



# Transforming Lowland Waterway Networks

## A Catchment Management Plan for Osbornes Drain Catchment

Prepared by EOS Ecology & Aqualinc Research  
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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 ripple</i>
<i>Ko koe te wai oraka mō tō iwi</i>	<i>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.

The Osbornes Drain Catchment Management Plan reflects a shared commitment between tangata whenua, local government, and landowners to improve water quality and strengthen ecological outcomes within the Osbornes Drain catchment, and beyond to Te Waihora.

The development of this plan, is the result of almost 20 years of work, which started as a project of the Te Waihora Management Board, evolved into a joint working party, and included a consenting process that began 2011 and was completed in 2017. Since 2017, the working party 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 to implement improvements to Osbornes Drain, including regular monitoring, drain cleaning and planting, sediment removal, fish rescue and most recently wetland enhancement. This Catchment Management Plan outlines the future interventions required to continue to improve water quality, ecological and mahinga kai outcomes, and ultimately for restoring the ecological and cultural health 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.





Middle reach of Osbornes Drain

Image source: EOS Ecology

# 1 Introduction

Much of Aotearoa New Zealand's lowland agricultural land was developed by converting vast areas of forest and wetland into pasture. This was facilitated by excavating drainage channels and laying networks of subsurface drains. While this land drainage began in the late 19<sup>th</sup> century, efforts to convert lowland wetlands to pastoral agriculture were accelerated by government subsidies during the 1950s and 60s. The Selwyn District land drainage schemes within the Te Waihora/Lake Ellesmere catchment are an example of this. Whilst recognising the indelible effect this has had on our waterway landscape, the resulting drainage schemes are not only essential to some of our most productive land but are steeped in a history of back-breaking pioneering and form part of the cultural identity of many New Zealanders. 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.

With their networks of straight lines and deeply incised channels, agricultural drains are often perceived to have low ecological value. However, although drainage 'improvements' tend to lead to declines in other values, such as biodiversity, cultural, and recreational values, these drains still have significant value. 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. To maintain the drainage function of these waterways, they are regularly maintained, typically through mechanical clearing of sediment and macrophytes. This mechanical clearance removes fauna, destroys habitat, and degrades water quality. Traditional funding mechanisms limit opportunities to trial and adopt alternative methods. Selwyn District Council (SDC) has now moved to district-wide rating for land drainage, including rating all properties across the district for waterway enhancement in the land drainage schemes. The development of Catchment Management Plans (CMPs) for land drainage catchments and initial enhancement works is being funded by all properties in the district, in recognition of the wider contributing catchment and the importance of restoration of Te Waihora/Lake Ellesmere to the district. Opportunities to further consolidate and leverage funding mechanisms are being explored.


‘Our freshwater 2023’ (MfE and Stats NZ, 2023) is the latest report on the state of Aotearoa New Zealand’s freshwater environment. Like its predecessors, the report emphasises the significant pressures human activities place on waterways and highlights their ongoing impact on the country’s freshwater resources. Land use changes driven by human habitation and primary industries have profoundly altered watershed landscapes. Deforestation, wetland drainage, loss of vegetative cover, and the expansion of impervious surfaces in our urban areas have disrupted the natural hydrological cycle, with further impacts anticipated as climate change intensifies.

Urbanisation and agricultural intensification can affect our surface waterways in different ways. In urban catchments, efficient stormwater networks short-circuit the natural runoff cycle, altering the hydrological regime. This results in flashy flows, lower base flows, and the transport of 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. The ‘lag effect’ of resultant environmental change (particularly in catchments with significant groundwater-surface water interactions) means 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. The concept of ‘shifting baseline syndrome’ also applies: each generation tends to accept the ecological state at the beginning of its lifetime as the baseline, which leads to a gradual normalisation of environmental degradation. In this way, an environment that would have been seen as degraded by our predecessors may come to be regarded as normal.

