilities for these catchments. Improved clarity around maintenance roles between SDC and landowners would further support a well-functioning drainage system and help align individual actions with the vision set out for these catchments (Section 2.1).



Juncus

Image source: EOS Ecology



Planted two-stage channel,
Ellesmere rated catchment

Image source: EOS Ecology

6 Solutions – Catchment-Scale Approach

With the goal of reimagining how the Greenpark, Ellesmere, Leeston, and Taumutu catchment could be managed — to continue to maintain adequate drainage function for productive land uses, while also improving biodiversity, water quality, cultural, and ecological values — it is anticipated that a combination of catchment-scale changes in land and drain management, along with the implementation of reach-scale interventions to improve the existing condition of waterways, will be needed. This section outlines the overarching catchment-scale approaches that will be crucial to achieving the vision for this catchment (Table 14). The following section (Section 7) details the specific ‘toolbox’ of interventions that are designed to mitigate some of the site-specific challenges facing the Greenpark, Ellesmere, Leeston, and Taumutu rated catchments at present



Piped channel outlet to the coast, Taumutu rated catchment.

TABLE 14:

Overview of the catchment-scale approaches recommended for use in the Greenpark, Ellesmere, Leeston, and Taumutu catchments.

Intervention Name	Intervention Description	Type of Catchment-wide Approach				
		Land Use Change	Farm Environment Plans/Better than Best Practice	On Farm Mitigation	Drain Maintenance Practices	Monitoring
Transformative practice	Striving for a transformative or 'better than good practice' approach to land management throughout the catchment, including the implementation of Farm Environment Plans (FEP) to help identify and manage or mitigate environmental risks or Stormwater, Drainage and Watercourse Management Plans (SDWMPs) to identify and manage the risks of drainage discharge. Recommendations include creating a base template for FEPs to assist smaller landowners in the catchment, implementing low/zero tillage practices, appropriate timing of fertiliser application, preparation of nutrient and sediment management plans, and careful positioning of feed points and resting areas for stock to reduce runoff.		✓	✓		
Land acquisition/ strategic land use change	This would include opportunities for creating large scale interventions (including urban-rural flood management), creating space for bank reshaping and increasing channel capacity, and helping with future climate change and sea level rise considerations.	✓				
Simplifying rated catchment boundaries	Simplification of the rated catchment boundary in the Leeston rated catchment would help to reduce confusion in the wider community regarding management responsibilities and thus greatly improve management and communication.				✓	✓
Smart systems for drainage maintenance and monitoring	Making use of 'smart' technology for monitoring the way that drains are maintained and managed. This would include an online interactive system for viewing maintenance records and monitoring of any tools/ interventions that require regular maintenance, as well as implementing some environmental monitoring to benchmark changes in environmental conditions in the network. Making this accessible to the wider public will help greatly with existing communication challenges.				✓	✓
Changing maintenance practices	Establishing a staged approach to maintenance that allows for current practices to evolve alongside the implementation of the new interventions and management approaches recommended in this CMP.				✓	

6.1 Transformative Practice

Transformative practice is a term that describes the deliberate or intentional effort to challenge existing paradigms and foster new ways of thinking and acting to achieve meaningful change and improve the sustainability of outcomes. In the context of this CMP, transformative practice may be described as a ‘better than good practice’ approach to land management. Industry agreed good management practices (GMP) relating to water quality essentially involve gaining an understanding of nutrient loss pathways on farmland and the risk of these to water quality and using this knowledge to manage these risks appropriately (Matrix of Good Management Governance Group, 2015). While GMPs establish a minimum standard of practice, they do not prevent individuals from aiming to improve further, which is why the term ‘better than good practice’ is used here (Table 15).

Transformational practice must be embedded into Farm Environment Plans (FEPs) or Stormwater, Drainage and Watercourse Management Plans (SDWMPs) to drive meaningful change at the farm level. Properties discharging drainage water to the SDC drainage network may require a SDWMP, the requirements of which are now formalised in the Selwyn District Council Stormwater and Drainage Bylaw 2025 (SDC, 2025). However, the cost of developing and implementing FEPs or SDWMPs can be prohibitive, particularly for small landholders. A templated approach is essential to streamline processes, reduce financial burdens, and ensure consistency across the catchment, which will enhance the collective impact of transformational practices.

Farm Environment Plans (FEPs) are tools to identify and manage the environmental risks of farming activities. In Canterbury, all farms that require a land use consent to farm must also prepare a FEP. Of crucial importance to good FEPs is identifying and managing critical source areas, where runoff accumulates in low-lying areas of farmland and may flow to nearby waterways via informal flow paths and ephemeral channels. Typical critical source areas include paddock depressions and informal flow paths, gateways, water troughs, bridges, and stock laneways near streams. The best practice management of these areas helps to reduce sediment and nutrient

loss from farmland to waterways. The channel and informal/overland flow path layer developed from LiDAR and DEM data as part of this CMP (Figure 10) could be provided as a shapefile to landowners throughout these catchments to help them with identifying critical source areas. Runoff can be mitigated by installing bunds and/or grass filter strips between critical source areas and waterbodies. Supporting landowners through the process of creating FEPs and incorporating relevant tools from this CMP into FEPs will allow for better integration of their land management practices with this CMP and reduce the potential for conflict. In addition to the tools and interventions recommended in this CMP, there are also online tools (such as <https://ourlandandwater.nz/fep-actions>) that can help landowners identify tools relevant to their farm type and the issues/pressures they face (identified in Section 4 and Section 5 of this CMP).

Incentivising and recognising those landowners that do more than the minimum in relation to their FEPs is also central to achieving a ‘better than good practice’ approach across the catchment. An example of ‘better than good practice’ would be setting aside land adjacent to drainage channels to facilitate the creation of wider two-stage channels or lineal wetlands, or implementing other interventions recommended in Section 7, both on private channels and within the rated network.

TABLE 15:

Summary of Good Management Practice (GMP) in farming guidance, with examples to demonstrate how 'better than good' practice may look for the Greenpark, Ellesmere, Leeston, and Taumutu catchments.

Good Management Practice (GMP) Guidance Matrix of Good Management Governance Group, 2015		Examples of 'Better Than Good Practice' in the Greenpark, Ellesmere, Leeston & Taumutu Catchment Context See Section 7 for further details of recommended interventions
Action	Implementation Guidance Examples	
Identify the physical and biophysical characteristics of the farm system, assess the risk factors to water quality associated with the farm system, and manage appropriately.	Consider: • biophysical characteristics such as soil types, topography, and climate • physical characteristics such as waterways, artificial drainage networks, irrigation • risk factors such as soil loss, nutrient loss, and damage to soil structure.	• Identify the farm characteristics and risk factors in the context of the catchment-specific state and pressures information, which have been provided in this CMP. • Working with your rural professional to develop your farm environment plan – utilising the information provided in this CMP and following a templated approach as discussed in Section 6.1.1 above.
Identify risk of overland flow of sediment and faecal bacteria on the property and implement measures to minimise transport of these to waterbodies.	Vegetated buffer strips/riparian planting adjusted in width for slope, hydrology, bank stability, land use, and proximity to critical source areas.	• A minimum riparian strip width of 5 m, with 10–15 m where space allows. • Establish suitable riparian planting in combination with the suggested tools provided in this CMP to ensure that riparian planting does not preclude other recommended in-channel interventions (i.e., creation of two stage channels and inline lineal wetlands etc.)
	Identify, record, and manage risk to and from critical source areas such as wallows, bank erosion, pugging, etc.	• Use the DEM-generated channel and overland flow path created as part of this CMP (Figure 10) to help identify critical source areas.
	Sediment traps.	• Event-based sediment traps on ephemeral/intermittent waterways. • Small-scale inline sediment traps for targeted accumulation and removal of fine sediments. • Use of wetlands for trapping of finer sediment.
	Paddock contouring, earth bunds, raised headlands.	• Paddock based detainment bund intervention where ground contours allow.
To the extent that is compatible with landform, stock class and intensity, exclude stock from waterways.	Plan and prioritise waterway areas (including wetlands) to fence, based on the vulnerability of the land, significance of the waterway and potential to impact on water quality off-farm.	• Bundle stock exclusion with other interventions where appropriate (e.g., two-stage channels, treatment wetlands). • Identify ephemeral flow paths on farm and consider temporary stock exclusion of these during wetter months.
Manage farming operations to minimise direct/indirect losses of sediment/nutrients to water, and maintain/enhance soil structure, where agronomically appropriate.	Consider distance from surface waterways, effectiveness of buffers.	• Implement measures relevant to the soil types (Figure 6) and terrain in the catchment. Gley and pallic (limited areas in all but the Greenpark rated catchments) soils in these catchments will require measures that keep them well vegetated and managed to reduce bank collapse. • Establish riparian setback distances exceeding 3 m on all waterway types in the catchment.
Manage the amount and timing of irrigation inputs to meet plant demands and minimise risk of leaching and runoff.	There is a demonstrable reason why irrigation is to be applied, for example to replace soil moisture deficit, for herbicide activation, or to prepare soil for cultivation.	• Irrigation systems are designed and maintained to operate efficiently, under normal operation. Irrigation applications do not result in leaching or drainage. • Soil moisture monitoring and predictive tools are used to schedule irrigation. • Farm staff are trained in the operation of irrigation systems and scheduling tools.
Manage grazing to minimise losses from critical source areas.	Graze lower lying areas and areas closest to waterways last.	• Vegetated buffer strips where appropriate. • Bank reshaping/two-stage channels where appropriate. • Stock exclusion of all perennial waterways. • Temporary stock exclusion of ephemeral waterways and informal flow paths during wetter months. • Not using wet ground for winter grazing in this catchment.

6.2 Land Acquisition/Strategic Land Use Change

In some cases, the strategic purchase, retirement, or lease of land will be a viable way of achieving improved values for some parts of the catchment. Changing land use or strategically retiring areas of land adjacent to drainage waterways may help to achieve water quality improvements as well as improved drainage efficiency. If suitable areas of land can be identified and purchased, then this may open the door for some of the large-scale interventions proposed in the ‘toolbox’ of solutions (Section 7). In some cases, this land may be suboptimal for current land use practices. In other cases, the opportunity may arise at the time of a land use change. Examples of interventions where land acquisition may be required are waterway realignment, off-channel sediment traps or flow detainment basins, and off-channel wetlands. Even smaller-scale interventions such as two-stage channels and inline lineal wetlands can benefit from additional space around drainage waterways, and these are the types of changes that can contribute to transformative or ‘better than good practice’ for the catchment.

For the Leeston catchment, the consideration of the downstream rural drainage network in the development of urban stormwater management plans would engender a holistic catchment-wide approach to water quality and quantity management. The strategic placement of larger integrated treatment and flood detention systems, which may require additional land purchase, could be considered to future-proof urban expansion by minimising downstream flood flow peaks.

For the Greenpark and Leeston rated catchments that abut the Te Waihora/Lake Ellesmere edge, there is the opportunity to consider strategic land purchase to form a continuous lake edge protected landscape. As most of the lake edge is already in either conservation area or reserve (Figure 8), it would not take a large land purchase or land use change to realise this vision. There are significant benefits from such an undertaking including providing a buffer zone for lake level rise linked to climate change, provision of additional wetland treatment opportunities for waterways discharging to the lake, and significant biodiversity and ecological

improvements via reconnecting the lake with its margins and creating a continuous lake edge habitat for biota migration. Supporting the land use change or land purchase for the remaining blocks of lake edge along the Leeston and Greenpark catchment boundaries would also support the wider vision of Whakaora Te Waihora (particularly the ‘transforming lake shore to wetlands’ programme vision).

6.3 Simplifying Rated Catchment Boundaries

The Leeston rated catchment is a patchwork of ten separate sub-catchment areas that bisect waterways and channels, and which cuts off the top of the Taumutu rated catchment (Figure 2), with the original reasoning for this segregation lost to history. With the generation of more accurate waterway, drainage channels, and overland flow paths as part of this CMP, there is an opportunity to create a single cohesive rated catchment boundary that reflects the drainage network and surface water flows that exists today. Simplification of the Leeston rated catchment boundary, and updating the Taumutu rated catchment boundary to include the upper section currently classified as part of the Leeson rated catchment, would also help to reduce confusion in the wider community regarding management responsibilities, thereby greatly improving management and communication.

6.4 ‘Smart Systems’ for Drainage Monitoring

The use of ‘smart’ technology has huge potential for improving the way that drainage waterways are maintained and managed, as well as for recording information about the installation and maintenance of interventions, and water quality monitoring. The widespread use of an electronic and spatial/GIS-based approach to gathering drainage maintenance records would provide a readily accessible and up-to-date record of maintenance across the catchment, ensuring timely access to information for those undertaking maintenance operations as well as those managing and implementing catchment solutions. This would help to streamline the maintenance programme and improve efficiencies across the catchment. Ultimately, accurate autonomous record keeping of what drain maintenance activities have been performed where (and when) will enable a more accurate assessment of drainage performance in different areas of the catchment.

This approach aligns well with the current transition from land drainage committees to CORDE for the delivery of land drainage maintenance, which is underway and being implemented over a three-year period. Maintenance activities undertaken by CORDE are already scheduled through contract documentation and tracked within SDC’s Asset Management System (AMS) for other service areas such as water races and land drainage, and once the transition is complete, land drainage maintenance will also be captured consistently through this system. The AMS includes a GIS interface, providing a strong foundation for spatially enabled maintenance records and supporting the application of smart, catchment-wide asset management practices.

The data provided by such a system could be used to optimise drain maintenance and may result in less maintenance-related disturbance to some areas that could otherwise be over-maintained. There would also be potential to include information from SDC’s standard operating procedure (Wilson, 2024) relating to the timing of works, erosion and sediment control, and fish management. Another benefit of such ‘smart systems’ would be the ability to provide landowners across the catchment

with accurate information on the maintenance work completed within the drainage network. Interventions that are implemented outside of the rated drainage network could also be included in this smart system, allowing all interventions across the catchment, whether private or publicly maintained, to be seen. This would allow for a truly catchment-wide integrated management programme and helping to alleviate the communication challenges that exist for these rated catchments.

Smart drainage monitoring could include, but not be limited to, the following aspects:

- GPS capabilities for drainage maintenance equipment to track implementation of maintenance.
- Digitisation of maintenance records.
- Georeferencing areas where and when catchment interventions (as per Section 7) are implemented, and dates for when monitoring and/or maintenance needs to be undertaken.
- Location-based information about native planting within the catchment, to encourage connections between discrete planting locations.
- A portable interactive interface that allows for the entry of notes regarding monitoring and maintenance needed and undertaken at a site.
- Location-based storage of water quality monitoring data to improve efficiency in reporting on any resource consent related monitoring.
- Location-based storage of FEPs and SDWMPs for properties within the catchment (recognising that privacy and commercial sensitivity of these would need to be managed).
- Inclusion of drainage maintenance activities undertaken outside of the rated drain network to make this a catchment-wide tool.



Low-lying area in the
Ellesmere rated catchment

Image source: EOS Ecology

6.5 Changing Maintenance Practices

6.5.1 A Phased Approach to Changing Maintenance

An integral part of reimagining how the Greenpark, Ellesmere, Leeston, and Taumutu land drainage catchments might be managed is to work towards improved maintenance practices for the catchment. As tools and solutions are implemented to deal with some of the key challenges facing the catchment, it is anticipated that the approach to maintenance will also need to change. This change will not be immediate. It is likely that there will be a period of transition between the full implementation of the proposed toolbox solutions for this catchment (outlined in Section 7) and the eventual phasing out of some of the current maintenance practices. However, the overarching goal of this CMP is to eventually phase out, where possible, the more ecologically disruptive interventions such as mechanical removal of sediment from the length of the drainage waterways (vs more regular sediment removal at key locations), while maintaining the drainage function of the network. It is acknowledged that some of the toolbox solutions also have maintenance requirements, particularly during their establishment, and that current maintenance tools may continue to be required in the future in areas where the suggested toolbox solutions provided are not able to be implemented.

There are opportunities for SDC to proactively engage with current and future landowners to enhance awareness of drainage maintenance responsibilities and to develop maintenance guidance for all waterway types to support landowners. While some LIM reports include information relevant to drainage responsibilities, this information is not yet consistently provided or comprehensive across all properties. However, LIMs are only one communication channel. A multi-channel approach, including direct engagement and broader community outreach, would help ensure that landowners are well-informed about their roles and responsibilities. Selwyn District Council has already engaged with landowners and other stakeholders to develop Standard Maintenance Procedures for drain maintenance, including consideration of ecological effects, and this work is ongoing and nearing completion. Encouragingly, there is a willingness among landowners to engage in discussions about drainage management, and providing clear, accessible, and consistent information will support their ability to make informed decisions. Considering options for improving communication both within and beyond the rated catchment will be important and could be achieved through a targeted communication and community engagement strategy.

6.5.2 New & Ongoing Maintenance Requirements

Once any of the toolbox interventions are established in the catchment, there will be a need to implement new proactive maintenance regimes to support these interventions. Each intervention will require sufficiently detailed maintenance guidance or plans to be followed after implementation. Weed management will be a crucial component of the new maintenance requirements. For example, it is important that weed species are controlled within newly planted two-stage channels and wetlands, to allow the new plants the best chance of becoming successfully established. Over time, some plants may require replacement to ensure that they perform their intended functions.

It will also be important to undertake regular weed surveillance of the drainage network, not only for the areas where interventions have been implemented, but also throughout the wider surface water catchment, as that can be an ongoing source of weeds. If new weed plant species become established and spread within the catchment, then ongoing maintenance costs are likely to increase. The best approach is to identify and control weed species before they become widespread, which requires a targeted and ongoing monitoring programme. Examples of terrestrial and aquatic weed species that should be monitored and removed from the catchment are shown in Figure 32.

As is currently needed, the surveillance and clearing of blockages will be an ongoing requirement for the drainage network. Overgrown vegetation or vegetation (such as tree trimmings or fallen trees) that make their way into the drainage network can create blockages and impede drainage during wet weather. The proposed toolbox of solutions is not expected to exacerbate this issue, particularly where bank reshaping is used to provide greater channel capacity. However, blockages will still occur and will need to be an ongoing aspect of the maintenance regime.

Fish salvage and relocation is an existing part of typical sediment removal operations and the need for this will be an ongoing requirement for the drainage network. However, the scale will reduce, since sediment removal activities will become more focused within defined areas.

Weed Species

Terrestrial



Common alder
Alnus glutinosa
Image source: Shutterstock



Grey willow
Salix cinerea



Crack willow
Salix x fragilis f. fragilis
Image source: Shutterstock



Purple willow
Salix purpurea
Image source: Shutterstock



Sycamore
Acer pseudoplatanus
Image source: DOC



Hawthorn
Crataegus monogyna
Image source: Shutterstock



Elderberry
Sambucus nigra
Image source: Shutterstock



Blackberry
Rubus fruticosus
Image source: Shutterstock



Gorse
Ulex europaeus
Image source: Shutterstock



African boxthorn
Lycium ferocissimum
Image source: Shutterstock



Wild broom
Cytisus scoparius
Image source: Shutterstock



Pampas
Cortaderia selloana
Image source: Shutterstock

FIGURE 32:

Examples of common terrestrial and aquatic weed species that would need to be monitored and removed before they can become widely established at a site and/or throughout the catchment. Monitoring and removal should be for any noxious weed that establishes in the catchments, not only limited to those shown here.



Arum lily
Zantedeschia aethiopica
Image source: Shutterstock



Japanese Honeysuckle
Lonicera japonica
Image source: Shutterstock



Ivy
Hedera helix
Image source: Shutterstock



Old Man's Beard
Clematis vitalba
Image source: J. Blakely



Spanish Heath
Erica lusitanica
Image source: Shutterstock



Scotch thistle
Cirsium vulgare
Image source: Shutterstock



Californian thistle
Cirsium avense
Image source: Shutterstock



Salt barley grass
Hordeum marinum
Image source: Shutterstock



Marram
Ammophila arenaria
Image source: Shutterstock



Buck's horn plantain
Plantago coronopus
Image source: Shutterstock



Nodding thistle
Carduus nutans
Image source: Shutterstock



Tall fescue
Lolium arundinaceum
Image source: Shutterstock



Tree lupin
Lupinus arboreus
Image source: Shutterstock

FIGURE 32:
...continued...