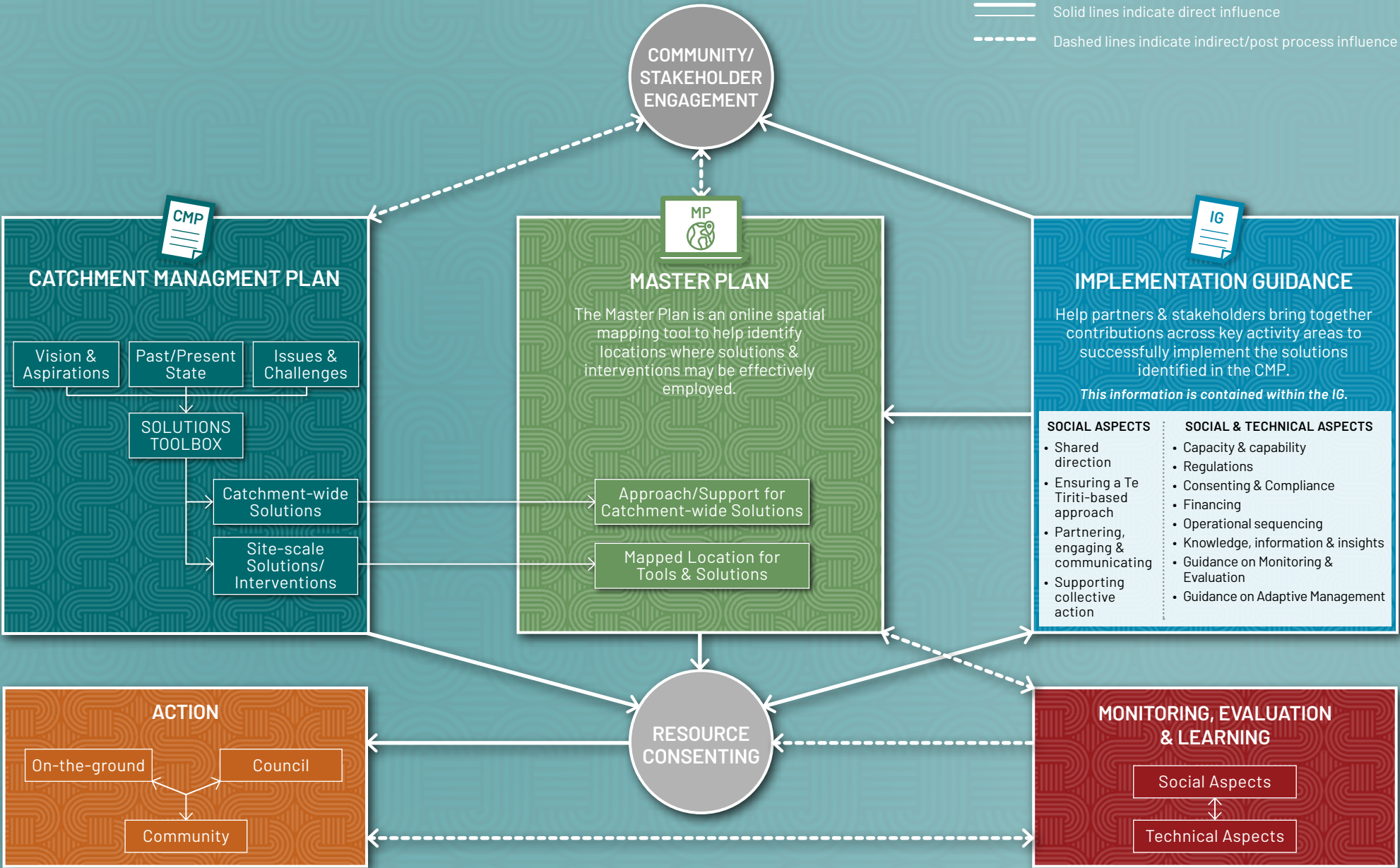
Water is fundamental to our survival, and the ecological health of our water bodies – oceans, lakes, and rivers – should concern us all, not just scientists. Our futures, as individuals, communities, and nations, are deeply interconnected with the state of the planet’s water. Improving the state of Aotearoa New Zealand’s

freshwaters demands more than minor adjustments to current practices. It requires transformative actions informed by a catchment-based approach, not only to halt further degradation but to repair the damage already done.

Whilst the changes proposed in this CMP are aspirational, they are also essential and can be used as a ‘new normal’ for waterway management in this catchment. Now is the time to act, seizing the opportunity to adopt new approaches that create a better future for our environment and our tamariki. 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. Beyond this CMP, 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).

**FIGURE 1:**  Interrelationships between the Osbornes Drain Catchment Management Plan (CMP) and supporting documents, illustrating how the CMP informs subsequent steps such as community engagement, Master Plan 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 Osbornes Catchment

Selwyn District Council manages seven classified/rated land drainage schemes within their district, including the Osbornes Drain land drainage scheme (subsequently referred to as Osbornes catchment; Figure 2). The Osbornes catchment discharges into Te Waihora/Lake Ellesmere. At 198 km<sup>2</sup>, Te Waihora/Lake Ellesmere is Aotearoa New Zealand's largest coastal hāpua/waituna (lake-lagoon), as well as being Canterbury's largest and Aotearoa New Zealand's fifth largest lake. As one of the most polluted coastal hāpua/waituna in Aotearoa 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 excess 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. It is expected that improving the health of the waterways of the Osbornes catchment and the water quality of the discharge from this catchment will contribute to the greater challenge of improving the health of Te Waihora/Lake Ellesmere.

The Osbornes catchment covers an area of approximately 1,780 ha of rural land, including around 9 km of classified/rated drainage waterways (subsequently referred to as rated drains or rated drainage waterways) and nearly 100 km of drainage waterways altogether. Unlike all other Te Waihora catchments, the Osbornes catchment does not discharge freely into the lake but instead accumulates and stores drainage water, intermittently discharging to the lake via a pump station. The low-lying flat land of Osbornes catchment was once part of Te Waihora/Lake Ellesmere and was submerged when lake levels were high. To facilitate agricultural land use, a series of stop-banks were created and tide gates installed. In the 1960s, a pump station was installed to discharge water from the drainage water to the lake via a constructed discharge channel. The pump station remains in place today, with most of the pumping occurring during the wetter winter months (June to September) and following periods of sustained rainfall. Adjacent to the eastern boundary of the Osbornes catchment runs the Halswell Canal, and whilst this does not typically collect water from the Osbornes catchment, on occasion, when the Osbornes pump is operating and there are high water levels downstream of the pump station, there can be some overtopping of water from the Osbornes catchment into the lower reaches of the Halswell Canal.






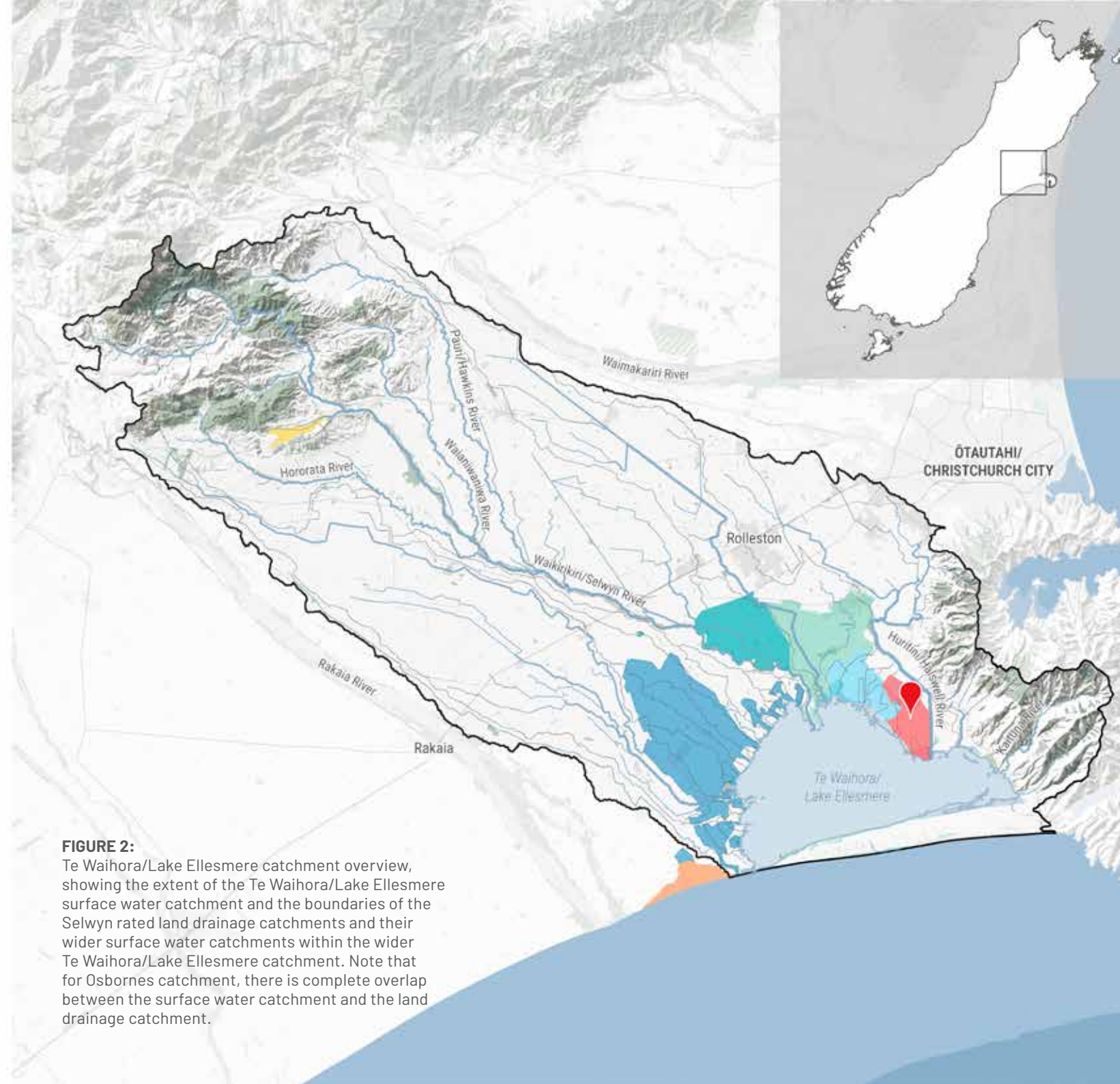
# Te Waihora/ Lake Ellesmere Catchment Overview