Marginal & Aquatic



Great Willowherb
Epilobium hirsutum Image source: Shutterstock



Yellow flag iris
Iris pseudoacorus Image source: DDC



Male fern
Dryopteris felix-mas



Lady fern
Athyrium felix-femina Image source: Shutterstock



Montbretia
Crocosmia xrococsmiiflora Image source: DDC



Beggars tick
Bidens frondosa Image source: Paulo Ventura Araújo



Purple loosestrife
Lythrum salicaria Image source: Gail Hampshire



Chilean/giant rhubarb
Gunnera tinctoria Image source: DDC



Blue water speedwell
Veronica anagallis



Reed canary grass
Phalaris arundinaceum Image source: DDC



Greater periwinkle
Vinca major



Carex pendula Image source: Jason Butt



Wetland restoration,
Taumutu rated catchment

Image source: EOS Ecology



Farming in the Leeston
rated catchment

Image source: EOS Ecology

7 Solutions – Toolbox Interventions

Alongside the catchment-scale approaches outlined above (Section 6), it is expected that tangible improvement of the Greenpark, Ellesmere, Leeston, and Taumutu catchments will require the implementation of reach-scale interventions to improve the water quality, condition, and function of the waterways. This section details a ‘toolbox’ of interventions that are designed to mitigate some of the main issues and challenges facing these catchments at present (Table 16). We note that riparian planting has not been provided as an intervention on its own; this is because riparian planting without also implementing bank or channel reshaping could create additional flood management issues. As such, riparian planting is coupled with an intervention, such that earthworks and planting are undertaken together.

7.1 Implementation of the Interventions Across the Greenpark, Ellesmere, Leeston & Taumutu Catchments

The natural and modified waterways within the Greenpark, Ellesmere, Leeston, and Taumutu catchments provide freshwater habitat that supports a range of aquatic life. While macroinvertebrate and fish communities vary considerably between these catchments, macroinvertebrate indicators suggest somewhat impacted conditions across all sites. Nevertheless, these catchments all support native fish species, with substantially greater species diversity recorded in the Leeston, Ellesmere, and Taumutu catchments compared with Greenpark (Section 7). This biodiversity persists despite the numerous issues and challenges affecting the catchments (Sections 4 & 5).

Our approach for this CMP began with developing a thorough understanding of the catchment, its physical characteristics, current state, the issues and challenges they face, and the existing drainage maintenance practices. A central component of this process was collaboration with a sub-group of Te Komiti Waiora (District Land Drainage and Waterway Committee) to incorporate historical and local knowledge, ensuring that the experiences and insights of those familiar with the catchment informed our understanding. This collaborative approach informed the development of a suite of intervention options designed to improve water quality, cultural values and ecological outcomes while maintaining essential drainage functions. As the first step toward identifying suitable locations for implementing these interventions, we provide guidance on the types of waterways each tool is best suited to, and where they are likely to have the greatest impact (Table 16). With this guidance in mind, specific locations for interventions will be worked through at the master planning stage. It is important to note that Table 16 presents the full range of potential interventions, but not all will be relevant or required at any one time.

TABLE 16:

Guidance on the waterway types suitable for each of the reach scale tools/solutions/interventions recommended for use in the Greenpark, Ellesmere, Leeston, and Taumutu catchments.

		Relevant Waterway Types (if applicable)				
Interventions		Perennial Waterways	Intermittent & Ephemeral Waterways	Informal/Overland Flow Paths	Springs	Water Races
1	BANK/CHANNEL IMPROVEMENTS		✓			
2		✓	✓			
3		✓				
4		✓	✓			
5		✓	✓			
6		✓				
7		✓				
8		✓				
9		✓				
10		✓				
11		✓	✓			
12	TREATMENT WETLANDS	✓	✓			
13		✓	✓			
14		✓	✓			
15		✓				

TABLE 16:
...continued...

			Relevant Waterway Types (if applicable)				
Interventions			Perennial Waterways	Intermittent & Ephemeral Waterways	Informal/Overland Flow Paths	Springs	Water Races
16	SEDIMENT MANAGEMENT	Off-channel sediment trap	✓				
17		Inline sediment trap	✓				
18		Inline event-based sediment trap & water level control		✓			
19		Detainment bund		✓			
20		Bunded sediment stockpile		✓	✓		
21	OTHER	Flood detention basin					
22		Protecting springheads				✓	
23		Īnanga spawning habitat	✓				
24		Protecting kōwaro/Canterbury mudfish habitat	✓	✓			

7.2 Information on Interventions

7.2.1 INTERVENTION 1: BANK/CHANNEL IMPROVEMENTS – Vegetated Swale

Vegetated swales are shallow channels lined with dense but low-stature vegetation. They are often used as a form of urban stormwater treatment because of the ability of a simple grass surface to slow runoff and filter out sediments, nutrients, and other contaminants before they reach waterways. However, vegetated swales can be equally useful in rural settings, where they may also be known as grass buffer strips or filter strips. Vegetated swales or filter strips can be effective for removing contaminants from surface runoff, in contrast to riparian buffers which tend to be more effective for improving the water quality of subsurface flow by plant uptake of nutrients. Since vegetated swales are typically vegetated with grass and require access to maintain them, establishing a permanent riparian buffer around them would not be appropriate.

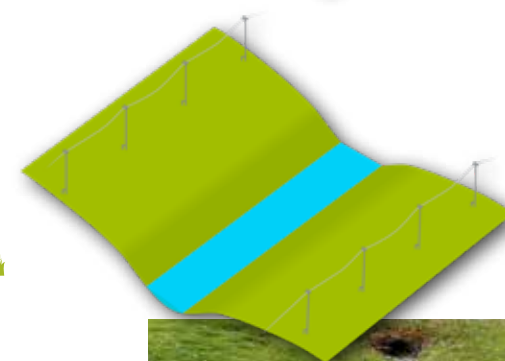
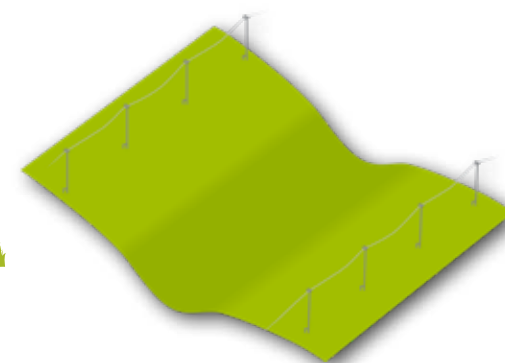
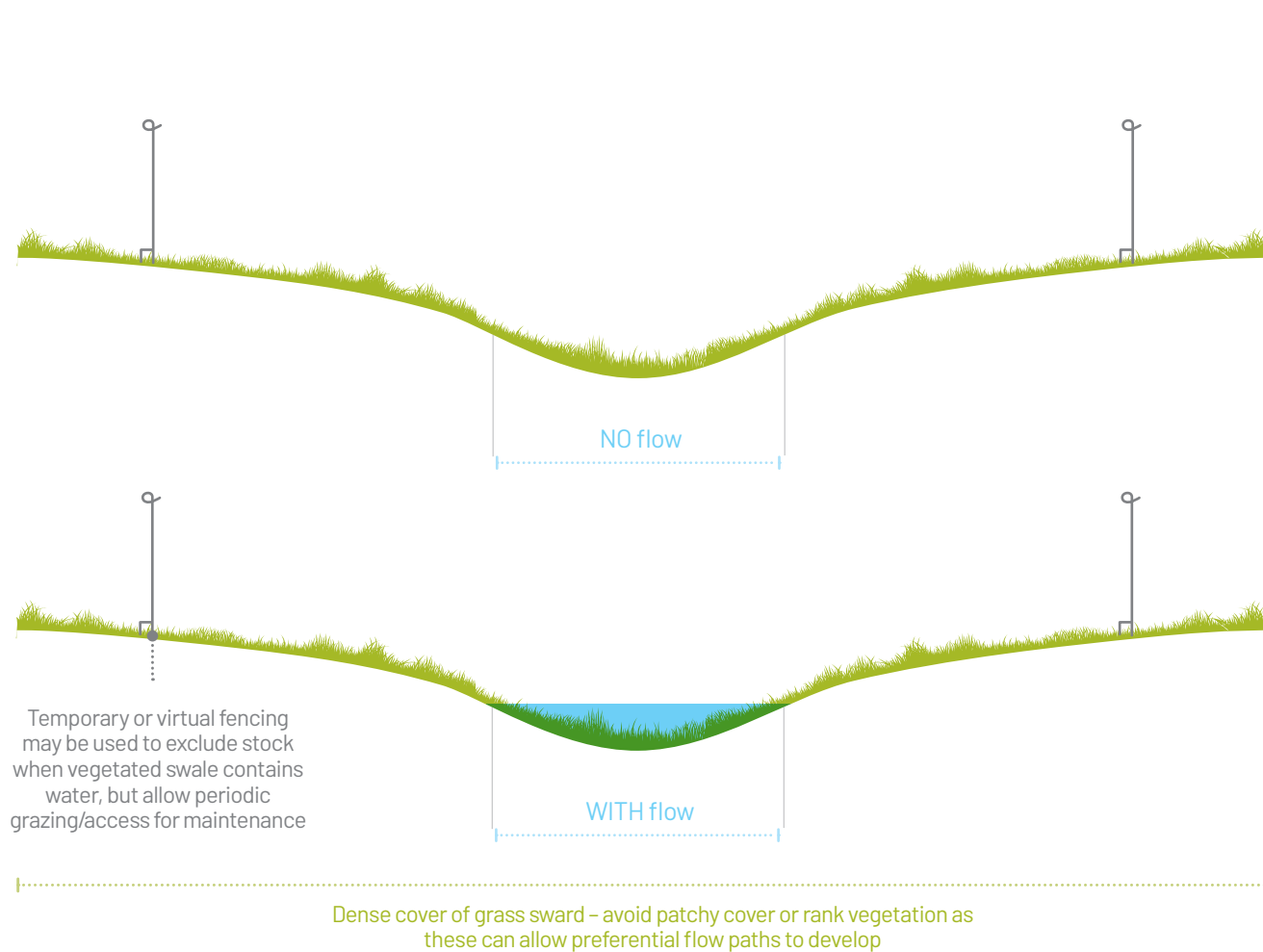
Simple channel reshaping of existing (or new) ephemeral channels to form a stable vegetated swale is most suited to ephemeral drainage waterways, or to smaller intermittent or ephemeral channels that are temporarily located within the catchment. This tool would be expected to reduce the amount of sediment released into the wider drainage network. In most situations, only minimal reshaping will be required to implement this tool, as suitable ephemeral channels already tend to have broad, shallow channel geometry. Within the Greenpark, Ellesmere, Leeston, and Taumutu catchments, the key requirements for effective vegetated swales are dense groundcover (most likely grass) and the exclusion of stock when channels contain flowing water. Patchy grass cover reduces the effectiveness of vegetated swales, since surface flow preferentially bypasses the denser grass swards. Ongoing maintenance is typically required for vegetated swales/filter strips, with grass needing to be maintained to form a dense grass sward. A well-maintained dense grass sward is likely to provide better filtration than rank grass cover, since small preferential flow paths tend to develop beneath the rank vegetation, reducing the effectiveness of the filter. While stock should be excluded from vegetated swales when these contain flowing water (to retain grass cover and avoid pugging), periodic grazing with sheep when channels are dry could be a useful tool to manage weeds in these areas and to keep a thick vegetated sward. Other means of maintaining a thick grass sward along road verges could include semi-regular mowing.

Key Features

- Only suitable for ephemeral (either permanently or temporarily located) channels/flow paths.
- Channel is grassed and accessible to allow for maintenance.
- Needs maintenance to maintain thick sward of vegetation.
- Stock is usually excluded when channel is wet but may be used to help manage vegetation cover.

Core Benefits

- Reducing sediment inputs to waterways by trapping sediment and slowing water.
- Providing for some filtration of overland flow.



Example of a grass swale.

Cross section showing the profile of a typical vegetated swale, (top) without flow, (bottom) with flow.

© EOS Ecology

7.2.2 INTERVENTION 2: BANK/CHANNEL IMPROVEMENTS – Two-Stage Channel

Two-stage channels are artificially created floodplains/benches formed by reshaping the banks of existing drains to create a lower bench before battering back the bank to the existing ground level. Two-stage channels typically have a narrower low flow channel and a much wider flood flow channel/capacity. The narrow low flow channel can maintain a water depth to provide for life supporting capacity during low flows, and (where there is sufficient gradient) can even increase water velocity, which can decrease sedimentation. Conversely, during high flows, water can flow over the wider flood channel, reducing water velocity across the wider fresh plain and enabling sediment to drop out of suspension, and reducing flooding by providing more flood flow capacity. Two-stage channels provide a much more stable lower bank that is less prone to erosion and bank slumping/collapse. They also help to absorb nutrients and trap fine sediment on their fresh plain (i.e., the first channel stage), as sediment is typically deposited or trapped by the vegetation on the lower bench during high flows.

Two-stage channel construction is most suitable for the perennial and larger/deeper intermittent or ephemeral channels within these rated catchments. In flowing waterways, the establishment of *Carex secta* along the channel margins can provide sufficient shading to suppress the growth of emergent macrophytes such as monkey musk and watercress. Placement of *C. secta* is critical to balance optimal shading with adequate drainage, particularly during flood events. At maturity, *C. secta* are large plants which, in narrow channels, can readily touch across the channel. This increases the risk of blockages during floods, especially if macrophyte material is transported downstream. Along channel banks, plants should be spaced no closer than 1.5 m apart to achieve canopy closure without excessive crowding. Spacing between plants on opposite banks should reflect channel width; where plants are spaced more than 2 m apart across the channel, they will not contact each other at maturity while still providing effective overhang of the channel margins. Providing a wider lower bench to allow for displacement of floodwater by the larger *C. secta* will help to maintain drainage function.

In low gradient or intermittently flowing reaches, the use of *C. secta* to shade out emergent macrophytes is unlikely to be effective. In these environments, riparian planting of the lower bench can instead promote plant uptake of subsurface nutrients (McKergow *et al.*, 2022) and assist with the trapping of fine suspended sediments when inundated. Riparian planting must be carefully planned and closely monitored to ensure successful outcomes. For the Greenpark catchment, which has a tendency toward standing rather than flowing water, the establishment of wetland vegetation within the channel, in combination with a two-stage bank profile, may be more appropriate in some locations (i.e., Lineal Wetlands as described in Section 7.2.13). Detailed guidance on two-stage channel design is available in Roznowski (2015), Natural Resources Conservation Service (2007), and on the Living Water website¹.

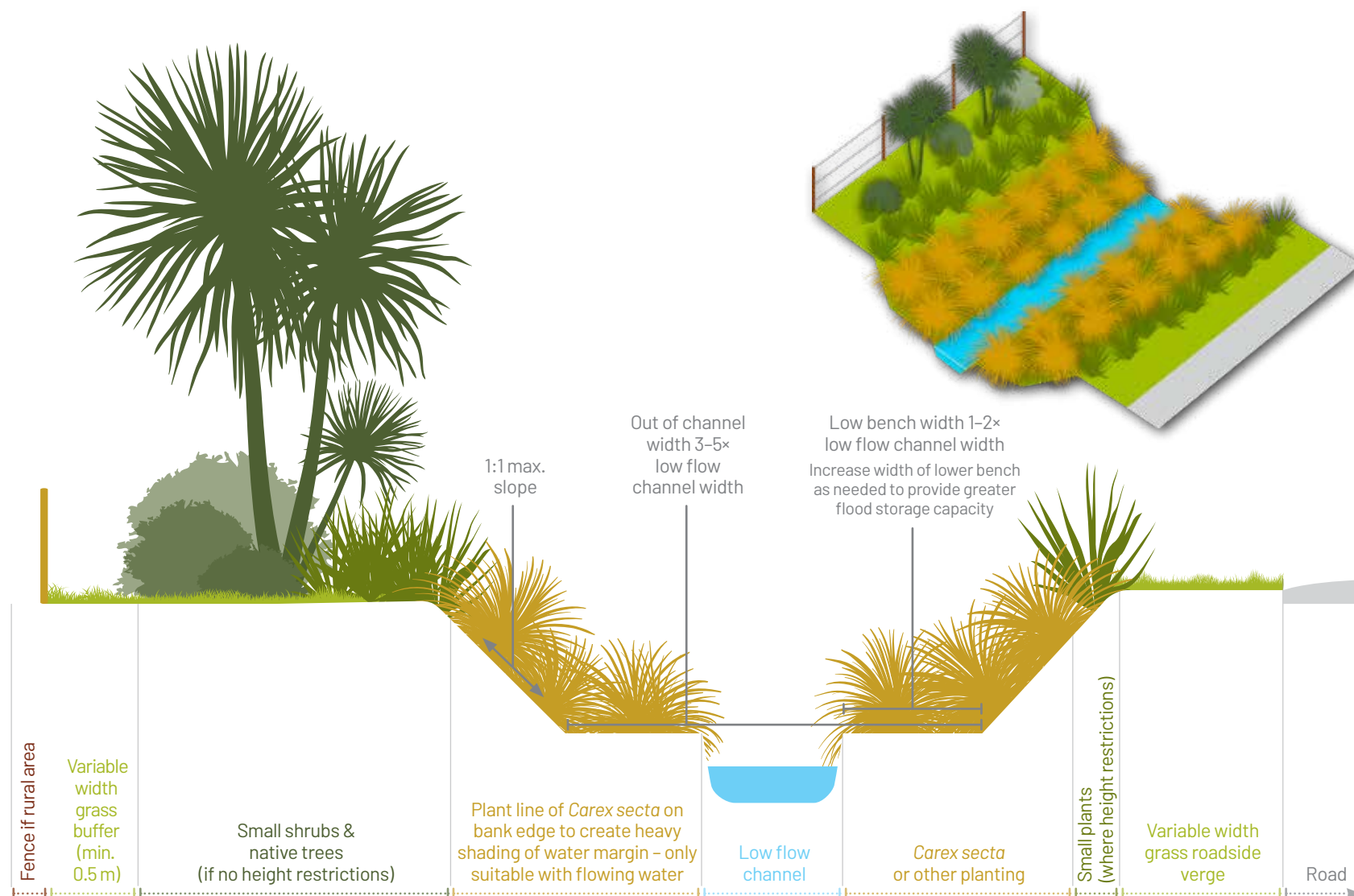
Key Features

- Low flow channel width maintained for baseflow.
- Low floodplain/bench to improve bank stability and increase flood flow capacity.
- Low floodplain provides space for riparian planting.
- Upper bank slope dependent on space available and existing ground levels (and can be steeper if needed).
- Work would include planting and fencing to exclude stock, and long-term management of vegetation.
- Requires space to create wider two-stage channel form.

¹ www.livingwater.net.nz/im:46358cf6-1e1b-4911-8aa7-2d4dab40551f

Core Benefits

- Reduced sediment inputs to waterways by improving bank stability and reducing slumping.
- Flood management – increased flood flow/water backup capacity.
- Planted low floodplain provides trapping of sediments & uptake of nutrients and *E. coli*.
- Some filtration of overland flow.
- Increasing habitat diversity & biodiversity.



Cross section showing the profile of a typical two-stage channel with riparian planting.

© EOS Ecology

7.2.3 INTERVENTION 3: BANK/CHANNEL IMPROVEMENTS – Two-Stage Channel (Large-Scale)

Two-stage channels (as described in Section 7.2.2) may be used at a larger scale in the larger perennial waterways within these catchments, where space allows. This approach is particularly well suited to flood-sensitive areas and locations where overbank flooding regularly occurs, or where enhanced flood storage is desirable. In these settings, a two-stage channel increases flood flow capacity and improves bank stability by reshaping the waterway margins to incorporate a much broader floodplain bench.

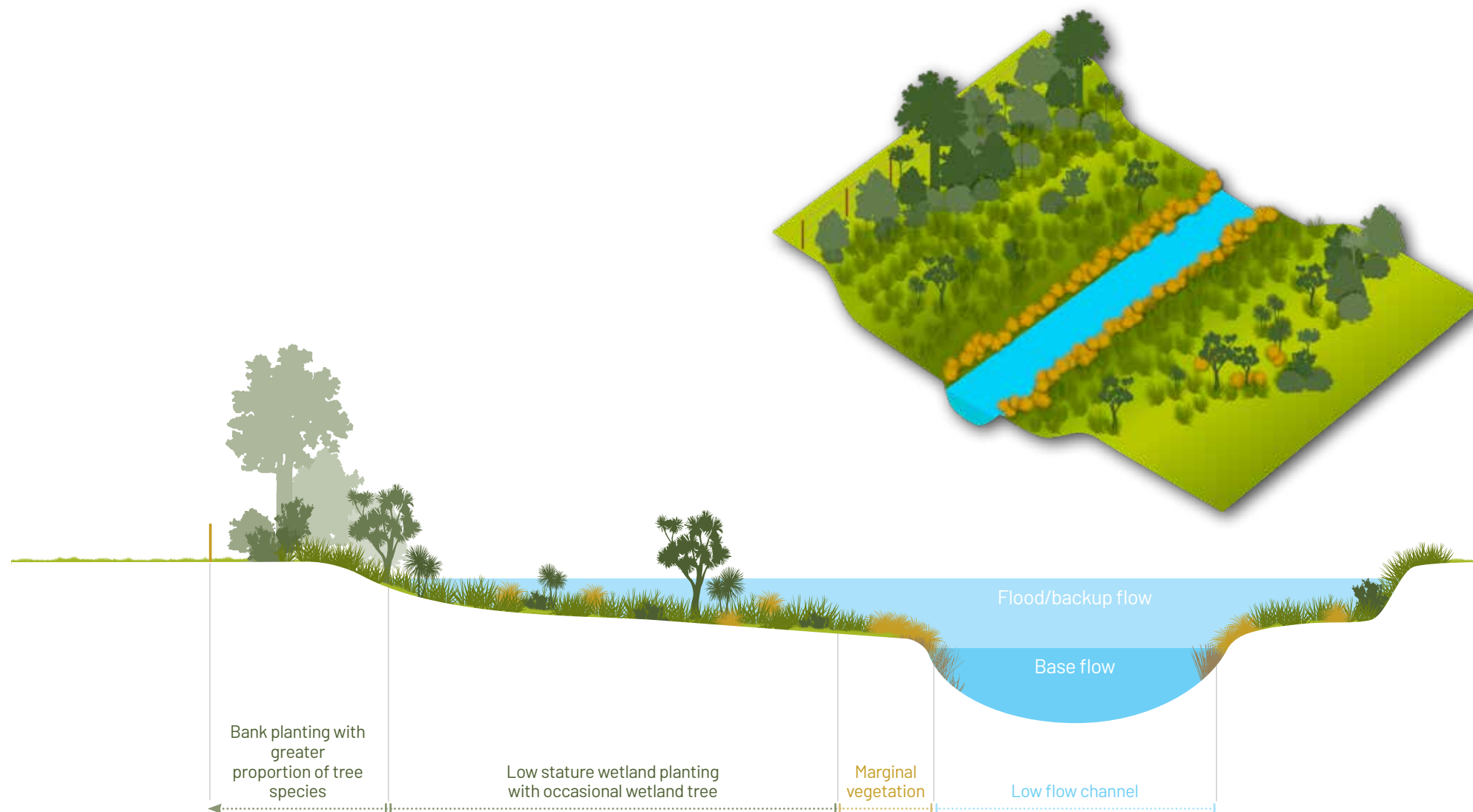
The widened floodplain provides space for riparian planting, which would be dominated by wetland vegetation but may also include selected shrub or tree species, along with low overhanging or emergent plants (e.g., rushes and sedges) at the channel margins. The primary function of this low floodplain planting is to slow floodwaters, promote the deposition and trapping of fine sediments, and facilitate nutrient uptake during inundation events, rather than to provide shading of the low flow channel. This makes the approach particularly appropriate in systems where flood attenuation, sediment management, and water quality improvement are key management objectives.

Key Features

- Instream channel width maintained for baseflow.
- Low and very wide floodplain/bench to improve bank stability and greatly increase flood flow capacity.
- Upper bank slope dependent on space available and existing ground levels (and can be steeper if needed).
- Work would include planting and fencing to exclude stock, and long-term management of vegetation.
- Requires space to create a much wider low bench.

Core Benefits

- Reduced sediment inputs to waterways by improving bank stability and reducing slumping.
- Flood management – increased flood flow/water backup capacity.
- Planted low floodplain provides trapping of sediments & uptake of nutrients and *E. coli*.
- Some filtration of overland flow.
- Increasing habitat diversity & biodiversity.



Cross section showing the profile of a large-scale two-stage channel (with extended floodplain). Indicative only; final design will depend on location and available land.

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7.2.4 INTERVENTION 4: BANK/CHANNEL IMPROVEMENTS – Fibre Rolls for Bank Edge Protection

A range of fibre rolls are available for stabilising stream bank edges, providing erosion protection and reducing the input of fine sediments to waterways. In addition to physical stabilisation, fibre rolls provide a suitable substrate for the establishment of riparian vegetation, which in turn offers long-term protection against erosion and sediment inputs. They are particularly well suited to locations with high, steep, and erosion prone banks where there is insufficient space to implement more extensive interventions, such as a two-stage channel (Section 7.2.2). They are also useful where existing infrastructure limits the ability to widen channels into adjacent land. In these situations, fibre rolls can be installed along existing bank edges to improve stability or used to build out into the low flow channel to create a low bench or fresh plain area suitable for planting. With this additional bank edge protection, steeper banks can be stabilised and made less likely to contribute fine sediment to the waterway network.

Fibre rolls are commonly manufactured from biodegradable materials such as coconut fibre, which typically breaks down over a period of three to five years. This timeframe allows sufficient time for vegetation to establish and replace the structural function of the fibre roll (e.g., <https://cirtexcivil.co.nz/products/silt-control/biocoir-coir-logs>; www.geofabrics.co.nz/products/biomac-waterlog-biodegradable-coir-log).

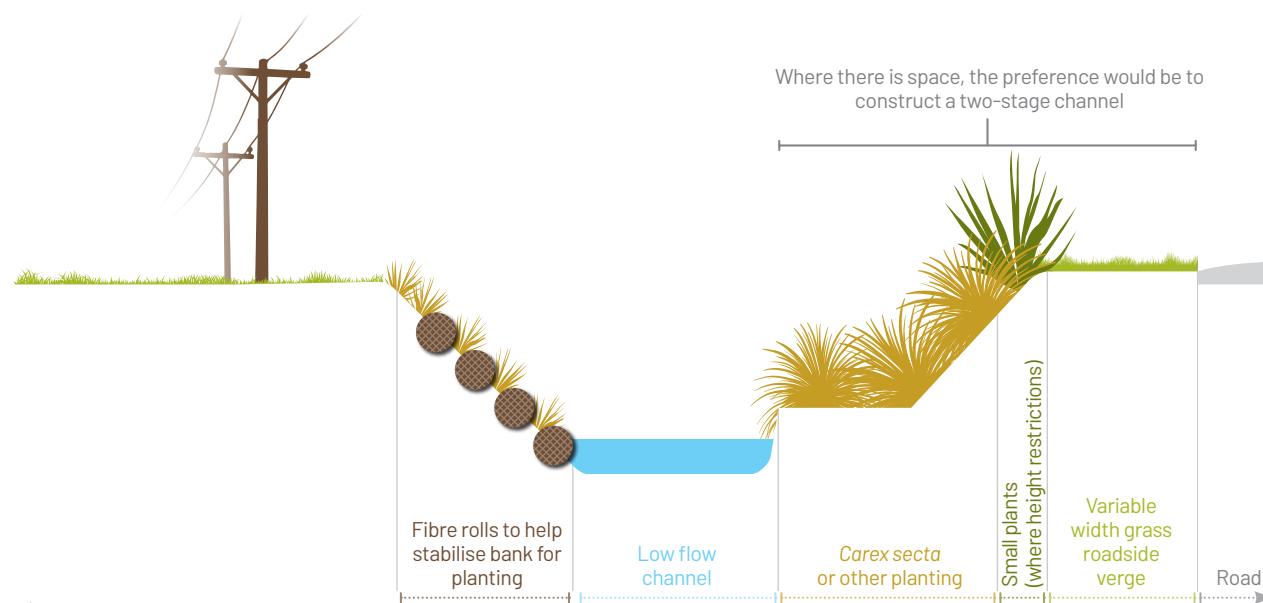
The benefits of fibre rolls include their permeability, which allows water to pass through while trapping sediments and contaminants before they enter waterways, as well as their ability to enhance habitat along waterway margins. Fibre rolls have the advantage of requiring minimal earthworks for installation. Within the Greenpark, Ellesmere, Leeston, and Taumutu catchments, fibre rolls may be used either as a standalone bank edge protection measure or in combination with other interventions such as bank reshaping and wetlands. They will be especially useful in situations where over-steepened banks are unavoidable because of space limitations.

Key Features

- Fibre rolls provide additional stabilisation and erosion protection to stream banks.
- Can be used to support steep banks where there is insufficient space for reshaping.
- May also be installed in combination with two-stage bank reshaping.
- Also provides aesthetic benefits, potential to improve access to the stream, and roosting sites for waterfowl.

Core Benefits

- Stabilises banks and reduces bank erosion.
- Avoiding the use of plastic products within waterways.

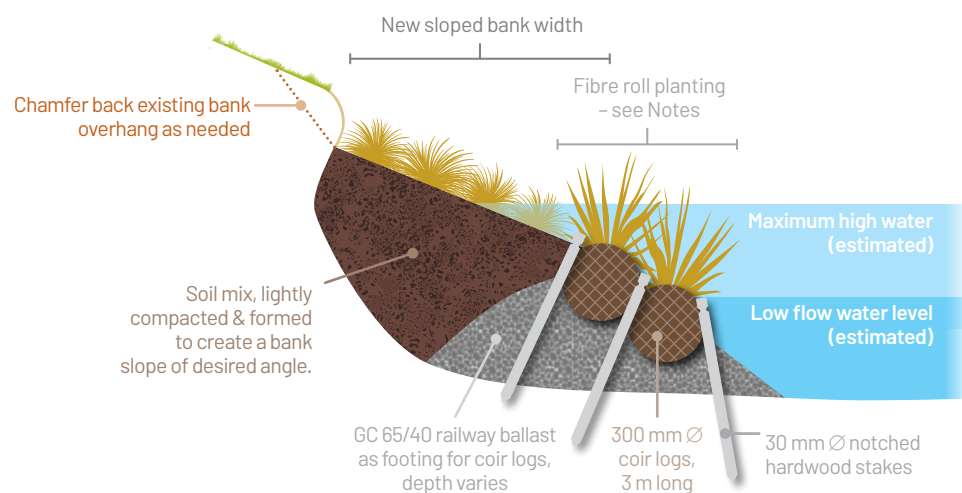


Where there is insufficient space to construct a two-stage channel, fibre rolls could be used for providing some bank stability, and planting media for vegetation.

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Fibre rolls are often made of natural materials that gradually degrade over 3–5 years. They provide a planting medium as well as being used to stabilise banks.



Fibre rolls can also be used to build out a low bench/fresh plain into the channel where needed to help stabilise the toe of the bank, and create a two-stage channel where there is not room to widen the overall channel width, but where the low flow channel is over widened.

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Note: planting vegetation into fibre rolls should be delayed approximately one month to allow stream sediment to infiltrate the fibre.

7.2.5 INTERVENTION5: BANK/CHANNEL IMPROVEMENTS – Regrading Bunded Margins

As described in Section 5.1.3, the raised or bunded margins of drainage channels have developed over time through repeated sediment excavation and placement of spoil along the drain edge. These elevated margins now act as physical barriers that can either divert flood flows onto adjacent lower lying land or prevent floodwaters from readily re-entering the channel once overtopping has occurred. This could prolong the duration of surface water flooding by preventing the more immediate discharge of surface water back into the drainage network. Regrading these bunded margins to restore connectivity with the adjacent floodplain is therefore a key intervention for improving drainage function and reducing the severity and duration of flood events. This intervention involves lowering or reshaping the raised banks so that floodwaters can return to the channel more efficiently and in a timely manner, as well as maintaining lower areas in the landscape where floodwater is able to re-enter the channel.

This intervention may be applied in targeted reaches where prolonged inundation caused by raised or bunded margins has been identified as an issue. Where another intervention such as a two-stage channel or an inline lineal wetland is being created, then these existing bunded margins would be removed as part of that process. In these places, this intervention would only require defining key low points for floodwaters to be able to drain back into the channel. Such low points can be determined using the DEM-generated informal/overland flow paths layer produced as part of this CMP (Figure 10). The use of an interactive online system (i.e., Section 6.1.4) for identifying where these key low points are will be important, so that they can continue to be maintained and not become blocked. As sediment removal becomes increasingly focused on targeted sediment traps in the future, it is expected that there will be less ongoing need for the widespread sediment excavation that has historically contributed to the formation of these bunded margins. Where sediment removal is still required, it is recommended that sediment be moved offsite (such as to a bunded sediment pile as described in Section 7.2.20).

Key Features

- Targeted regrading of raised or bunded stream margins where prolonged inundation has been identified as a recurring issue.
- Lowers or reshapes banks to restore natural overland flow connectivity between inundated land and the channel.
- Can be incorporated into other interventions (two-stage channel, inline lineal wetland)
- Where sediment removal is still required, then use of a sediment stockpile area will prevent bunded margins from re-forming.
- Will require managing controlled low points to allow predictable, stable re-entry points for floodwater.

Core Benefits

- Reduces the duration and extent of floodwater ponded on farmland by enabling more efficient return of floodwater to the channel.
- Improves drainage function across the catchment.
- Reduces the mobilisation of sediment and nutrients from inundated land.
- Restores a more natural connection between channel and floodplain.



Spoil left alongside drainage channels can divert flood flows onto adjacent lower lying land or prevent floodwaters from readily re-entering the channel once overtopping has occurred.

7.2.6 INTERVENTION 6: BANK/CHANNEL IMPROVEMENTS – Waterway Naturalisation

Some of the rated catchments include natural waterways that are either connected to the drainage network or form part of the actively managed drainage network, with some having been historically straightened to improve drainage function. However, it is now generally accepted that restoring natural sinuosity (i.e., re-meandering) to a straightened waterway can transform a uniform ‘drainage channel’ into a functional ecosystem that balances flood management with ecological health. The increase in the hydraulic residence time and the surface area of the sediment-water interface significantly enhances the channel’s capacity for nutrient processing, with sinuous reaches identified as ‘nitrogen removal hotspots’ where denitrification rates can reduce nitrate concentrations by over 70% due to improved microbial activity (Lee *et al.*, 2025). While straightening was historically intended to move water quickly, re-meandering can also aid in flood attenuation by reducing the channel slope and slowing water velocities, which decreases downstream erosive energy; this may be less relevant for most of the low gradient rated catchments here. Ecologically, this physical complexity creates a mosaic of habitats that are absent in straightened channels.

If waterway naturalisation or re-meandering is undertaken, then ensuring that there is sufficient flood plain capacity will be important to provide ongoing flood flow management. Riparian planting would also be needed to improve terrestrial habitat value and connectivity and should be accounted for in any flood flow management. While riparian restoration is most effective when planned and implemented at the catchment scale, targeted riparian planting along re-meandered reaches is also expected to provide additional benefits for cultural values and recreational use of waterway corridors, including improved landscape character and amenity. However, this form of riparian planting is not expected to provide sufficient shading to significantly reduce macrophyte growth or remove the need for ongoing macrophyte management in re-meandered reaches.

Ultimately, the decision to re-meander a section of straightened channel will need to be carefully worked through to ensure that there is not unintended worsening of flooding and bank erosion as a result (Yu *et al.*, 2023), meaning that any largescale meandering should be undertaken on a case-by-case basis. Where space is not available for a large-scale re-meander, then j-hook vanes (see Section 7.2.7) can provide for a smaller-scale meander and increased diversity of water velocity conditions within the straightened channel alignment.

Key Features

- Increased nutrient uptake.
- Improved instream habitat and function.
- Requires large areas of land and significant earthworks.

Core Benefits

- Improved instream habitat and function, and greater nutrient uptake potential.
- Increased flood capacity if designed correctly.



A re-meandered section of channel with associated riparian planting.

7.2.7 INTERVENTION 7: BANK/CHANNEL IMPROVEMENTS – Woody Material

The addition of woody material — such as stumps, logs, and log vanes — to waterways can create instream habitat for fish and aquatic invertebrates. Adding wood to streams can provide a variety of ecosystem benefits, including enhanced instream habitat (which is particularly lacking in soft bottomed streams), increased flow heterogeneity (where there is flowing water), streambank stabilisation, carbon sequestration, and water quality improvement (Barrett *et al.*, 2024). Constructed instream habitat structures are commonplace overseas, but only a few trial examples exist in Aotearoa New Zealand. For example, recent log vane trials in Waituna Creek (Southland) showed substantially higher diversity and biomass of native fish around installed logs compared with upstream reaches without added woody material. Detailed guidance for working with woody material in Aotearoa New Zealand settings is now available (Barrett *et al.*, 2024; <https://storymaps.arcgis.com/stories/b0ef87cf6feb405e836b580c75fa894b>). When installed correctly, log vanes (referred to as j-hook vanes) can stabilise banks whilst varying mid-channel habitat through the creation of stable scour pools. Detailed design and installation guidance for log vanes can be found in Rosgen (2006).

Within the Greenpark, Ellesmere, Leeston, and Taumutu catchments, woody material could be used effectively alongside other interventions such as two-stage channels, treatment wetlands, or wider waterway naturalisation works. However, careful design is essential to ensure that woody material does not exacerbate existing channel constrictions or choking. Woody material should only be installed where sufficient hydraulic capacity exists, or can be created through bank reshaping, so that drainage function is not compromised. It is also critical that woody material is securely anchored to prevent mobilisation during high flow events and subsequent damage to downstream infrastructure.

Kōwaro/Canterbury mudfish (*Neochanna burrowsius*) are known to occur within parts of these catchments, and the integration of woody debris may be important for supporting their long-term population viability. Carefully placed woody material can create refuge habitat during low flow periods by helping retain moisture in the underlying streambed, which kōwaro burrow into during times of channel drying (McMurtrie, 2020a, 2020b). Incorporating ecological assessment into site selection and design processes will help ensure that woody-debris structures enhance habitat values for this nationally critical species while avoiding unintended impacts on drainage function or management.

Key Features

- Woody debris such as stumps or small logs are positioned where they are partially submerged during low flows.
- Should be installed in combination with two-stage bank reshaping to ensure channel capacity is maintained

Core Benefits

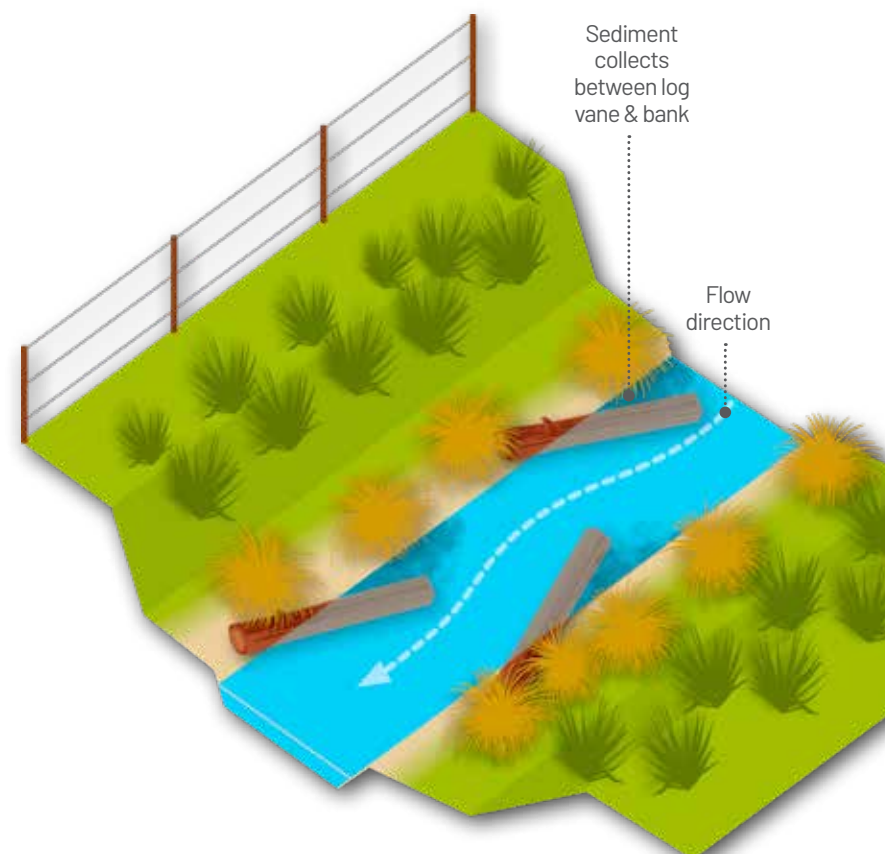
- Increased instream habitat availability and diversity for fish & invertebrates.
- Provides improved habitat for native fish, including taonga species such as tuna/longfin eels.
- Provides additional refuge habitat for kōwaro/ Canterbury mudfish.
- Provides wider water quality improvements and roosting sites for waterfowl.
- Stabilises banks and reduces bank erosion if installed correctly.