## SELWYN DISTRICT RATED CATCHMENTS:

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

## OTHER:

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



**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 and their wider surface water catchments within the wider Te Waihora/Lake Ellesmere catchment. Note that for Osbornes catchment, there is complete overlap between the surface water catchment and the land drainage catchment.

0 5 10 km



Map © EOS Ecology, 2025 / [www.eosecology.co.nz](http://www.eosecology.co.nz)

Layer source: Waterways (River Environment Classification (REC); NIWA), hillshade (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)

There is one main rated drain within the catchment (Osbornes Drain), as well as some main lateral rated drains and numerous private drains that discharge into Osbornes Drain. Osbornes Drain extends from the northwest corner of the catchment towards the southwest, where it discharges through the pump station into a constructed channel that leads to Te Waihora/Lake Ellesmere. The purpose of the drainage scheme is to control the groundwater levels within the catchment and to act as a flood control scheme. An estimated average water flowrate of 0.025 m<sup>3</sup>/s is discharged from Osbornes catchment, based on records of pumping duration from the pump station between October 2013 and April 2015, although there is considerable daily variation in the duration of pumping and therefore the volumes discharged (GHD, 2015). In recent times, it has been estimated that more than 60% of the total discharge to Te Waihora/Lake Ellesmere is likely to be runoff from rainfall events, rather than lateral seepage from the groundwater system (GHD, 2015). The estimated annual water volumes discharged from Osbornes catchment suggest that it is a minor volume contributor to Te Waihora/Lake Ellesmere, with greater inflows contributed by the Waikirikiri/Selwyn River, Ararira/LII catchment, Huritini/Halswell River, and Harts Creek catchments (Hamilton *et al.*, 2017; GHD, 2015).

Although Osbornes Drain contributes only a relatively small volume of water to Te Waihora/Lake Ellesmere, its discharge contains very high concentrations of contaminants such as phosphorus, *E. coli*, and suspended sediment, which contribute to the poor overall health of the lake. This concern has been formally recognised in the current Osbornes catchment resource consents, which authorise a specified quality of water that is able to be discharged from the catchment to Te Waihora/Lake Ellesmere, and require a programme of improvements to be able to meet these discharge standards. This CMP is a key document in that process, identifying a range of catchment-wide and site-specific interventions that could be implemented to improve the health of the Osbornes catchment and improve the quality of the discharge to the lake.



Unrated channel alongside  
Hudsons Road

Image source: EOS Ecology



Raupō (*Typha orientalis*)

Image source: EOS Ecology

## 2 Vision for Osbornes Catchment

### 2.1 Vision & Values for the Osbornes CMP

The vision and values of the Osbornes catchment have been developed by the Osbornes Drain Catchment Management Working Party, consisting of representatives from Te Taumutu Rūnanga, Te Rūnanga o Ngai Tahu, Department of Conservation, Osbornes Land Drainage Committee, 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 holds resource consents (CRC172230 and CRC172231) to operate the Osbornes Drain land drainage scheme and pump station discharges, and to undertake maintenance activities including vegetation and sediment removal. Several technical reports prepared during the resource consent application process have informed this CMP, covering discharge water quality, necessary water quality improvements, mitigation measures, hydrology, and ecological considerations. Information from these reports has been incorporated into this CMP:

- **PDP (2013): *Water Quality Improvements*** – water quality and contaminant sources, proposed improvement options including on-farm practice, sediment removal, and baseflow augmentation from groundwater.
- **Low Environmental Impact (2015): *Mitigation Measures Assessment*** – stock exclusion, farm management practices, on-farm wetlands, sediment bunding, instream wetlands, and sediment traps.
- **GHD (2015): *Hydrology and Water Quality*** – recommended monitoring regime, pump station and forebay improvements, wetlands.
- **Boffa Miskell (2015): *Osbornes Drain Ecology*** – existing ecological condition, previous extent of wetlands, ecological benefits of options suggested in other reports.