Log vanes are typically installed pointing upstream, and can be used in both small and large channels. They are used to vary instream habitat while also promoting bank stability through the accumulation of sediment. However, in areas with slow water velocity they might not realise their full potential of creating varied water velocity and stable scour pools.



Woody material is especially important for areas where kōwaro/Canterbury mudfish are present, as they provide key refuge habitat during periods of low flow or channel drying.



When installed correctly, log vanes can provide upstream bank protection through sediment deposition, and stable areas of mid channel pools downstream.

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7.2.8 INTERVENTION 8: BANK/CHANNEL IMPROVEMENTS – Cobble Clusters

Cobble clusters are a type of small-scale constructed instream habitat used to enhance habitat complexity and flow diversity for fish and aquatic invertebrates. The addition of cobble clusters to waterways can increase flow and habitat diversity in reaches that are otherwise uniform in habitat and flow. They provide important refuge and shelter, as well as suitable egg-laying sites for a range of native fish and invertebrate species. Cobble clusters are particularly suited to waterways with an existing hard substrate where flow conditions are relatively uniform, including modified waterways or drains with perennial flow. Local examples where this approach has been successfully implemented include the Ōpāwaho/Heathcote River (where cobbles and boulders have been installed at seven sites between Barrington Street and Waltham Road) and Dudley Creek (where cobbles have been installed along a 700 m reach adjacent to Stapletons Road) in Christchurch.

Key Features

- Groups of cobbles or boulders are positioned within the stream so that they are submerged during low flows.
- Varies water velocity at a local scale, improving habitat diversity.
- Should not adversely impact the hydraulic capacity of the waterway.
- Low-cost intervention.

Core Benefits

- Enhancing invertebrate & fish habitat.
- Improves instream habitat diversity & provides egg-laying sites for fish & invertebrates.



An array of cobble clusters increases instream habitat diversity for invertebrates and fish in gravel bed waterways.



The presence of large cobbles or boulders in the stream bed increases instream habitat diversity.



Bully eggs found on the underside of this cobble – an example of the benefit of introducing large substrate to waterways.

Image source: EOS Ecology

7.2.9 INTERVENTION 9: BANK/CHANNEL IMPROVEMENTS – Culvert Replacement

Replacing undersized or poorly functioning culverts is an important intervention for improving drainage performance within the Greenpark, Ellesmere, Leeston, and Taumutu catchments. As outlined in Section 5.1.2, culverts that are undersized, incorrectly installed, or poorly maintained can create bottlenecks that restrict conveyance during high flow events. This can lead to upstream ponding and localised flooding, particularly where debris and vegetation mobilised from upstream accumulate at culvert inlets. Replacing these structures with appropriately sized culverts, such as box culverts or larger pipe culverts, would increase capacity, reduce the incidence of water backing up across farmland, and improve overall drainage efficiency during high flow conditions. This work would be informed by SDC's district-wide fish passage assessment, scheduled for completion in June 2026, which will guide the prioritisation and design of future culvert and waterway structure renewals.

Culvert replacement should be considered and implemented alongside other interventions, such as two-stage channels, as these may alter channel capacity and highlight the limitations of existing undersized structures. Replacement culverts and associated structures are also required to provide for fish passage. Several migratory native species have been recorded across the catchments, including shortfin eel, longfin eel, and inanga (Table 10), all of which would benefit from improved passage at culverts. This can be achieved by aligning designs with the New Zealand Fish Passage Guidelines (Franklin *et al.*, 2024), including maintaining continuity of instream habitat, minimising alteration of natural gradients or alignments, providing suitable water depths and velocities for upstream migration, and avoiding vertical drops at inlets and outlets. However, the Leeston catchment supports populations of kōwaro/Canterbury mudfish, which are sensitive to predation and typically do not persist in habitats occupied by trout or other predatory fish. As a result, fish passage provision must be carefully balanced with the need to protect and maintain suitable habitat for kōwaro/Canterbury mudfish.

Key Features

- Replacement of culverts that are undersized, poorly installed, or regularly obstructed.
- Use of box culverts or larger diameter pipe culverts to improve flow capacity and reduce upstream ponding.
- Design must incorporate best-practice fish passage principles, unless fish passage must be prevented to protect kōwaro/Canterbury mudfish

Core Benefits

- Reduced backwatering at known choke points during rainfall events.
- Lower likelihood of culvert blockages caused by vegetation or debris from upstream.
- Enhanced fish passage for migratory native species.



Example of an undersized culvert in the Leeston rated catchment.



Example of a more suitably sized culvert in the Leeston rated catchment.

7.2.10 INTERVENTION 10: BANK/CHANNEL IMPROVEMENTS – Fish Passage at Structures

Poorly designed or degraded instream structures, such as weirs and culverts, can create barriers to the movement of native fish species. Within the Leeston catchment, there are a number of existing weirs along Hanmer Road drain that present barriers to fish passage, and there are also likely to be a number of culverts within the other rated catchments that create similar challenges to upstream fish passage. Selwyn District Council is currently undertaking a district-wide fish passage assessment, scheduled for completion in June 2026, which will help to guide the prioritisation of future culvert and waterway structure renewals.

Fish passage improvements of instream structures could include the installation of riffle ramps downstream of weirs and culverts where an existing vertical drop is present, to reinstate hydraulic connectivity and provide passable water depths and velocities for fish migration. Any replacement of culverts and associated structures is required to provide for fish passage. Several migratory native species have been recorded across the catchments, including shortfin eel, longfin eel, and inanga (Table 10), all of which would benefit from improved connectivity. Design should align with the New Zealand Fish Passage Guidelines (Franklin *et al.*, 2024), including maintaining continuity of instream habitat, minimising alteration of natural gradients and alignments, avoiding vertical drops at inlets and outlets, and ensuring flow conditions remain passable.

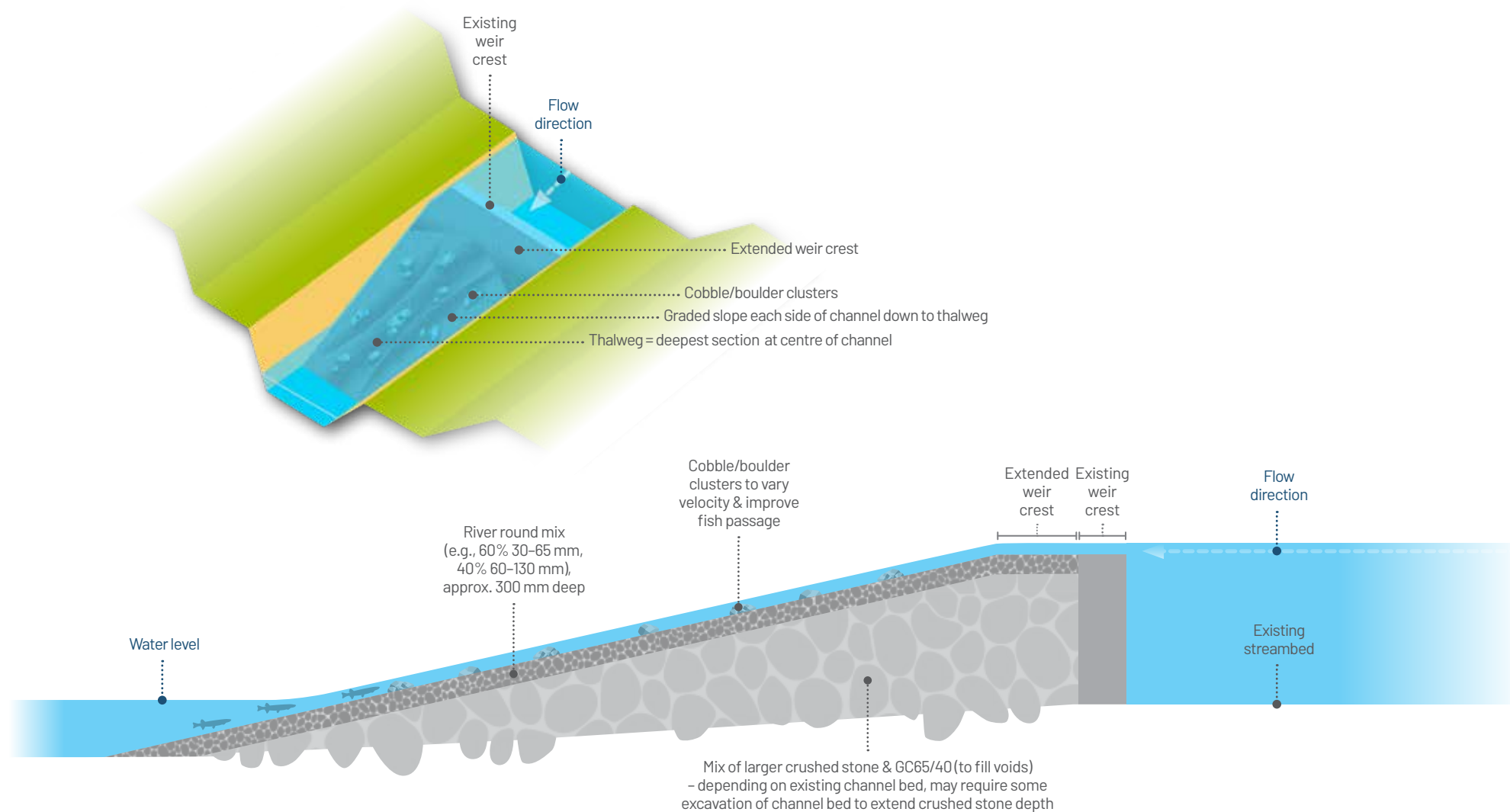
However, fish passage must also be considered for exclusion purposes in specific locations, particularly within the Leeston catchment where kōwaro/Canterbury mudfish are present. As this species is highly vulnerable to fish predation and typically does not persist in waterways occupied by trout, the provision of fish passage must be carefully balanced with the need to protect and maintain suitable mudfish habitat, which may include retaining or designing selective barriers where appropriate.

Key Features

- Long-term management of fish passage at structures.
- Complies with the New Zealand Fish Passage Guidelines for the provision of fish passage.
- Do not implement if nearby upstream habitat has kōwaro/Canterbury mudfish.

Core Benefits

- Improved connectivity of habitat for fish.
- Better downstream bank/channel erosion protection.



Long section showing a riffle ramp downstream of an existing weir structure. This design could be modified to be used downstream of a perched culvert as well. (Drawing is indicative only.)

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7.2.11 INTERVENTION 11: BANK/CHANNEL IMPROVEMENTS – Stock Exclusion

Where perennial waterways in the catchment do not already have stock excluded, this should be treated as a priority intervention. Given the significant challenges posed by fine sediment in these catchments, excluding stock from waterways is a basic intervention that can help reduce sediment inputs and protect channel stability. Stock exclusion is most effective when implemented alongside other interventions (e.g., bank/channel improvements, treatment wetlands, sediment management interventions) but it can also be deployed as a standalone intervention where gaps in existing stock exclusion remain. Priority areas include perennial waterways, springheads, sediment traps, and treatment wetlands. However, excluding stock from intermittent drainage channels, as well as temporarily excluding stock from informal flow paths and ephemeral channels during wet periods, will also deliver meaningful benefits.

As described in Section 5.1.2, fences across waterways can trap debris during high flows, reducing the effectiveness of the drainage network and contributing to localised flooding. For this reason, stock management practices must align with drainage needs, and in some cases alternative approaches to stock exclusion should be considered. Stock exclusion does not always require permanent fencing — technologies such as virtual fencing and GPS-enabled collars offer greater flexibility, particularly in areas where fence location may need to change over time. Regardless of the method used, stock exclusion also requires ongoing maintenance to ensure excluded areas remain free of weed species and continue to function as intended.

Key Features

- To be used in locations where stock have access to waterways.
- Suitable for all waterway types.
- Exclusion setbacks should aim for a ‘better than good practice’ approach as described in Section 6.1.
- Fencing across waterways should be avoided, as it can trap debris and worsen flooding.

Core Benefits

- Improving instream habitat by removing direct stock access to waterways.
- Reduction in sediment, *E. coli*, and nutrient inputs to waterways by removing direct stock access.
- Improved bank condition & channel stability through reduced trampling & pugging by stock.



A fenced waterway within private farmland in the Leeston catchment. Although this waterway is fenced to prevent stock access, it may benefit from additional interventions such as a two-stage channel to improve flood flow capacity.



Stock exclusion does not always mean fencing – virtual collars are now available that give greater flexibility for stock exclusion. Image source: Shutterstock



Weed control along the edge of the planted area and the fence is important. Where space allows, a 1 m unplanted buffer zone on the riparian side is recommended to reduce the encroachment of planted vegetation into the adjacent paddock. Spot-spraying of weed species may also be required.

7.2.12 INTERVENTION 12: TREATMENT WETLANDS – Off-Channel Large-Scale

Where space is available, large-scale wetlands offer benefits for flood management and water quality improvement, while providing increased habitat for biodiversity. Based on the national guidance from NIWA (2021), wetlands treating agricultural runoff and drainage flows should be sized at 1–5% of their contributing catchment (approximately 100–500 m² of wetland per ha), although in practice, large-scale wetlands are often designed around the land area that is available. If the optimal size cannot be achieved in a single wetland, establishing multiple smaller wetlands throughout the catchment can collectively provide the required treatment area at the catchment scale. Off-channel large-scale wetlands can treat baseflows and most flood flows while allowing a portion of the largest flow events to bypass via the existing stream channel, thereby maintaining fish passage, providing more consistent flows to the wetland, and reducing flood damage to the wetland. Where full treatment of all flows is required, inline systems may be appropriate, provided they include a bypass for major flood events. Wetland design should discourage preferential flow paths and may be constructed as a single cell/elongated channel or as a series of smaller cells, with two or more cells being recommended by Eivers (2018).

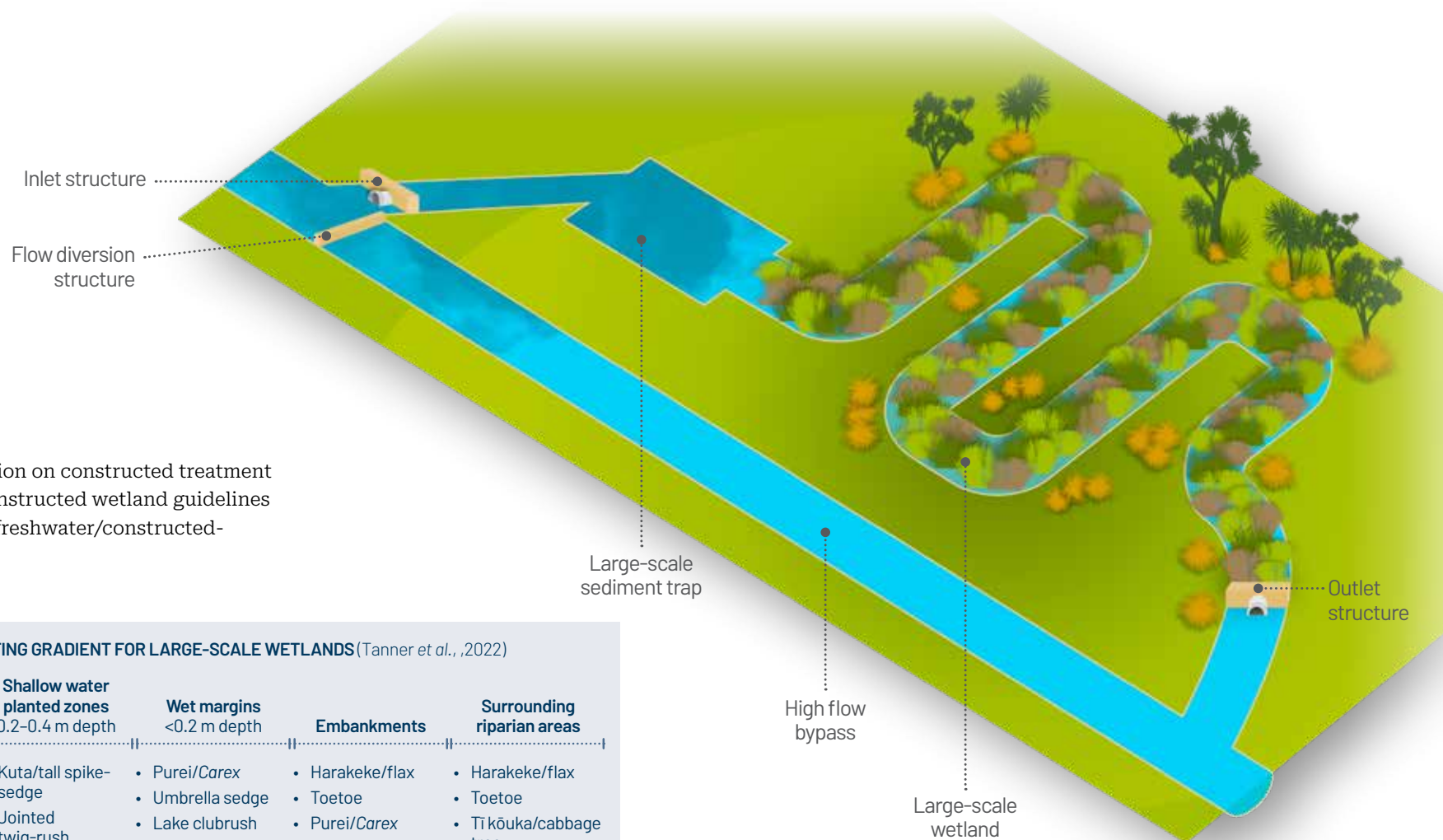
By their nature, wetlands will accumulate sediment over time. To reduce the need to disturb the wetland habitat for sediment removal, large-scale wetlands should be paired with an upstream sediment trap (Section 7.2.16 and Section 7.2.17), which reduces sediment entering the wetland system and extends its lifespan. The design of any large-scale wetland will depend on local site characteristics, such as soil type and groundwater interactions, and whether it will function primarily as an infiltration or open water wetland. Innovative options for incorporating additional filter mediums such as floating wetlands into the wetland should be considered during the detailed design stage, with the suitability of these being contingent on the site conditions and wetland design. For these reasons, large-scale wetlands should be designed by specialists with experience in wetland design and construction and familiarity with the local catchment context.

Key Features

- Requires large area of land and earthworks, and custom designs.
- Suitable for locations where sufficient land may be available, including the willow-dominated lower reaches of Wairiri Stream downstream of the rated catchment and key convergence points in the upper surface water catchment.
- Off-channel design allows for larger flood events to bypass.
- Detailed design required for large-scale wetland projects.
- Always combine with an upstream sediment trap to increase longevity.

Core Benefits

- Primary benefit: water quality improvement (once system is established).
- Provides substantial flood-storage capacity which attenuates peak flows and reduces downstream flooding.
- Improved ecological and biodiversity values.
- Reduced downstream transport of fine sediment and other contaminants.
- Flood management benefits through creating an area where flood waters can spread out.