The primary purpose of this CMP is to drive and make a commitment to water quality improvement for the Osbornes catchment. In doing this, the CMP will also help to achieve compliance with the conditions of the discharge permit for this catchment. As a condition of the discharge permit (CRC172231), the Consent Holder, SDC, was required to develop an Integrated Land Drainage Catchment Management Plan (ILDCMP) for the Osbornes catchment. The ILDCMP (Selwyn District Council (SDC), 2017) will be superseded by this CMP, which will need to meet the consent requirements of the discharge permit (CRC172231).

The ILDCMP prepared in 2017 (SDC, 2017) outlined objectives that remain the basis of the current CMP, which will be supported and enhanced by the values established in this CMP (Section 2.1):

- The protection and enhancement of attributes that contribute to the values of both Ngāi Tahu and the Department of Conservation in the network and from the pump station discharge.
- The improvement of water quality and ecosystem health, in the catchment and in particular in both the network and receiving environment.

- Restore the mana of the wetland and drainage system downstream of the pump station.
- The avoidance of erosion and the effects of sediment discharge.
- The reduction of the adverse effects of flooding.
- Efficient and effective drainage system which facilitates sustainable farming practices.

### Key Resource Consent Conditions for Osbornes Catchment

Selwyn District Council holds resource consents to operate the Osbornes Drain land drainage scheme and to undertake vegetation and silt removal for maintenance purposes. These consents are:

- **CRC172230** – Land use consent (s13) to excavate material and disturb the bed and banks of a surface water body.
- **CRC172231** – Discharge permit (s15) to discharge water that may contain contaminants into Osbornes Drain.

Other relevant conditions from the current discharge permit CRC172231 include<sup>1</sup> (note that this consent commenced on 24 February 2017 and expires 24 February 2027):

- **Condition 4:** Details sites that are excluded from discharging under this consent – these include sites registered by Canterbury Regional Council (CRC) on the Listed Land Use Register (LLUR), sites on historic landfill, sites which hold existing discharge consents that are non-compliant, sites which do not have a farming land use consent and Farm Environment Plan (FEP), and sites where discharge from the property exceeds the water quality targets in the consent. *There are a number of properties excluded from discharging under this consent as a result of this condition – SDC maintains a list and map of excluded sites which it provides to CRC for consent compliance (Figure 3). Note that FEP in this context means ILDCMP approved FEPs as per condition 31(l) of CRC172231, rather than those required under the Canterbury Land and Water Regional Plan (LWRP).*

<sup>1</sup> For complete wording of consent conditions please refer to consent CRC172231: [www.ecan.govt.nz/data/consent-search/consentdetails/CRC172231/CRC172231](http://www.ecan.govt.nz/data/consent-search/consentdetails/CRC172231/CRC172231)

- **Condition 5:** Details the role of the Osbornes Drain Catchment Management Working Party, which meets at least twice per year to review progress with the ILDCMP, as well as to review and finalise work programmes for the catchment and assess water quality improvement measures implemented by the consent holder.
- **Condition 11:** Details how discharges from the pump station must cease if the quality of the discharge exceeds water quality limits set out in the consent.
- **Condition 16:** Details the requirements for an eel and fish impediment relocation programme to be implemented, including eel and fish salvage for two nights per year for the first five years of the consent.
- **Condition 17:** Details the requirement for a habitat restoration and enhancement plan for the section of Osbornes Drain downstream of the pump station.
- **Condition 23–26:** Set out the requirements of the ILDCMP, including the objectives, statutory and non-statutory mechanisms to achieve compliance with the consent, identification of areas subject to flood hazards, framework for assessment of the monitoring programme results, and assessment of options for treatment, preventative, improvement, remediation, and enhancement measures for the catchment. ***This is the key condition that is relevant to this CMP and masterplan for Osbornes catchment – the requirements of this condition have been incorporated into this CMP as much as possible.***

The Osbornes discharge permit (CRC172231) excludes discharges *from sites which do not have a farming land use consent and FEP* (Condition 4f). Under this consent, an FEP refers specifically to an ILDCMP-approved FEP, as required by condition 31(l), which requires that all properties discharging to Osbornes Drain have such approval. While properties requiring a farming land use consent must also have an FEP under the Land and Water Regional Plan (LWRP), these differ substantially from the requirements of CRC172231, and none have yet been approved under the ILDCMP. The ILDCMP-approved FEP focuses on drainage management, and its requirements are now formalised in the SDC Stormwater and Drainage Bylaw 2025 as

a ‘Stormwater, Drainage and Watercourse Management Plan’ (Section 6.18 of the SDC Stormwater, Drainage and Watercourse Bylaw 2025; SDC, 2025)

There are several reasons why properties in the catchment may not require a land use consent. For example, if they comply with all permitted activity rules or if the property is smaller than 5 ha. As currently written, this could unintentionally exclude smaller landowners, such as those with lifestyle blocks, from utilising the Osbornes discharge consent to authorise their discharge.

However, Environment Canterbury have clarified that the intent of the consent is not to exclude properties that do not require a farming land use consent. These properties must still have an FEP that complies with the Osbornes discharge consent, rather than other regulatory plans or consents, to authorise discharge to Osbornes Drain. If they did not meet this requirement by 1 January 2017, any discharge from that property to Osbornes Drain is excluded from the consent and is therefore unauthorised. Currently, Environment Canterbury and SDC are taking an education-based approach to compliance and enforcement.

Unless private drainage within the catchment complies with the Osbornes Drain consent, discharge to any SDC or rated drain is likely to require a separate resource consent under the LWRP, regardless of property size<sup>1</sup>. Even the use of land for farming activities on properties less than 10 ha must have nitrogen loss below 15 kg per ha per annum or consent is required (see LWRP rule 11.5.8).

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<sup>1</sup> See LWRP rules 5.75, 5.77, 5.95, 5.99, 9.5.18, and 11.5.6.



# Osbornes Catchment Listed Land Use Register (LLUR)

LLUR sites

OTHER:

Land drainage catchment

Rated drain

Embankment (1889 estimate)

Roads

Pump station



Map © EOS Ecology, 2025 / [www.eosecology.co.nz](http://www.eosecology.co.nz)

Layer source: Listed land use register (Environment Canterbury), pump station (EOS Ecology), Osbornes rated drain & land drainage catchment (Selwyn District Council), hillshade (Land Information New Zealand; LINZ), roads (Esri vector tile service), embankment (Maw & Main; 1989), imagery (LINZ)



**FIGURE 3:**

Map showing land parcels permanently excluded from the Osbornes consent and required to obtain consent directly from Environment Canterbury. These are those on the LLUR (Listed Land Use Register) and locations of past landfills.



Wetland area downstream of  
Osbornes Drain pump station

Image source: EOS Ecology

## 3 State of Osbornes Catchment

### 3.1 Past State

The Osbornes catchment has not always looked as it does today (Figure 4). In pre-European times, the lower parts of the catchment were covered by water, with wetland and/or a shallow arm of Te Waihora/Lake Ellesmere covering a substantial proportion of the catchment (Table 1; Figure 5). The vegetation cover for the higher and dryer parts of the catchment would have been a mixture of podocarp/native conifer forest types, including kahikatea-pukatea-tawa forest and matai-kahikatea-totara forest. At the time of European arrival, the area now occupied by Osbornes catchment was located between the high and low water lines that were surveyed circa 1860 (Figure 6). Therefore, most of the catchment would have been a shallow bay that would have been flooded with both fresh and brackish water when Te Waihora/Lake Ellesmere was at high levels. Flooded areas may have supported submerged aquatic macrophytes such as *Ruppia* species and charophytes, whilst wetland vegetation would have been limited to the higher areas around the margins of the open water, where the land was not regularly inundated. The dunelands at the top of the catchment are located around the upper boundary of the area that was occasionally flooded (Figure 5; Figure 6). Tussock, flax, and grasses were present in the higher northeastern part of the catchment, while to the southwest of the wetland salt-tolerant herbaceous shrubs, ferns and grasses were dominant, with these areas of vegetation correlating with lighter sandier (and saltier) soils (Figure 6). Regular openings of Te Waihora/Lake Ellesmere began in 1868 (Maw & Main, 1989), which would have substantially altered the wetting duration and hydrology of the Osbornes catchment area.

The Halswell Canal was constructed during 1889 and is located to the east of Osbornes catchment, with the spoil from the canal construction being used to construct an embankment on the true right bank of the canal (Maw & Main, 1989). The embankment extends 2.6 km in a north-south direction along the eastern boundary of the catchment towards Te Waihora/Lake Ellesmere, then a further 1.7 km west to meet the higher land at Greenpark Huts (Figure 5; Figure 6). The embankment was faced with stone and measured a maximum height of 2.4 m above mean sea level. Once the embankment was in place, Osbornes Drain discharged into Halswell Canal through a wooden flapped floodgate. However, the higher water levels in the Halswell Canal would have often impeded drainage and so Osbornes Drain was rerouted directly to Te Waihora/Lake Ellesmere in the early 1900's, with the floodgate being replaced with a double manually operated floodgate in 1955.