For further information on constructed treatment wetlands, see the constructed wetland guidelines (<https://niwa.co.nz/freshwater/constructed-wetland-guidelines>).

RECOMMENDED PLANTING GRADIENT FOR LARGE-SCALE WETLANDS (Tanner *et al.*, 2022)

Open water >0.5 m depth	Shallow water planted zones 0.2–0.4 m depth	Wet margins <0.2 m depth	Embankments	Surrounding riparian areas
- No planting - Self colonised by submerged plants	- Kuta/tall spike-sedge - Jointed twig-rush - Lake clubrush - Raupō	- Purei/<i>Carex</i> - Umbrella sedge - Lake clubrush - Jointed twig-rush - Harakeke/flax	- Harakeke/flax - Toetoe - Purei/<i>Carex</i> - Wiwi/rushes	- Harakeke/flax - Toetoe - Ti kōuka/cabbage tree - Mānuka - Coprosma - Kahikatea - Māhoe

Large-scale wetlands should be bundled with large-scale sediment traps, to reduce the volume of sediment reaching the wetland. For guidance on planting see 'Technical guidelines for constructed wetland treatment of pastoral farm run-off' (NIWA, 2021b).

(Drawing is indicative only. Large-scale wetlands require a site-specific design.)

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7.2.13 INTERVENTION 13: TREATMENT WETLANDS – Inline Lineal

Inline lineal wetlands are an opportunity to create wetlands within existing drainage channels by widening channels and planting wetland vegetation. They will be particularly effective where the channels are relatively deep, but water depth is relatively shallow. Lineal wetlands are likely to be well suited to the Greenpark catchment in particular due to its low gradient and generally slow-flowing water. Where there is insufficient space to create off-channel wetlands, there may remain an opportunity to create larger lineal wetlands through the planting of wetland vegetation into the base of these deeply incised channels, along with modification of the banks to form a wider two-stage channel profile to increase channel flood flow capacity. To maintain an optimal base flow water depth of 0.1–0.3 m, the base flow channel width can be widened to reduce the water depth or small earth bunds used to increase and maintain the optimal water depths within cells along the lineal length of the wetland. These earth bunds could be constructed by machinery at the time of bank reshaping or installed at a later stage following observations of the wetland's function. In some parts of Aotearoa New Zealand, similar small water level control structures have been created by filling harakeke kete with soil, providing a natural and culturally sustainable approach. This approach offers inherent flexibility, as these structures can be installed at any time without the need for heavy earthmoving machinery.

Given the relatively flat gradient of the rated catchments, flood flows may sometimes back up through the system rather than being controlled by channel hydraulics. As such, additional flood flow storage capacity can be achieved through modifying the existing banks to a two-stage channel design that will provide a greater cross-sectional area for holding water. As much of the Ellesmere, Greenpark, Leeston, and Taumutu rated catchment areas were likely once large wetlands (as indicated by the presence of gley soils), the use of these inline lineal wetlands is a practical and realistic option for the catchments.

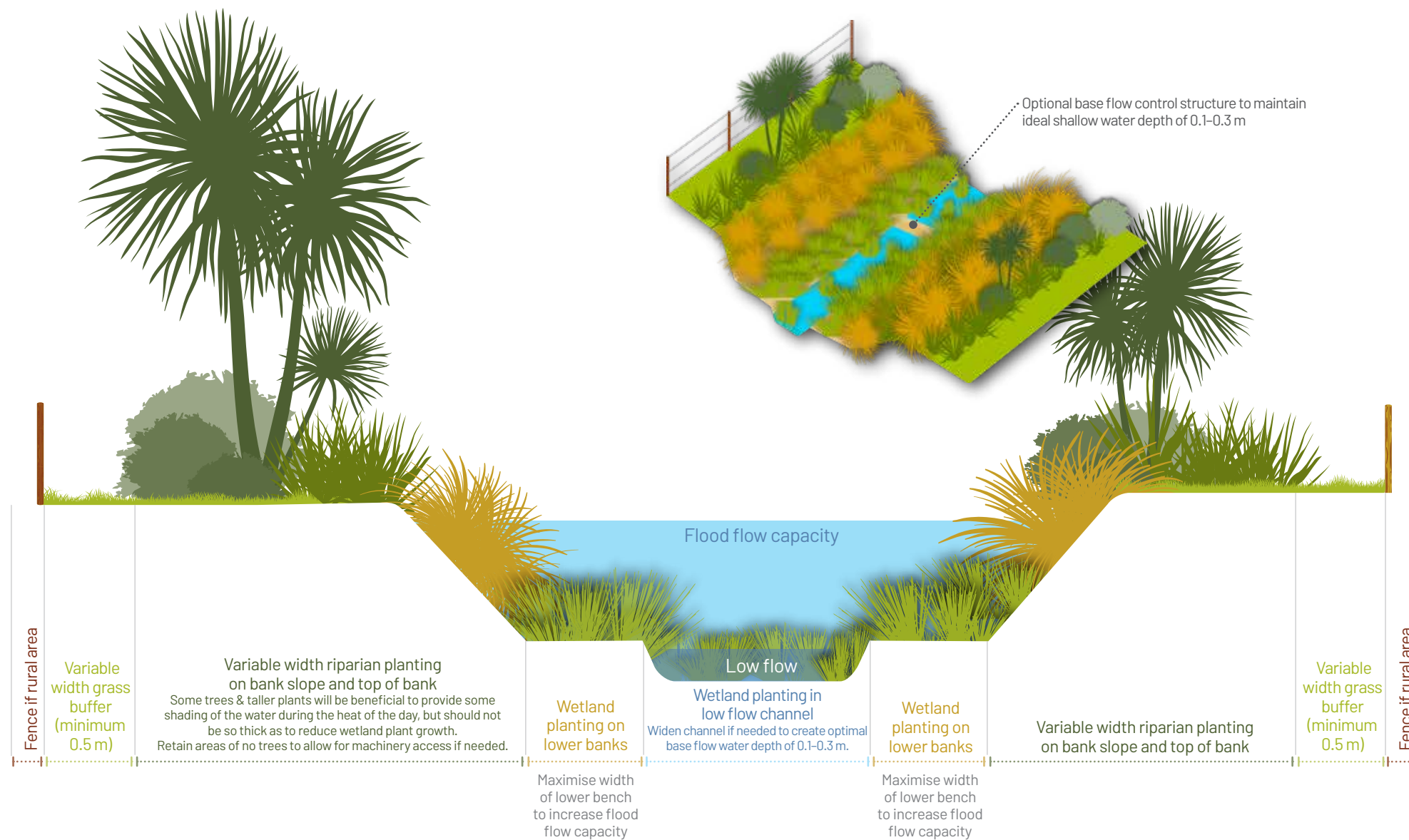
Lineal wetlands are expected to retain water during rain events and improve water quality before water continues through the drainage network. However, if the channel contains fine sediment with high organic content, it may be advisable to remove this material prior to planting and undertaking works, as legacy sediments can cause a net release of nutrients during the initial years of wetland establishment (Rebecca Eivers, pers. comm.). To improve longevity and performance, lineal wetlands should be combined with an upstream sediment trap (Section 7.2.17), to reduce sediment inputs and extend the effective lifespan of the wetland.

Key Features

- More suitable for deeper/incised channels where flood flow capacity can be maintained through bank reshaping to a two-stage channel.
- Requires some surface baseflow (water depth 0.1–0.3 m) or subsurface water.
- Work would include planting and fencing to exclude stock, and long-term management of vegetation.
- Requires space to create wider two-stage channel form.

Core Benefits

- Water quality improvement.
- Increase in wetland habitat and biodiversity.
- Reduced downstream transport of fine sediment and other contaminants.
- Reduced peak runoff and increased flood flow capacity.



Cross section showing the profile of a typical two-stage channel with riparian planting. (Drawing is indicative only.)

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7.2.14 INTERVENTION 14: TREATMENT WETLANDS – Small-Scale

Small-scale wetlands are envisaged as an on-farm opportunity. Their small size means they may be implemented without the need for consent, depending on the volume of earthworks required and the volume of water dammed or diverted. These wetlands are most effective when treating small sub-catchments. National guidelines recommend a wetland to sub-catchment area ratio of around 1–5% (NIWA, 2021b), while more recent work in the Waikato region suggests around 1.5% for treatment wetlands in headwater catchments (Rebecca Eivers, pers. comm.). As such, the use of multiple small wetlands across the smaller sub-catchments of the Greenpark, Ellesmere, Leeston, and Taumutu catchments would be an appropriate and practical approach. Wetland design should discourage preferential flow paths and can be constructed as a single cell/elongated channel or as a series of smaller cells. NIWA (2021b) recommends an overall length to width ratio between 5:1 and 10:1, while work by Eivers (2018) is based around a circular, off-channel design. A low gradient is critical to the design of wetlands, with prolonged residence time through the wetland important. Given the naturally low gradients of the Greenpark, Ellesmere, Leeston, and Taumutu catchments, the area is well suited for such wetland treatment systems, which could be used to treat key areas of overland flow. To improve longevity, wetlands should be complemented by an upstream sediment trap (Section 7.2.16), which reduces sediment loading and extends the functional life of the wetland. Where sufficient space is available, a repeated treatment train of sediment trap followed by wetland, repeated in series, may be incorporated (Eivers, 2018).

Wetland design must also consider the potential for nitrate-N conversion to ammonium-N under oxygen-limited (anaerobic) sediment conditions, particularly where organic carbon availability is high. To address this, Eivers (2018) recommends a multi-cell or modular design to improve ammonium-N removal. The use of infiltration outlets is also recommended to enhance phosphorus attenuation. Plant species selection is critical. Short-lived annual and perennial species should be avoided as they can become a nutrient source, while the presence of macrophytes can substantially increase removal efficiencies in small treatment wetlands (Eivers, 2018). Regardless of the species selection, careful and ongoing weed management is required to prevent the establishment or dominance of undesirable species. Wetlands tend to perform best with regular baseflow, but well-designed systems can still provide benefits for ephemeral channels. To improve longevity, wetlands should be bundled with a sediment trap upstream (Section 7.2.16 and Section 7.2.17), which will reduce the volume of sediment reaching the wetland and extend its effective lifespan.

In addition to improvements in water quality (particularly nitrogen removal), small-scale wetlands can provide benefits for flood management, sediment control, and biodiversity. Performance may be variable during the first 3–5 years following establishment; so allowing sufficient time for the wetlands to settle before expecting them to perform well is important. Opportunities for small-scale wetlands may be identified through farm environmental planning processes, including the identification and retirement of wet areas or critical source areas.

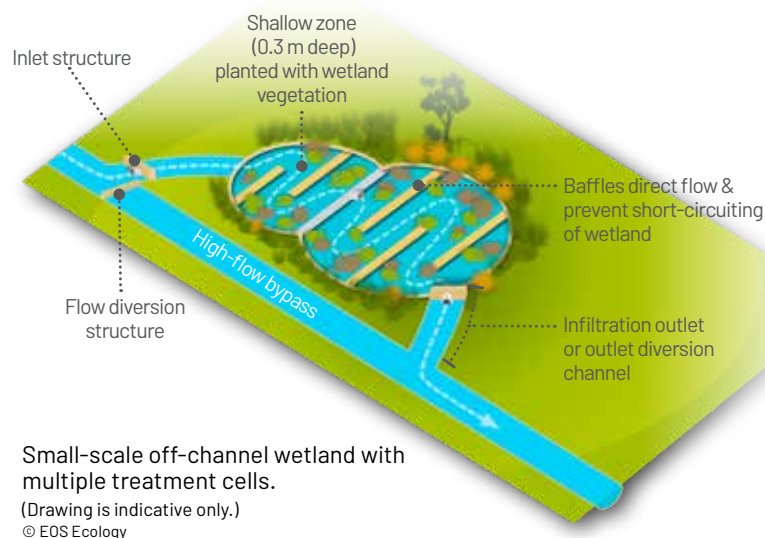
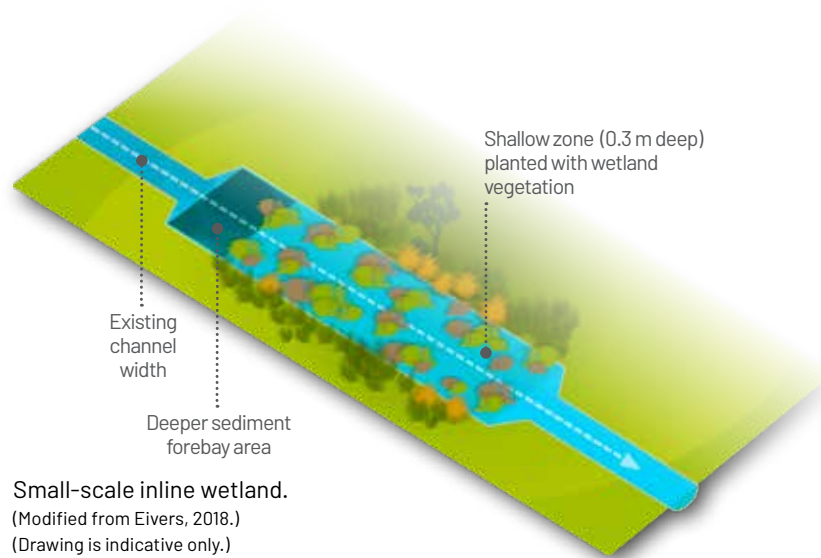
Design should be undertaken by specialists experienced in small-scale, off-channel wetland design and familiar with the Greenpark, Ellesmere, Leeston, and Taumutu catchments. For further information on small scale constructed treatment wetlands, see the NIWA constructed wetland guidelines (<https://niwa.co.nz/freshwater/constructed-wetland-guidelines>), and Eivers (2018).

Key Features

- Located on both rated and unrated drainage waterways.
- Best sited in smaller/headwater sub-catchments and could be used around confluence points for smaller drainage channels or to treat critical source areas.
- Help with flood management and improving water quality.
- Small-scale earthworks.
- Ability to create a standard design(s) that could be used across the catchment.
- Work would include planting and fencing to exclude stock.
- Ideally combine with an upstream sediment trap to increase longevity, or where space allows a repeated treatment train of sediment trap + treatment wetland + sediment trap.
- Identify as ‘treatment wetlands’ rather than natural wetlands to allow for maintenance.

Core Benefits

- Water quality improvement (once system is established).
- Increase in wetland habitat area and biodiversity values.
- Reduced downstream transport of fine sediment and nutrients.
- Reducing peak runoff.



Note: wetlands will function best when combined with an upstream sediment trap, or (at a minimum) with sediment forebay in first wetland cell.



A small-scale off-channel wetland constructed with multiple cells and a control structure to allow for water quality testing and flow control.

7.2.15 INTERVENTION 15: TREATMENT WETLANDS – Floating

Floating wetlands can provide an effective ‘early works’ intervention to support water quality improvements while longer term mitigation measures are still being planned and implemented. They are suitable for installation only in deeper reaches of drainage waterways or in permanently ponded areas, where sufficient water depth and residence time can be maintained. Floating wetlands require a relatively long hydraulic residence time (i.e., 3–5 five days for increased nitrogen removal) to provide time for plant uptake and microbial processes. There may be locations in the Taumutu catchment, particularly around the fish hatchery, where water depth is sufficiently deep and residence time is adequate, since water discharge is controlled through an outlet structure.

Floating wetlands require a water depth of 0.8–1.5 m to prevent plant roots from growing to the streambed and attaching. Floating wetland modules should be arranged to minimise preferential flow paths around the modules. Dissolved oxygen levels beneath floating wetlands can be particularly low, which may limit habitat suitability for some fish species. Native plant species recommended for floating wetlands include *Carex*, *Juncus*, *Ficinia*, *Schoenoplectus*, and *Machaerina* species. Ongoing maintenance is important to ensure effective wetland function and includes periodic cutting of the floating vegetation to promote growth and remove dead material, weed control, and removal of accumulated sediment and organic material from beneath the wetland.

There are a range of floating wetland providers, including smaller modular systems, that could be useful here. The modules are anchored to prevent them from floating away, while still allowing them to rise and fall with changing water levels. The modules can also be moved around to facilitate maintenance, including the removal of sediment underneath. The flexibility of modular systems allows the network to be expanded over time if monitoring indicates that a greater wetland footprint is required to achieve specific nutrient-reduction targets.

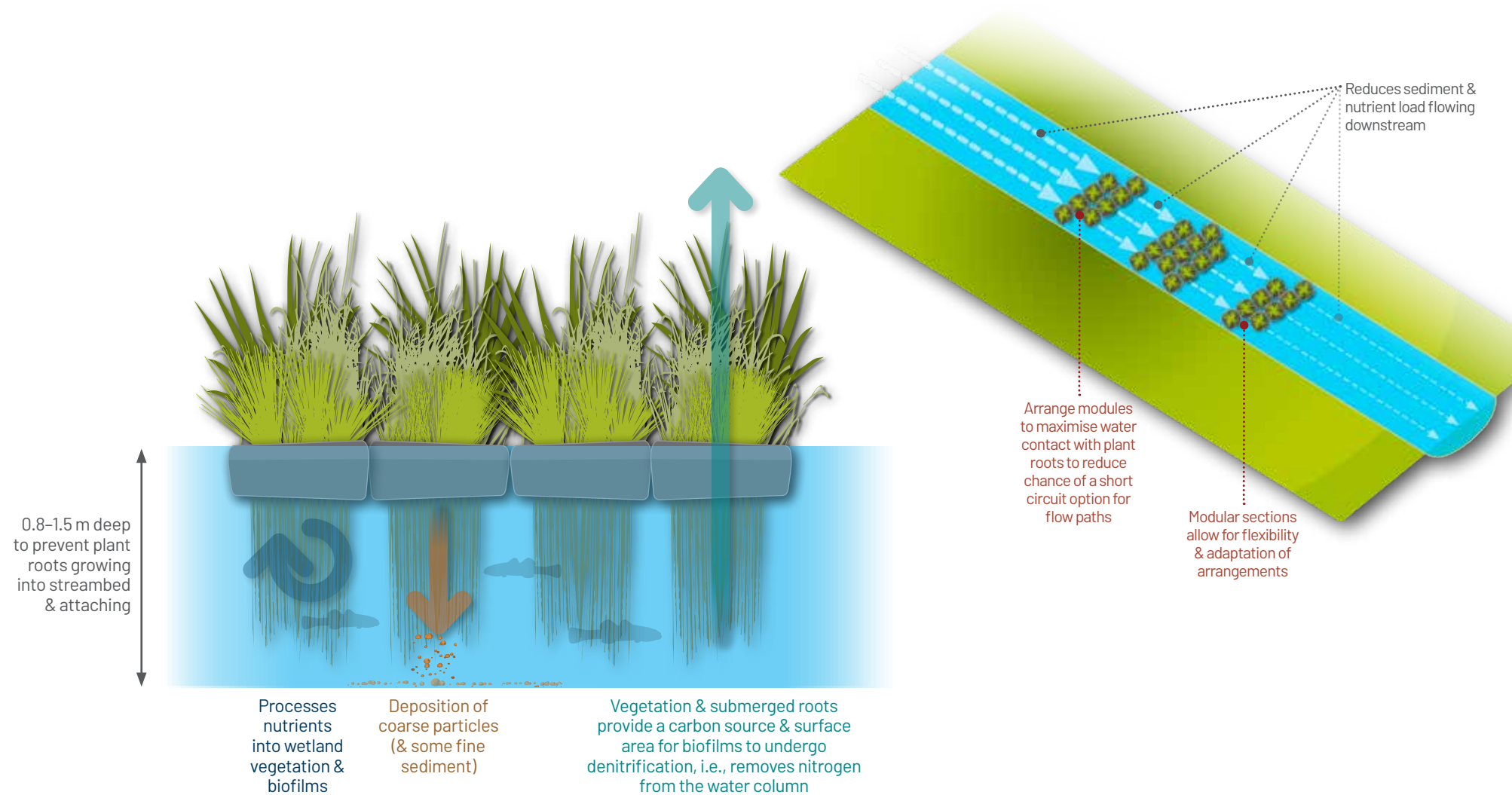
Floating wetlands are expected to reduce nutrient concentrations through direct plant uptake and via biofilm growth on the plant roots, as well as reduce suspended sediment loads through filtration and settling. While their performance in agricultural catchments is not well understood and can be highly variable (Waterhouse *et al.*, 2024), floating wetlands are generally considered effective for reducing nitrogen, phosphorus, and fine sediment, as they provide opportunities for denitrification, plant uptake, and physical filtration. Given the water depth requirements for floating wetlands, suitable sites within the Greenpark, Ellesmere, Leeston, and Taumutu catchments are limited. Potential applications include flood detention basins (Section 7.2.21), where floating wetlands could be used to further improve the quality of discharged water, provided that permanent water depths can be maintained.