The Osbornes Drain land drainage and pumping scheme was initiated in 1962/63 by the North Canterbury Catchment Board and was constructed under supervision of the Ellesmere County Council during 1967/68 (Maw & Main, 1989). Although the existing embankment along the Halswell Canal and west to Greenpark Huts

# 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.

## 1330 ONWARDS Māori Settlement



In pre-European times, the lower parts of the Osbornes catchment formed a shallow bay that was flooded when Te Waihora/Lake Ellesmere was at higher levels.

## 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. Image source: Stu Farrant

## 1880 S ONWARDS Land Drainage & Farm Development



The Halswell Canal was constructed in 1889 to connect the Huritini/Halswell River to Te Waihora/Lake Ellesmere. The purpose was to drain the surrounding land for farming. The spoil from the canal was used to build an embankment that would protect the Osbornes catchment from inundation from Te Waihora/Lake Ellesmere.



Osbornes Drain initially discharged into Halswell Canal through a wooden flapped floodgate but was later routed directly to Te Waihora/Lake Ellesmere. The Osbornes Drain land drainage and pumping scheme was constructed during 1967/68, including 13 km of drains, a pump station and two pumps.

**FIGURE 4:**

A visual history of the changing states of the Osbornes catchment.

**TABLE 1:**

Summary of the past land cover/vegetation type categories for Osbornes catchment. This table uses modelled information to show the expected past vegetation cover of the catchment, in the absence of human intervention. Based on Manaaki Whenua – Landcare Research potential vegetation pattern for Aotearoa New Zealand's GIS layer (Leathwick, 2001).

Category	Proportions in Osbornes Catchment Area		Further Details
	ha	%	
<b>Podocarp (native conifers)</b>	951	53.6	Kahikatea-pukatea-tawa, Matai-kahikatea-totara, Kahikatea-totara and Rimu-matai-miro-totara/kamahi, Rimu-matai-miro-totara/kamahi forest types.
<b>Wetlands (partial)</b>	797	44.9	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.
<b>Dunelands</b>	24	1.4	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.
<b>Unclassified</b>	2	0.1	Unclassified areas include permanent snow & ice, rivers, lakes, urban areas etc.

provided protection from inundation of the Osbornes catchment by lake water, the farmland in this area still suffered from high localised groundwater levels and rainfall-induced flooding. With the water table near ground level during the wetter months of the year, grazing was limited by poor quality pasture due to waterlogged and salt-affected soils. Thus, the drainage scheme (and an associated irrigation scheme) was envisaged to alleviate these issues by draining excess water and helping to leech out the excess salt in the soils. Along with 13 km of drains, the scheme included a pump station and two pumps with a combined instantaneous capacity of 1.7 m<sup>3</sup>/s. At the time of its development, there were 19 land holdings within the Osbornes catchment area and 14 of these were classified as deriving benefit from the scheme (Maw & Main, 1989). A review of the drainage scheme performance after 20 years of operation found that the scheme was effectively removing enough water and salt to prevent undue pasture damage and the maintenance costs were lower than had been expected (Maw & Main, 1989).

Alongside the catchment drainage scheme, irrigation development has played a key role in maintaining production during dry periods (summer/autumn) and in flushing out residual salts left in the soils from when the area was part of Te Waihora/Lake Ellesmere. In earlier phases of catchment development, excessive irrigation was encouraged to facilitate salt outwash from the soils. This salt outwash remains evident today, with catchment discharges still having elevated conductivity.