Key Features

- Requires permanent and deep water — limited to the perennial reaches of the drainage network or to permanently ponded areas.
- Requires deeper water so that plant roots do not attach to the channel bed.
- May need to be combined with reshaping as a two-stage channel to provide capacity for the floating wetland within the channel.
- Relatively easy to install & maintain, with no earthworks required.
- Provides an early/immediate intervention option.

Core Benefits

- Water quality improvement.
- Easy to install and remove.



Cross section illustrating how a floating wetland modular system works.

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7.2.16 INTERVENTION 16: SEDIMENT MANAGEMENT – Off-Channel Sediment Trap

The purpose of sediment traps (off-channel and inline options) is to provide a location for targeted accumulation and removal of sediment that reduces the environmental impacts and financial costs of widespread sediment removal across the drainage scheme, as well as reducing the amount of fine sediment being transported down the drainage network and providing managed areas where sediment accumulation can be more easily monitored. The success of sediment traps relies on having enough of them placed in the right locations throughout the catchment. Ideally, sediment traps should be maximised in the mid-upper catchment to ensure that sediment originating from these areas is not able to be transported to the lower reaches of the catchment. However, they are also an important feature to include upstream of any treatment wetland to increase the life of the wetland. Sediment traps are not as effective at settling out very fine clay-sized particles or lighter organic particles, which are more effectively trapped by treatment wetlands — as such, a combination of sediment traps and treatment wetlands should be used to manage sediment in catchments with finer pallic soils.

Small-scale inline or off-channel sediment traps would need to be numerous to achieve substantial benefits for sediment reduction. Their effectiveness would need to be monitored over time to establish how often they require emptying, whether additional traps would be needed to support the desired sediment reductions, and to establish a workable maintenance schedule for the traps. The need for fish rescue protocols would also need to be considered as part of the maintenance procedure for sediment traps. Mechanisms to support this type of intervention could include the application for a catchment-wide resource consent for the initial construction of small-scale sediment traps and for the ongoing removal of sediment from these traps.

An advantage of off-channel sediment traps over inline sediment traps is that they face less risk of accumulated sediment being flushed out during a flood event, since flood flows pass down the existing channel. However, given the low gradient nature of these rated drainage catchments, this may not be as much of a consideration. Off-channel sediment traps are also easier to empty because they can be isolated from the main channel, which allows for faster fish removal and reduces the risk of re-suspended sediment discharging downstream. However, they do require additional land compared to an inline sediment trap and this may create challenges in some areas.

Further information on off-channel sediment traps can be found in Eivers (2018) and via the Living Water website (www.livingwater.net.nz/im:c379467d-fdcb-44bc-9a69-dc61b62460ca).

Key Features

- Requires land adjacent to the existing channel.
- Suitable upstream of treatment wetlands, to reduce sediment input to wetlands.
- Can be isolated from the active channel during maintenance, enabling more efficient sediment removal and fish rescue.

Core Benefits

- Facilitates the deposition & mechanical removal of fine sediment from the drainage network (not as effective in trapping very fine, clay-sized material).
- Reduces downstream transport of fine sediment and associated contaminants.
- Reduces ecological impacts of widespread sediment removal.
- Increases longevity of treatment wetlands (when used in conjunction with these).

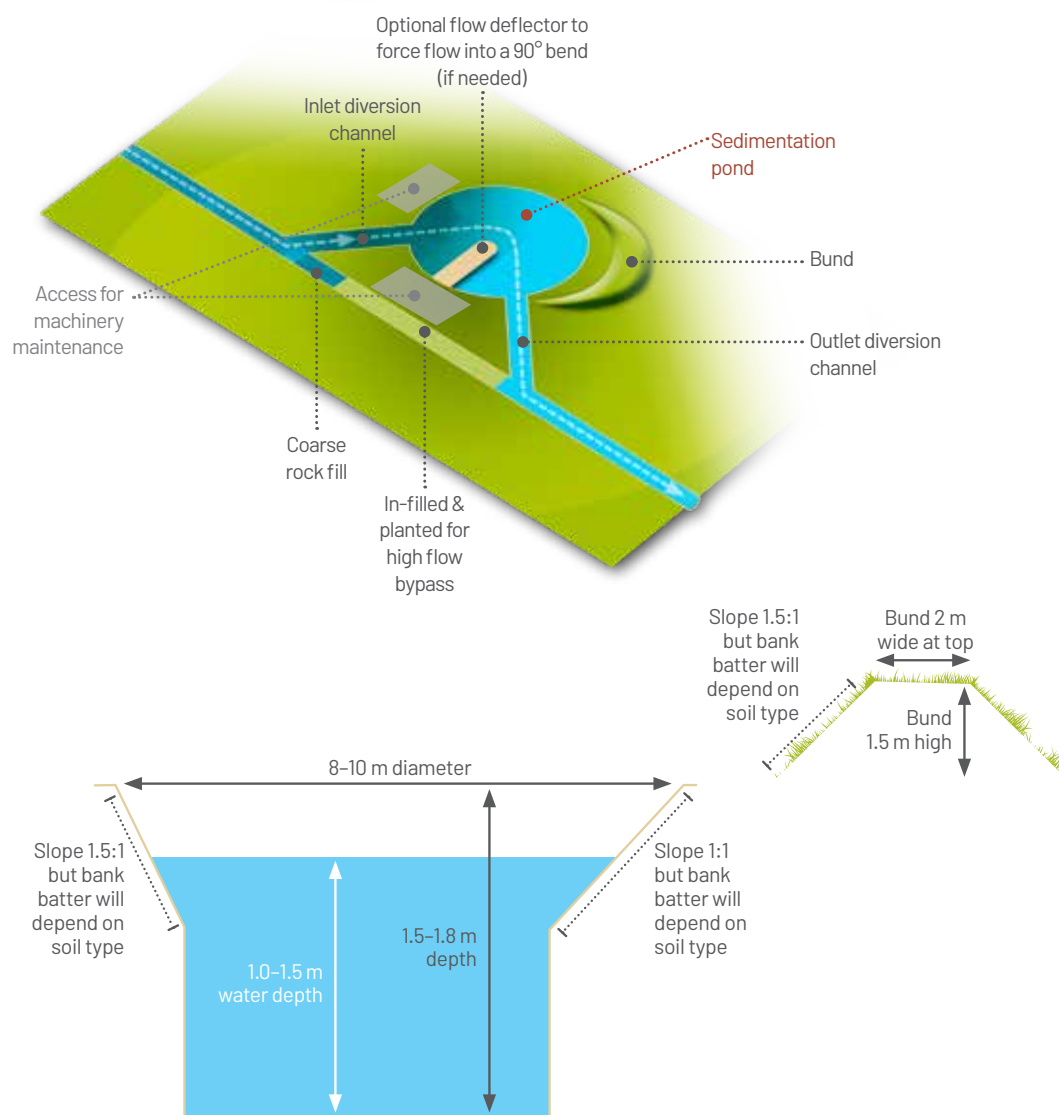


Diagram illustrating sedimentation pond.
(Modified from 'Sedimentation Pond' design in Eivers (2018).)
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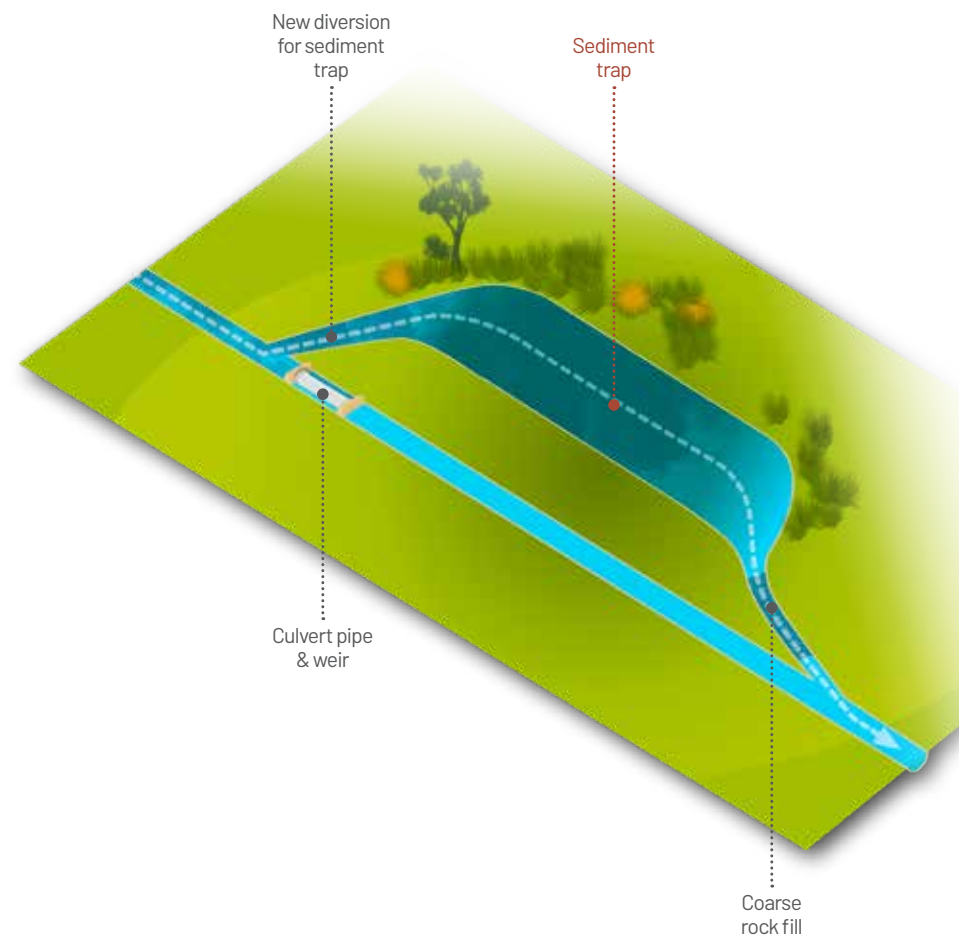


Diagram illustrating off-channel sediment trap.
(Modified from Living Water website www.livingwater.net.nz/im:c379467d-fdcb-44bc-9a69-dc61b62460ca.)
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7.2.17 INTERVENTION 17: SEDIMENT MANAGEMENT – Inline Sediment Trap

The purpose of sediment traps (off-channel and inline options) is to provide a location for targeted accumulation and removal of sediment that reduces the environmental impacts and financial costs of widespread sediment removal across the drainage scheme, as well as reducing the amount of fine sediment being transported down the drainage network and providing managed areas where sediment accumulation can be more easily monitored. The success of sediment traps relies on having enough of them placed in the right locations throughout the catchment. Ideally, sediment traps should be maximised in the mid-upper catchment to ensure that sediment originating from these areas is not able to be transported to the lower reaches of the catchment. However, they are also an important feature to include upstream of any treatment wetland to increase the life of the wetland. Sediment traps are not as effective at settling out very fine clay-sized particles or lighter organic particles, which are more effectively trapped by treatment wetlands — as such, a combination of sediment traps and treatment wetlands should be used to manage sediment in catchments with finer pallic soils.

Small-scale inline or off-channel sediment traps would need to be numerous to achieve substantial benefits for sediment reduction. Their effectiveness would need to be monitored over time to establish how often they require emptying, whether additional traps would be needed to support the desired sediment reductions, and to establish a workable maintenance schedule. Fish rescue protocols may also be needed as part of their maintenance. Mechanisms to support this type of intervention could include the application for a catchment-wide resource consent for the initial construction of small-scale sediment traps and for the ongoing removal of sediment from these traps.

Compared to off-channel sediment traps, inline sediment traps are at greater risk of having accumulated sediment flushed out during a high flow event. However, in lower gradient parts of the Greenpark, Ellesmere, Leeston, and Taumutu rated catchments, flood flow velocities may not get high enough to scour out accumulated material from inline sediment traps. Removal of sediment may still require additional measures to limit resuspended sediment from being released, since they are in line with the main waterway. Planning sediment removal for times when water levels in the wider drainage network are lower would reduce the risk of sediment being resuspended and transported downstream.

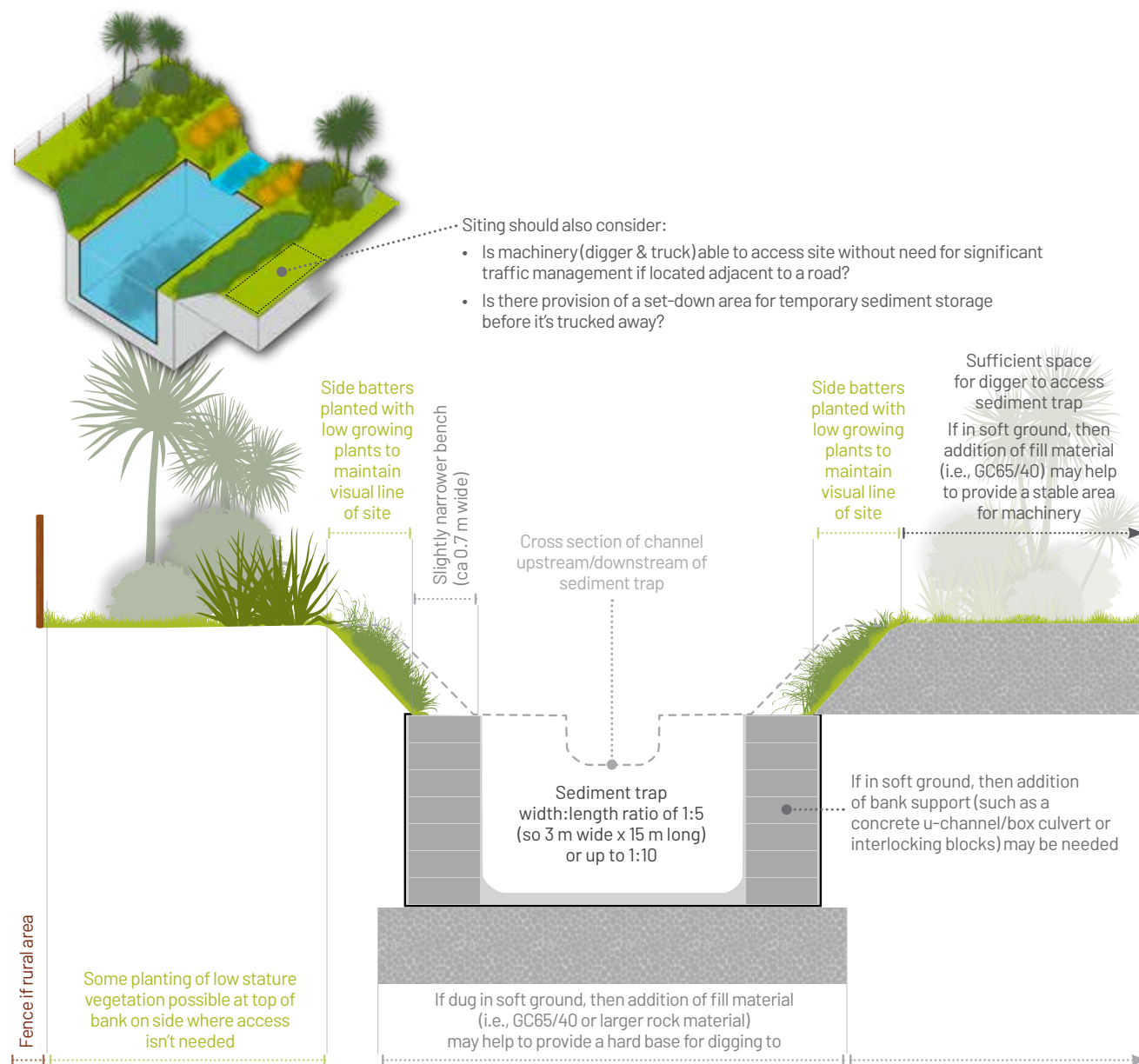
Inline sediment traps would involve enlarging and formalising existing sediment accumulation areas, with a recommended minimum width-length ratio of 1:5 and maximum ratio of 1:10. They need good machinery access for maintenance and sufficiently stable ground to allow for regular machinery access. To ensure that the sediment traps don't become a source of bank erosion, these widened and deepened sections of channel may need to be lined in some way to ensure that over time they do not become over-deepened and widened. Gabion baskets, aggregate lining, concrete structures, or the use of an excavation design model by machine operators may be suitable to achieve this. Regardless of the measures implemented, it will be important to employ expert operators to undertake sediment removal and maintenance, as care will be needed to avoid damage to the sediment trap. The size of the machinery used to dig out the sediment trap will have an influence on where in the network they can be installed, with the reach of an excavator being a key consideration for the design. Further information on inline sediment traps can be found on the Living Water website (www.livingwater.net.nz/im:2115c587-9312-407d-a73e-6372ee3638cb).

Key Features

- Suitable for all drain types with perennial or intermittent flow.
- Reduces sediment impact downstream but can also provide low flow habitat for fish.
- Less effective for trapping finer clay sized soil particles.
- Hard edge lining may be necessary, with a focus on utility/maintenance requirements rather than biodiversity values.

Core Benefits

- Facilitates deposition and mechanical removal of fine sediment from the waterway network (not as effective in trapping finer clay-sized material).
- Reduces downstream transport of fine sediment and associated contaminants.
- Reduces the ecological impacts of widespread sediment removal.
- Increases longevity of treatment wetlands (when used in conjunction with these).



The flat area of water in this channel is a sediment trap location. When the trap is nearly full, a digger can reach over the fence and planting to remove sediment.



An inline sediment trap may simply be a widened and deepened area of channel, where the flow is slower and encourages the deposition of fine sediment. However, we are recommending a more hard-edged solution, to enable easier access for maintenance. Image source: Robin Smith, DOC

Small-scale inline sediment traps provide a location for targeted accumulation and removal of fine sediments. An inline sediment trap may simply be a widened and deepened area of channel.

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7.2.18 INTERVENTION 18: SEDIMENT MANAGEMENT – Inline Event-Based Sediment Trap & Water Level Control

Inline event-based sediment traps are targeted sediment removal areas for ephemeral sections of channel where conventional inline sediment traps would be less effective. Based on the design principles of peak runoff control structures, these traps incorporate a controlled in-channel backup of water during higher flow events, which encourages the deposition of fine sediment. To achieve this, a downstream control structure — such as a culvert outlet, bund, spillway, or choked outlet — is installed to allow normal intermittent flows to pass, while temporarily holding back water during elevated flow events to increase residence time and facilitate sediment deposition. As with other types of sediment traps, inline event-based sediment traps are most effective at settling larger, heavier particles and far less effective at capturing fine clay-sized particles such as loess-derived silt from pallic soils.

This intervention could also be adapted as a form of water level control in drainage channels to help to retain water within the soil profile during the drier summer months, increasing pasture and crop productivity during an otherwise moisture deficit period (Ballantine & Tanner, 2013). The simplest form of water level control involves installing a temporary control structure (i.e., a weir) in the channel at the end of the wet period to raise the water table, then removing or lowering the structure before the onset of the main wet season. Note that this approach requires active monitoring and maintenance, although more automated forms of control are available that enable dynamic adjustment in response to soil water content. Such features not only help with retaining soil moisture during drier summer months but also provide for sediment trapping and where sufficient residence time is provided, they may allow for denitrification through microbial activity.

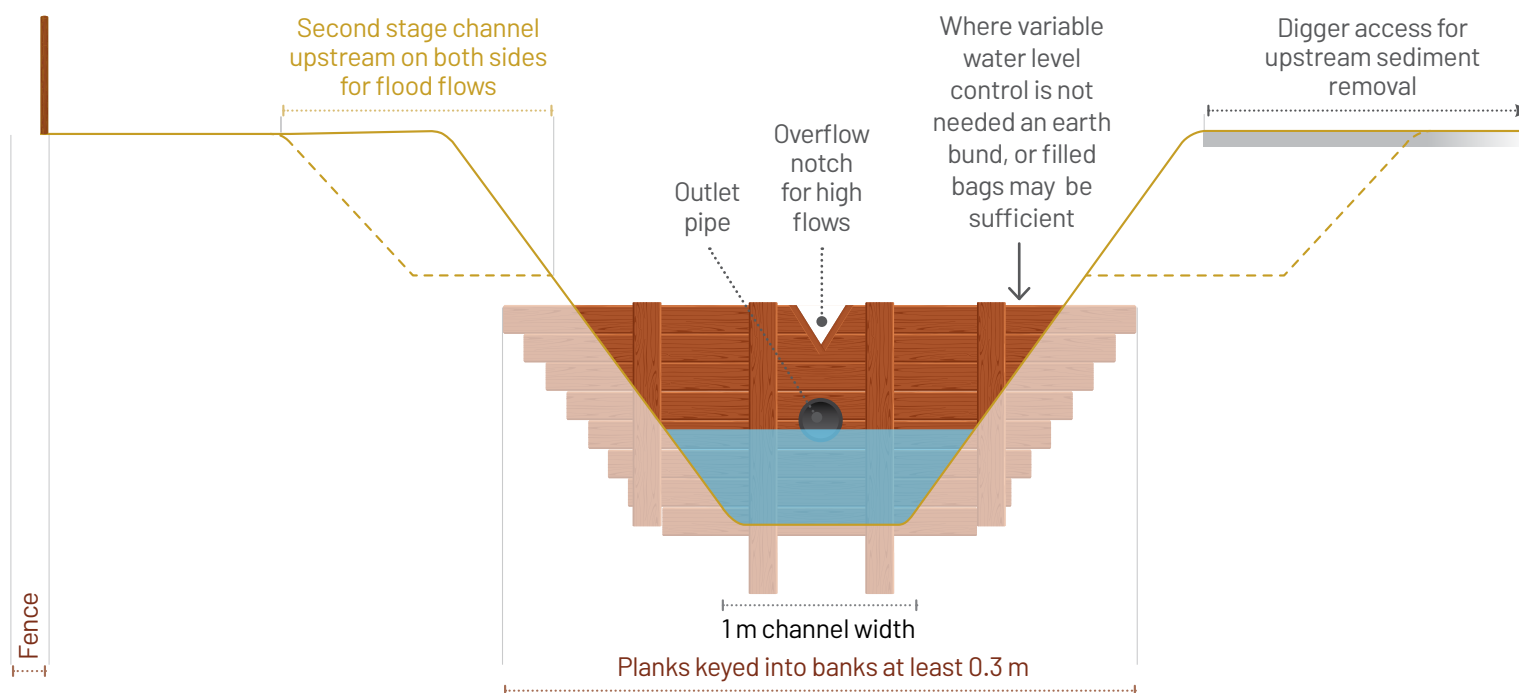
As inline event-based sediment traps or water level controls introduce a fish passage barrier, they are only suitable for ephemeral reaches with low upstream fish habitat values. The design of these structures would need to consider the existing ground levels and channel capacity to ensure that water does not overflow, with automated flow-control systems providing an optimal solution where feasible. These types of small-scale interventions would need to be numerous to achieve substantial benefits for sediment reduction, and their effectiveness would need to be monitored over time to establish their efficacy and maintenance programme. Mechanisms to support this type of intervention could include applying for a catchment-wide resource consent covering both the initial construction of sediment traps and the ongoing removal of accumulated sediment from these traps.

Key Features

- Suitable for ephemeral/intermittent channels.
- No fish passage, so not suitable for perennial sections of channel.
- An intervention for reducing sediment impact downstream, not for biodiversity purposes.
- Peak flow control structure used to accumulate sediment and facilitate mechanical removal.

Core Benefits

- Facilitates deposition and mechanical removal of fine sediment from the waterway network (not as effective in trapping finer clay sized material).
- Reduces downstream transport of fine sediment and associated contaminants.
- Reduces ecological impacts of widespread sediment removal.



Water level controls can be used to better manage soil moisture levels in dry summer periods. Automated or semi-automated control can improve easy management of the structure.

Small-scale event-based sediment traps can be used in ephemeral channels. Small-scale event-based sediment traps and water level controls could be combined for multi-purpose use in some areas of the catchment. Image is indicative only – there are alternatives to the type of structure used to form the control point.

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7.2.19 INTERVENTION 19: SEDIMENT MANAGEMENT – Detainment Bund

Paddock-based detainment bunds are an edge-of-field mitigation tool used to reduce sediment and nutrient losses from overland flow generated during heavy rainfall events. Typically constructed across informal flow paths or ephemeral waterways, these bunds temporarily hold back runoff, allowing fine sediment to settle out of suspension and be deposited back on the paddock. Detainment bunds have been shown to be a cost-effective means of retaining both fine sediment and particulate phosphorus within paddocks; however, they are generally ineffective at reducing dissolved nutrient concentrations (Clarke, 2013; Levine, 2020).

The Greenpark, Ellesmere, Leeston, and Taumutu catchments contain an extensive network of informal flow paths, particularly when compared with the length of rated waterways (Table 7). In some locations, these informal flow paths originate within critical source areas, including raceways, grazed forage crops, and pugged areas of paddocks. Such critical source areas typically contribute a disproportionately high load of fine sediment and nutrients (particularly phosphorus) that becomes mobilised during rainfall events. As runoff from paddocks and critical source areas feeds into these informal flow paths, they are likely to represent a significant pathway for contaminant transport to downstream waterways.

Paddock-based detainment bunds are typically constructed across paddocks to intercept informal flow paths and temporarily retain runoff for periods of up to several days, allowing fine sediment to settle out. In sloped catchments, the existing landform can often be used to create an effective detainment area, whereas flatter catchments generally require more substantial bunding to achieve adequate water retention. An optimal detention period of approximately three days is recommended as longer water retention may damage pasture and limit continued grazing. Unlike inline sediment traps (Section 7.2.17) and event-based sediment traps (Section 7.2.18), which are installed within defined waterway channels, paddock-based detainment bunds are specifically designed to treat runoff within informal flow paths where there is no defined channel. An advantage of paddock-based

detainment bunds is the large temporary ponding area they provide, which enables finer sediment particles to settle more effectively than in inline or event-based sediment traps. While constructed wetlands also promote fine sediment settling (or trapping), they may lack sufficient capacity during high-flow events, when paddock-based detainment bunds are likely to be more effective. Overall, paddock-based detainment bunds offer the advantage of treating runoff close to its source, reducing soil and nutrient losses from pastoral farmland and removing entrained contaminants before they enter downstream waterways.

Detainment bunds rely on some infiltration of water into the soil, which enhances their ability to retain finer sediment particles compared with conventional sediment traps. However, in poorly drained soils, infiltration is limited. Under these conditions, detainment bunds function primarily by temporarily retaining runoff long enough for coarser or heavier sediment particles to settle before water is released to the receiving channel or waterway. As a result, their effectiveness for trapping fine particulates is reduced, and their function more closely resembles that of a traditional sediment trap. In flat catchments with poor drainage, there may be insufficient fall to promote gravity-driven drainage, and the area required for effective detainment may be relatively large. Given the generally flat topography and predominance of poorly drained soils in the Greenpark, Ellesmere, Leeston, and Taumutu catchments (Figure 7), paddock-based detainment bunds are likely to primarily function to reduce peak runoff to the downstream catchment and retain coarser sediment particles. Their implementation should therefore focus on locations with extensive informal or overland flow paths and land uses known to generate elevated sediment loads.

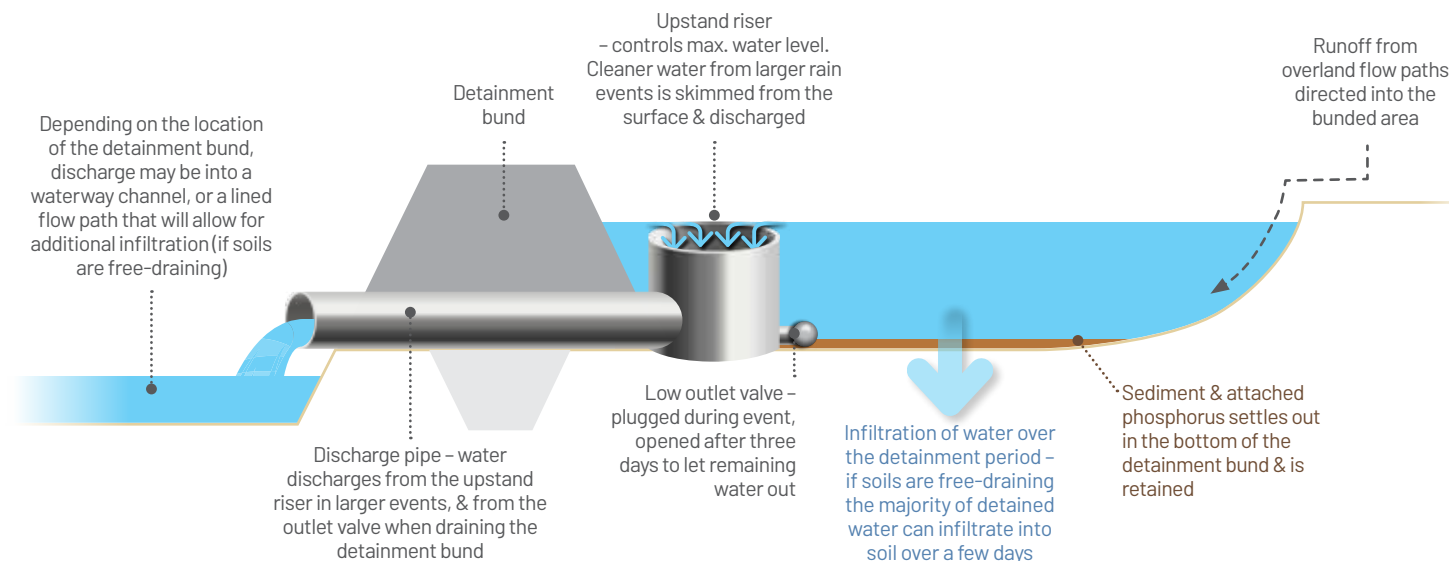
Further information on detainment bund design can be found in Patterson (2019) and Patterson *et al.*, (2019). Guidance from a specialist to design site-specific detainment bunds is recommended.

Key Features

- Suitable for overland flow paths.
- Holds back flows during rainfall events to trap fine sediments and particulate nutrients, but less effective in poorly drained soils where infiltration will not occur.

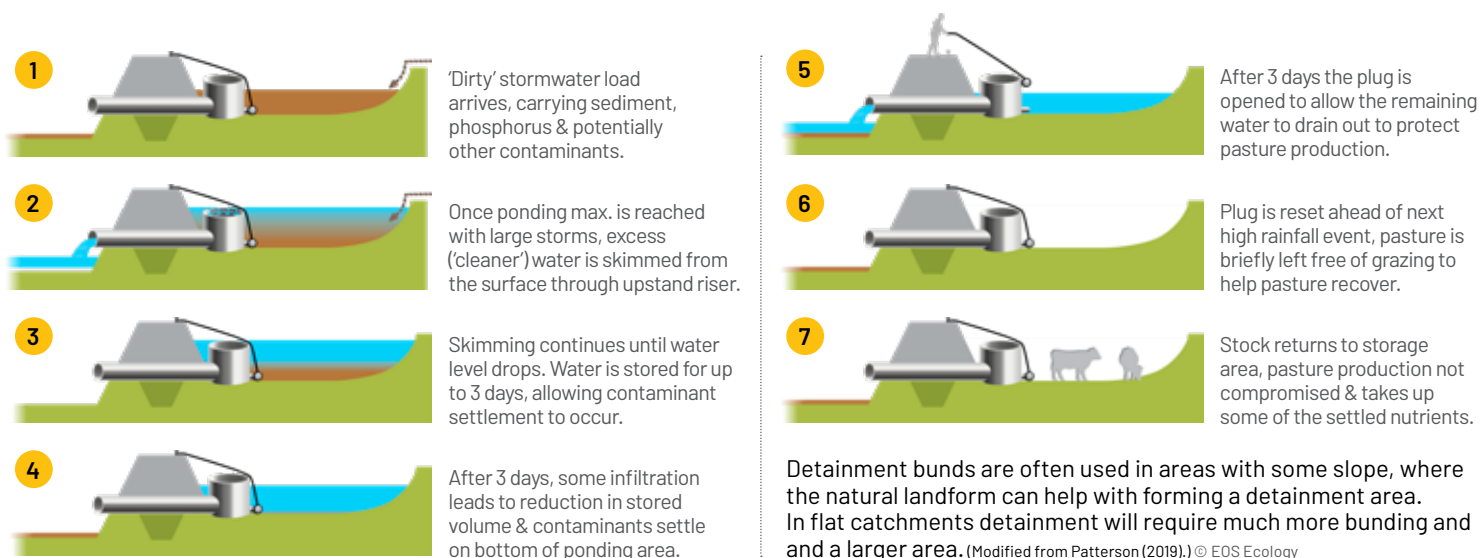
Core Benefits

- Reduces downstream transport of fine sediment and associated contaminants.
- Retains soil and associated nutrients on pastoral farmland.
- Attenuates peak runoff during rainfall events.



Detainment bunds pond water behind an earth bund, which may be around 1.5 m in height, to allow for suspended sediments and associated phosphorus to settle out of suspension. They have a choked outlet to control the residence time of water. Detainment bunds are designed to be completely dry between rain events, and to hold water for no more than around three days, to avoid pasture damage.

(Diagram informed by Patterson (2019) and Patterson *et al.*, (2019).) © EOS Ecology



7.2.20 INTERVENTION 20: SEDIMENT MANAGEMENT – Bunded Sediment Stockpile

The Greenpark, Ellesmere, Leeston, and Taumutu rated catchments have an established and ongoing requirement for the mechanical removal of fine sediment to maintain the drainage function of the waterways within these schemes. Sediment removal is also necessary to reduce the risk of accumulated fine material contributing to water quality issues both within the catchments and in the downstream receiving environments, including the Waikirikiri/Selwyn River, Te Waihora/Lake Ellesmere, and the coastal marine area. As the suite of interventions recommended in this CMP are progressively implemented across these catchments, a shift in sediment management practices is anticipated. The current widespread approach to sediment removal is expected to transition toward a more targeted system focused on the accumulation and removal of sediment from well-defined sediment traps (Sections 7.2.16, 7.2.17, & 7.2.18).

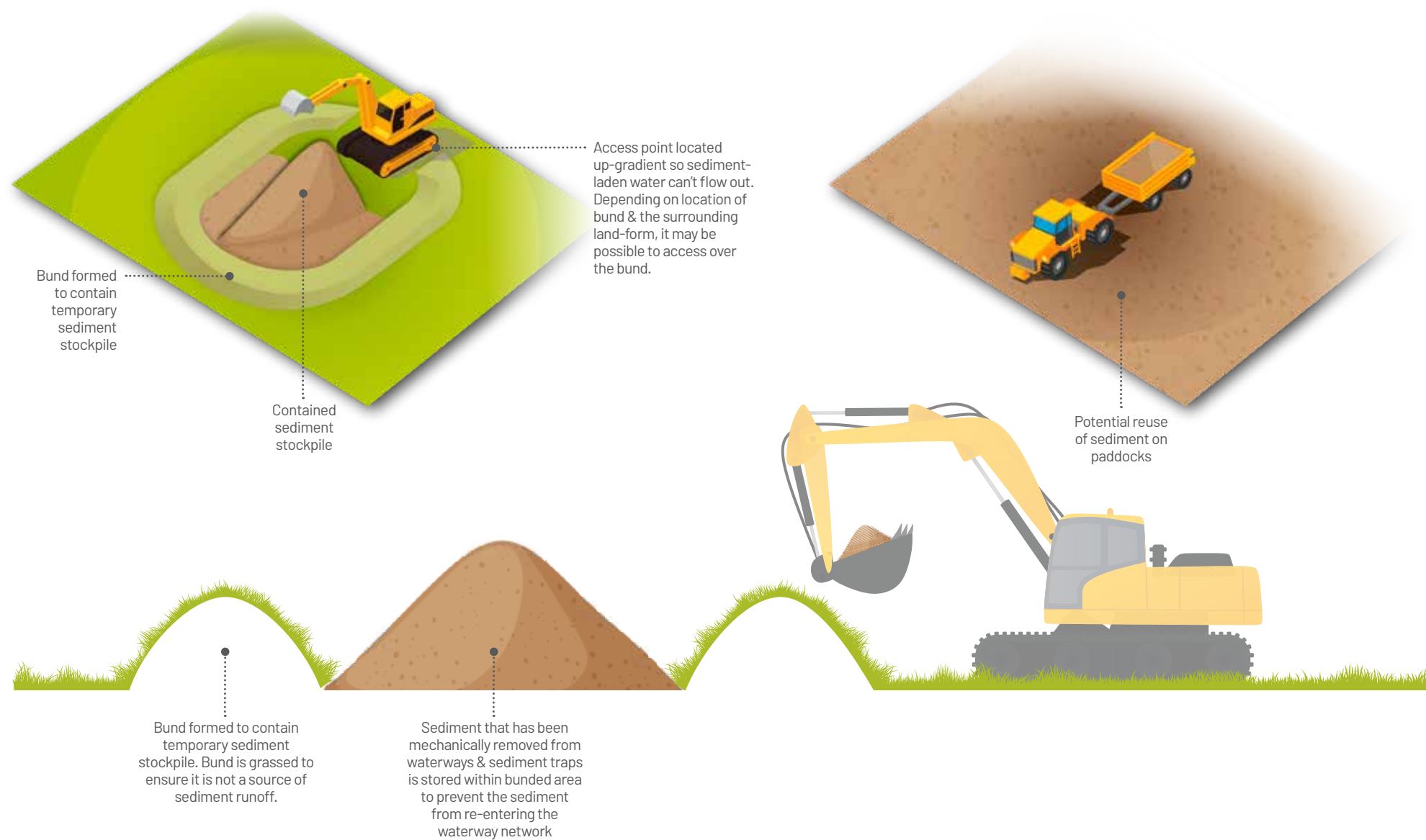
Under both the existing and future sediment removal approaches, there are clear advantages in retaining sediment within the catchment for reuse where feasible. Achieving this will require dedicated areas for stockpiling extracted material in locations that prevent sediment from being transported back into waterways and avoid the accumulation of material alongside the drainage network (Section 5.1.3). Bunded stockpiles provide a temporary storage solution for excavated sediment, reduce the risk of elevated margins forming alongside channels, and enable material to be tested for contamination and assessed for its suitability for land-based reuse within the catchment. Where sediment is deemed suitable for reuse, bunded stockpiles also provide flexibility to time land application to suit seasonal conditions and support effective stabilisation through grass or other vegetation establishment. The location of bunded sediment stockpiles will need to be determined based on land availability, proximity to sediment traps, and operational practicality, and should be appropriately sized to accommodate anticipated sediment volumes for the catchment or catchments they service.

Key Features

- Provides temporary storage of sediment mechanically removed from channels.
- Prevents excavated sediment from washing back into waterways.
- Avoids a buildup of material alongside the drainage network that prevents flood water from entering the channel.
- Useful for both existing sediment removal and future maintenance of sediment traps.
- Enables sediment reuse to be timed appropriately.

Core Benefits

- Reducing the quantity of fine sediment transported back into the drainage network.
- Allows floodwater to re-enter the channel.
- Providing for the re-use of sediment within or outside of the catchment.



Diagrams illustrate banded sediment scenario.

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7.2.21 INTERVENTION 21: OTHER – Flood Detention Basin

With the anticipated expansion of the urban area within the Leeston catchment, there is concern in the wider community about the potential exacerbation of downstream flooding and adverse impacts on downstream water quality (Section 5.1.4). As a result, the use of flood detention basins will be an important intervention, particularly within the Leeston catchment, although other suitable locations may also exist. Where space is available, flood detention basins can provide significant flood mitigation benefits, along with some improved environmental and amenity values. These artificially constructed depressions store water temporarily to attenuate flood flows and can provide water quality benefits through the settling out of heavier sediments. They gradually discharge floodwaters via an outlet control structure to either the downstream receiving environment, or to a downstream treatment wetland that can provide further water quality treatment. Detention basins are either referred to as dry detention basins (they remain dry between rainfall events) or wet ponds (they retain a wetted area between rainfall events), with the choice of basin dependent on underlying soil conditions and water table. Effective long-term management of a detention basin is important to ensure it continues to function as planned. If detention basins are successful in settling heavier sediment, they will require periodic sediment removal, and vegetation in the basin will need to be managed over time to ensure weed species do not become established and infiltration (if this is part of the basin function) is not impeded.

Flood detention basins require site-specific design which considers local topography, soil infiltration capacity, and anticipated flood flows, and should therefore be designed by specialists experienced in detention basin design and construction, and who are familiar with local conditions.

Key Features

- Requires large area of land and earthworks, and custom designs.
- Suitable for locations within or downstream of the developing urban area of Leeston.

Core Benefits

- Provides flood-storage capacity which attenuates peak flows and reduces downstream flooding.
- Reduced downstream transport of heavier sediment and associated contaminants.
- Improved amenity and possible biodiversity values.



A detention basin that was initially grassed and later planted to provide greater overall values. Image source: CCC (2003)

7.2.22 INTERVENTION 22: OTHER – Protecting Springheads

Springheads often appear as wet or muddy areas where one or more springs emerge at the land surface. In rural settings where stock have access to these areas, trampling and soil disturbance can result in springheads becoming a significant source of sediment entering the drainage network. In urban environments, stormwater discharges in proximity to spring systems can substantially alter their hydrological stability and adversely affect the biota that inhabit spring-fed ecosystems.

In rural areas, springheads should ideally be fenced to exclude stock, with the fenced area planted in appropriate vegetation. This may include larger shade trees where feasible, along with low-maintenance groundcover species to stabilise soils and reduce ongoing management requirements. Management approaches may involve fencing and planting individual springheads or, where springs occur in clusters, setting aside larger areas to support more extensive spring-fed habitat. As such, this intervention may be implemented in conjunction with small-scale (Section 7.2.14) or large-scale (7.2.12) wetlands. Priority should be given to permanently flowing springheads, particularly where they are located close to, and discharge into, permanently flowing drains within the catchment.

Where springs occur within land proposed for urban development, it is appropriate to isolate these systems from stormwater inputs, especially for larger springheads or interconnected spring networks within a development area. Sequestering spring systems from stormwater runoff helps maintain natural hydrological regimes, avoids the effects of the flashy flows typical of urban catchments, and supports the retention of higher water quality and ecological values.

Key Features

- Identifies and fences off areas of pasture where springheads are present.
- Requires minimal ongoing maintenance once vegetation is established.

Core Benefits

- Enhances aquatic habitat and overall biodiversity.
- Protects and supports cultural values.
- Reduces sediment inputs to the drainage network.
- Reduces *E. coli* and nutrient loads.
- Reduces ongoing maintenance requirements and associated impacts.



A springhead in the Leeston catchment that has been planted and fenced.



This spring seepage would benefit from fencing. This would also promote natural regeneration of the wetland vegetation but will likely require some weed management as a result.



For land undergoing urban development, sequestering larger springheads from stormwater inputs would be ideal to help protect the spring's stable hydrology.

Image source: EOS Ecology

7.2.23 INTERVENTION 23: OTHER – Īnanga Spawning Habitat

The Ellesmere, Leeston, and Taumutu catchments have all recorded the presence of īnanga (*Galaxias maculatus*); however, confirmed īnanga spawning habitat within the catchment is limited. Although the Land and Water Regional Plan (LWRP) identifies the entire margin of Te Waihora/Lake Ellesmere (and some sections of land drainage waterways) as ‘īnanga spawning habitat’, this does not reflect current habitat condition or existing spawning usage. The only confirmed īnanga spawning site within Te Waihora/Lake Ellesmere and its tributaries is located in Waikekewai Creek (Taylor *et al.*, 1992), in the south-west corner of the lake near the outlet to the ocean. A targeted investigation undertaken during the 2021–22 īnanga spawning season found very few adult īnanga present and no evidence of active spawning anywhere in Te Waihora/Lake Ellesmere or its tributaries (Meijer *et al.*, 2024). The study concluded that īnanga are currently unable to establish a persistent population within the Te Waihora/Lake Ellesmere tributaries due to the mismatch between lake openings to the sea and the peak migration periods of juvenile īnanga, as well as the degradation and loss of suitable spawning habitat throughout the catchment. The limited ocean opening may also influence the behaviour of īnanga. Typically, īnanga spawning occurs when the banks are temporarily inundated during high ‘spring’ tides, but Richardson & Taylor (2002) noted that the īnanga spawning recorded around Te Waihora/Lake Ellesmere was out phase with the tidal cycle and was instead triggered by water levels controlled by prevailing winds. Elevated water levels in Te Waihora/Lake Ellesmere and its tributaries (due to a closed lake and/or flooding) may further impact the persistence of a local īnanga population, as eggs laid in permanently inundated vegetation are less likely to survive due to predation by other fish. As such, successful īnanga spawning in Te Waihora/Lake Ellesmere depends on the presence of appropriate hydrologic conditions.

In tidal waterways, īnanga typically spawn in riparian vegetation along the margins of low-gradient waterways near the upstream edge of the saltwater wedge, when the banks are temporarily inundated during high ‘spring’ tides. Areas where this could occur are limited to lake-proximal sections of waterways in the Taumutu and Leeston

catchments, and likely require the outlet to be open to the ocean in order for tidal cycles to influence water levels. Optimal spawning habitat in tidal waterways includes unimpeded fish access, suitable bank slopes, and dense vegetation at ground level in the low-lying river section near the upstream edge of the saltwater wedge zone. For lowland lakes and non-tidal waterways, spawning is more typically triggered by elevated water levels associated with environmental factors such as prevailing winds and catchment flooding (Orchard & Schiel, 2021; Richardson & Taylor, 2002). Vegetation structure of the spawning zone is critical, with key features including thick vegetation providing extensive roots and stems at ground level that retain moisture levels and create a complex structure for eggs to stick to. Īnanga spawning zones are often dominated by exotic pasture grasses, particularly tall fescue, creeping bent, and Yorkshire fog, which can form dense vegetation swards. While these species can provide structural characteristics suitable for spawning and egg survival, ongoing grazing, mowing, and bank maintenance can prevent the development of the dense root mats and ground-level cover required for successful īnanga spawning.

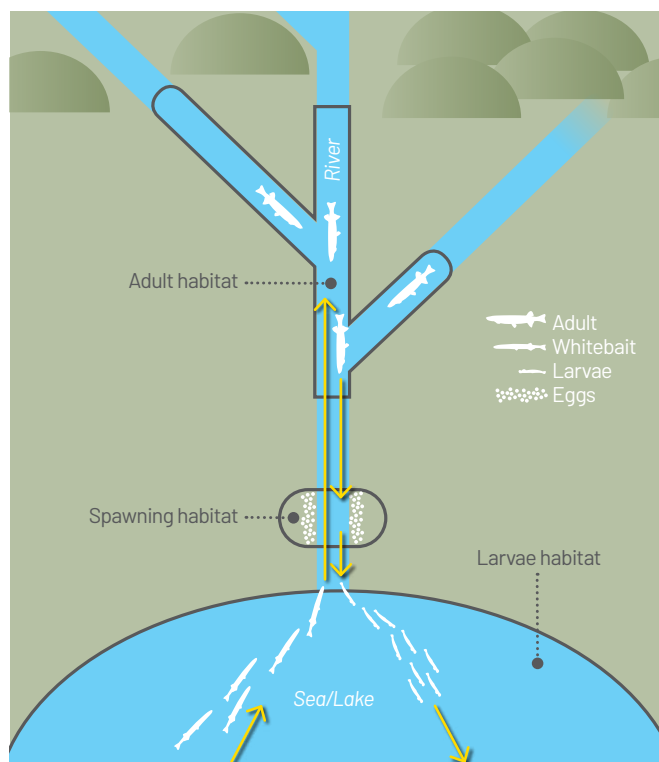
The purpose of this intervention is to therefore restore functional īnanga spawning habitat by identifying, protecting, and enhancing suitable reaches of waterways within the catchment. Where high-quality spawning habitat is not currently available, straw or hay bales may be installed as a temporary measure to provide substitute spawning habitat (EOS Ecology, 2017) until enhancement measures can be implemented. Key measures include stock exclusion to prevent trampling and vegetation loss, riparian vegetation that develops low growing but dense vegetation, bank regrading to provide optimal slopes of around 7–25 degrees, and ongoing management to maintain optimal conditions (including vegetation management and predator control, and reduction of sediment inputs from the wider catchment through sediment control measures such as sediment traps). Through sustained protection, habitat enhancement, and catchment-wide management, this intervention aims to re-establish functional īnanga spawning habitat and improve the long-term viability of īnanga populations within the rated catchments.

Key Features

- Restoring functional īnanga spawning habitat in areas where spawning could occur.
- Requires stock exclusion and modified maintenance regime to protect spawning habitat.
- Can include bank regrading to achieve optimal slopes for spawning.
- Potential limited by irregular access to the sea from Te Waihora/Lake Ellesmere and piped coastal outlets in the Taumutu rated catchment.

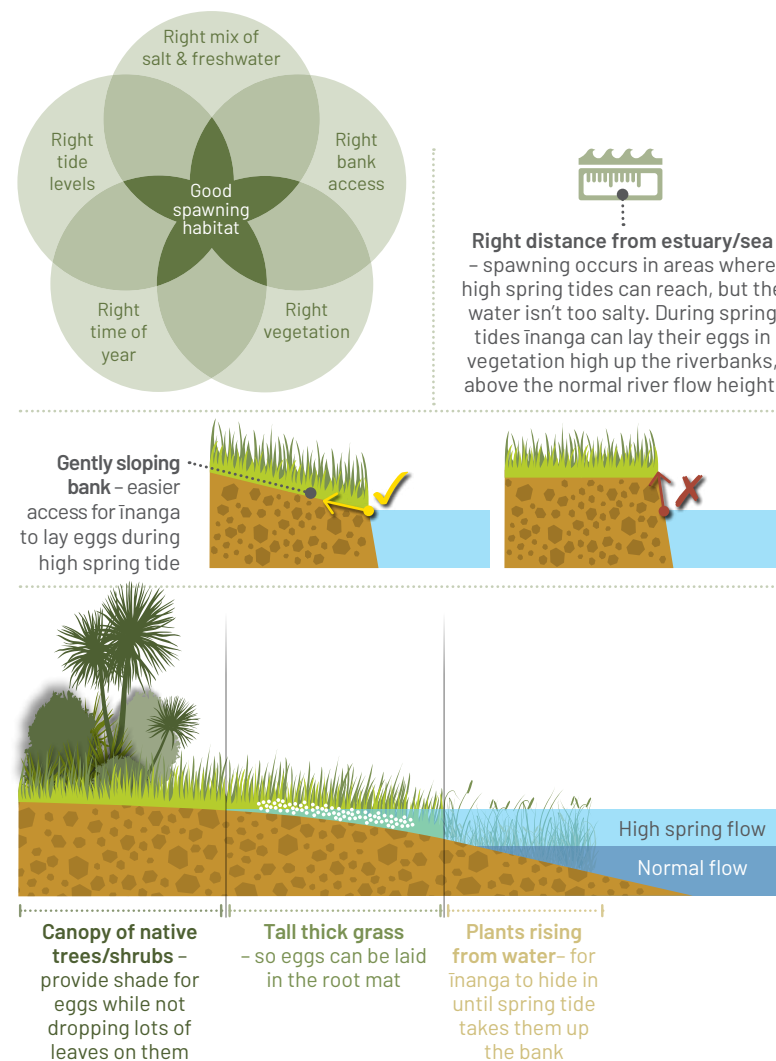
Core Benefits

- Restores functional īnanga spawning habitat & population recovery.
- Improves overall riparian condition.
- Protects culturally and ecologically significant values.



īnanga adults move down to the saltwater wedge to spawn, when the riverbanks are inundated with the high 'spring' tides. Eggs remain out of water and hatch when they are inundated by the next month's 'spring' tides. They are washed out to sea (or downstream lake) where they will remain for six months before migrating into streams as whitebait. The īnanga population within the Te Waihora/Lake Ellesmere catchments are restricted by the limited lake opening to the sea, whilst the Taumutu waterways discharge directly to the coast via pipe outlets that will be challenging for īnanga whitebait to negotiate.

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It takes a very specific combination of conditions to create good spawning habitat for īnanga. Once these conditions have been established they need to be protected and maintained – a reduction in any of the key spawning habitat elements will mean reduced or absent spawning and egg survival.

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7.2.24 INTERVENTION 24: OTHER – Protecting Kōwaro/Canterbury Mudfish Habitat

Kōwaro/Canterbury mudfish (*Neochanna burrowsius*) is one of only four fish species in Aotearoa New Zealand with a conservation status of *Threatened – Nationally Critical*, and a *Conservation Dependent* qualifier – meaning it’s at higher risk of extinction if current conservation efforts cease. This is the highest threat classification for our freshwater fishes. Kōwaro are known to be found in catchments across the Canterbury region, including from some sites in the Leeston rated catchment. However, there is increasing concern for the future of this species, which has a highly fragmented population within an otherwise intensifying agricultural landscape (Dunn *et al.*, 2025; O’Brien & Dunn, 2007). As their populations are so fragmented and much of their natural habitat is lost, they are more sensitive to local habitat disturbance and other pressures (EOS Ecology, 2025). Because of their fragmented and isolated populations, the ability for a local population to recover from a significant disturbance is completely dependent on there being sufficient survival of fish from that site, as there is nowhere for the population to be supplemented by recolonisation from other habitats. As such, protecting the remaining populations that we have is important.

Consideration of the protection of existing kōwaro populations in the Leeston rated catchment is based on a few key requirements:

- Kōwaro are known for their ability to burrow into drying stream beds or to seek out other refuge habitat in drying conditions (such as under car tyres and corrugated iron, as summarised in O’Brien & Dunn, 2007). Such an evolutionary tactic provides them with a unique opportunity to survive extreme conditions that would be fatal to other fish species. However, behavioural experiments have shown that this burrowing behaviour does not always occur, or when it does the choice of habitat within which they seek cover is largely opportunistic, with many fish dying in unfavourable places (O’Brien & Dunn, 2007). Long-term management of this species should therefore not rely on their ability to survive drying habitats.
- Kōwaro are a non-migratory species, and they typically thrive in isolated waterbodies. This is likely due to their sensitivity to fish predators, such as trout, which can decimate a local population. Keeping trout and other migratory fish species out of key kōwaro habitat is critical to their long-term survival, meaning that fish passage barriers may be needed if there is a surface water connection to other waterbodies with migratory fish species.
- Open habitats that have good mix of emergent and marginal vegetation, which provides habitat for adults to lay their eggs, fry to hide amongst, and invertebrates (upon which they feed) to live amongst. The placement of logs and other large structures that fish can use as refuge during low flow conditions will be important, as these help to keep the ground underneath moist for longer.
- Excluding stock will help to maintain healthy marginal vegetation where kōwaro may lay their eggs.
- Key water quality conditions include water temperatures that do not exceed 30 degrees, dissolved oxygen levels that do not drop below about 80% for extended periods during the egg development stage (i.e., in spring), and water clarity that remains relatively clear (as they are a visual predator).
- Kōwaro are typically found in slow flowing or ponded habitats that are often fed by groundwater inputs rather than from large surface water catchments. As such, they do well in the slow flowing springfed drainage channels and ponds in the Leeston catchment.

Key Features

- Helps protect & enhance reaches where kōwaro/ Canterbury mudfish are known to be present.

Core Benefits

- Improved ecological & biodiversity values.
- Protection of a critically endangered species only found in Canterbury.

What to do about your own kōwaro habitat:

- **Avoid habitat disturbance or spraying.** If work needs to be done nearby, do it outside their spawning season (late winter–spring).
- **Plan ahead if you're doing any works nearby.** Seek appropriate advice, and consider any approvals/consents you may need.
- **Avoid altering the surrounding ground and surface waters.** Changes to water takes or drainage can affect water permanence (how often/long standing water stays on the surface), and therefore, kōwaro survival.
- **Avoid altering connections with other water bodies,** as this can introduce predators and competitors (like trout and eels) into their habitat.
- **Exclude stock** to reduce damage to their habitat.



Slow flowing or ponded water is where they're often found, in habitats fed by groundwater (springs).



They prefer habitats with less shading and more aquatic plants – which they lay their eggs on, and the young fish fry hide amongst.



They prefer relatively clear water clarity and dissolved oxygen levels that don't drop much below 80% in spring (during the egg development phase).



While they can sometimes survive their habitat drying out, survival is not guaranteed.



Refuge habitat like logs and a soft streambed they can burrow into to help keep them moist during drying periods.



They don't do well around predatory fish (especially trout) or too many other fish competitors.

These images summarise the ideal conditions for kōwaro/Canterbury mudfish. Kōwaro are known for their ability to survive their habitat of drying out, although this is more of an extreme survival trait than an everyday behaviour. Other than a few key 'must-have's', their habitat requirements are not onerous, and many of our rural streams and drains can be the perfect place for them to survive and thrive in.

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Restored channel in
Ellesmere rated catchment

Image source: EOS Ecology

8 Long-Term Vision & Aspirations

Intensively modified catchments are among the most degraded aquatic systems in Aotearoa New Zealand. Halting further degradation, and improving both waterways and their downstream receiving environments, requires substantial changes in management practices. Although the Greenpark, Ellesmere, Leeston, and Taumutu rated catchments are highly modified, important ecological values persist and could be improved through a more holistic and catchment-wide approach to management. As such, the catchment-scale approaches and toolbox of interventions outlined in this CMP address essential drainage needs while laying the foundation for strengthening ecological, cultural, and landscape values over time.

While SDC has a central role in leading, coordinating, and implementing changes within the rated drainage network, delivery of the CMP vision will ultimately depend on collaborative action across the entire catchment. Many of the interventions will need to be located on private land or outside the rated drainage area and will require the active participation of landowners, mana whenua, and other stakeholders, supported by appropriate funding mechanisms and changes in land and water management practices. Management of the wider groundwater-fed catchment that falls outside the boundaries of the surface water and rated catchment will also have a role to play in improving nutrient water quality from within the rated areas.

The CMP sets out a suite of tools that have shown success in trial settings but have not yet been implemented at a whole-catchment scale in Aotearoa New Zealand. The Implementation Guide (IG) for the Ararira/LII (Aqualinc *et al.*, 2023) demonstrated how similar tools could be integrated into the existing management framework through a staged and coordinated approach to achieve the catchment vision. This guidance is equally applicable to the Greenpark, Ellesmere, Leeston, and Taumutu rated catchments. While some of the solutions proposed in this CMP may involve higher upfront costs than current practices, their multiple long-term benefits support a more sustainable and resilient future for the catchment.

Effective implementation of this CMP, and of other CMPs within the Selwyn District, will rely on an adaptive management approach. This involves setting appropriate measures and targets across multiple values, monitoring progress, and identifying when adjustments are needed. Early measures are likely to focus on drainage performance and water quality, with cultural and ecological indicators incorporated over time. This also means that the interventions proposed in this CMP, which includes the full range of potential interventions, may not all be relevant or required at the same time, and the focus may shift over time as key interventions are implemented, and catchment conditions begin to improve. Through an adaptive approach,

underpinned by robust monitoring and evaluation, this plan sets the foundation for transforming these four rated catchments into a healthier and more resilient system. It will also contribute positively to the wider Te Waihora/Lake Ellesmere environment and reflects the aspirations of the local community.

The next steps involve engaging with the community, developing a masterplan, and establishing partnerships to support implementation. Formalising roles and responsibilities, strengthening relationships with landowners and mana whenua, and securing co-funding opportunities will be critical to ensuring that interventions across both rated and non-rated areas can be delivered effectively.



Muruwai/Copper Lagoon,
Taumutu rated catchment

Image source: EOS Ecology

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