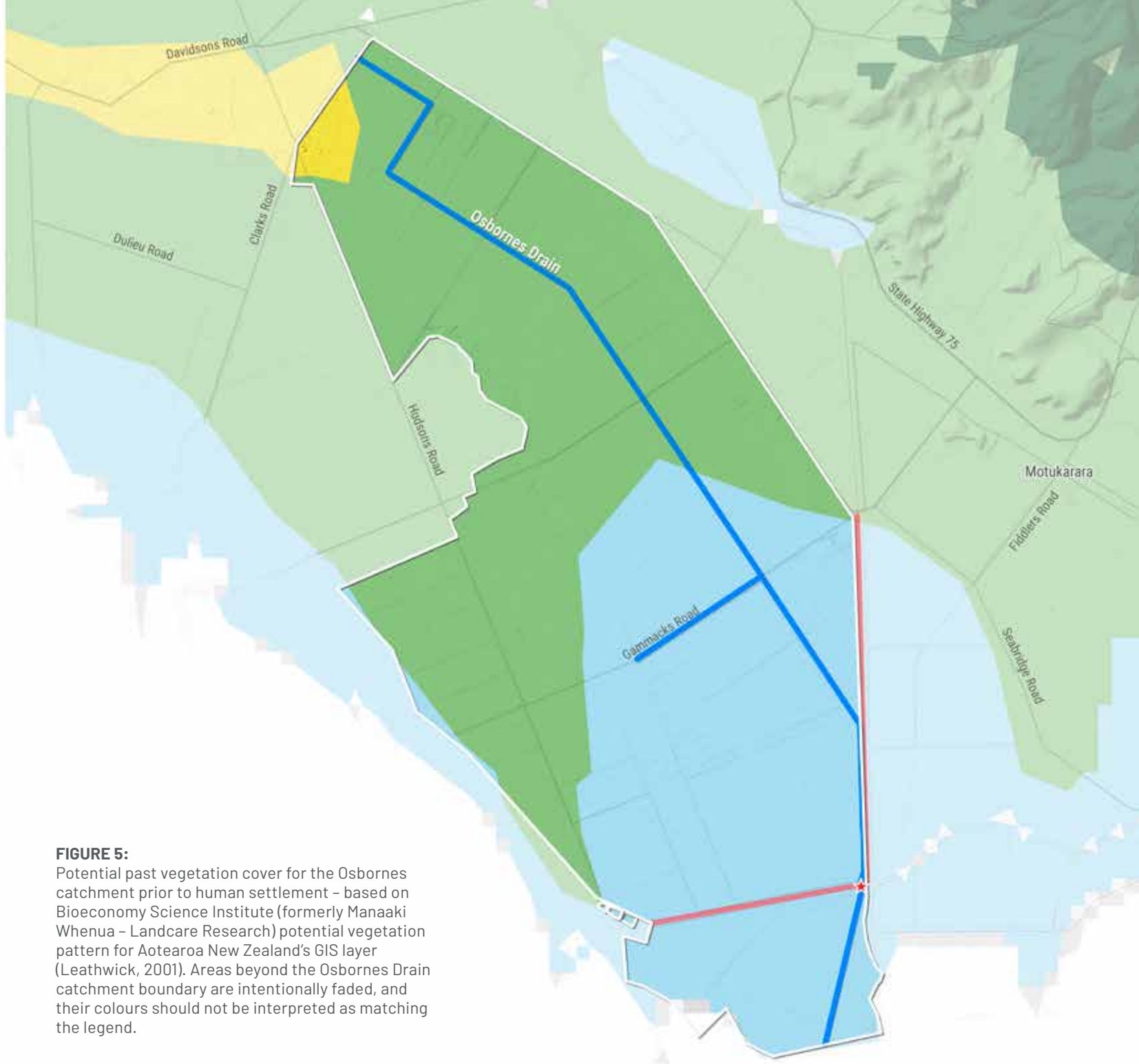
## Osbornes Catchment Pre-human Vegetation

### VEGETATION TYPES:

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

### OTHER:

- Land drainage catchment
- Rated drain
- Embankment (1889 estimate)
- Roads
- Pump station



**FIGURE 5:**

Potential past vegetation cover for the Osbornes catchment prior to human settlement - based on Bioeconomy Science Institute (formerly Manaaki Whenua - Landcare Research) potential vegetation pattern for Aotearoa New Zealand's GIS layer (Leathwick, 2001). Areas beyond the Osbornes Drain catchment boundary are intentionally faded, and their colours should not be interpreted as matching the legend.






Map © EOS Ecology, 2025 / [www.eosecology.co.nz](http://www.eosecology.co.nz)

Layer source: Vegetation types (Manaaki Whenua/Landcare Research), waterways & pump station (EOS Ecology), Osbornes rated drain & land drainage catchment (Selwyn District Council), hillshade (Land Information New Zealand; LINZ), roads (Esri vector tile service), embankment (Maw & Main, 1989)








# Osbornes Catchment Black Maps Land Cover

## LAND COVER:

-  Herbaceous (fern/grass/herbs)
-  Waterbody/wetland
-  Tussockland/flaxland/rushland
-  Tussockland/flaxland/rushland (mixed)
-  Unvegetated/sparsely vegetated

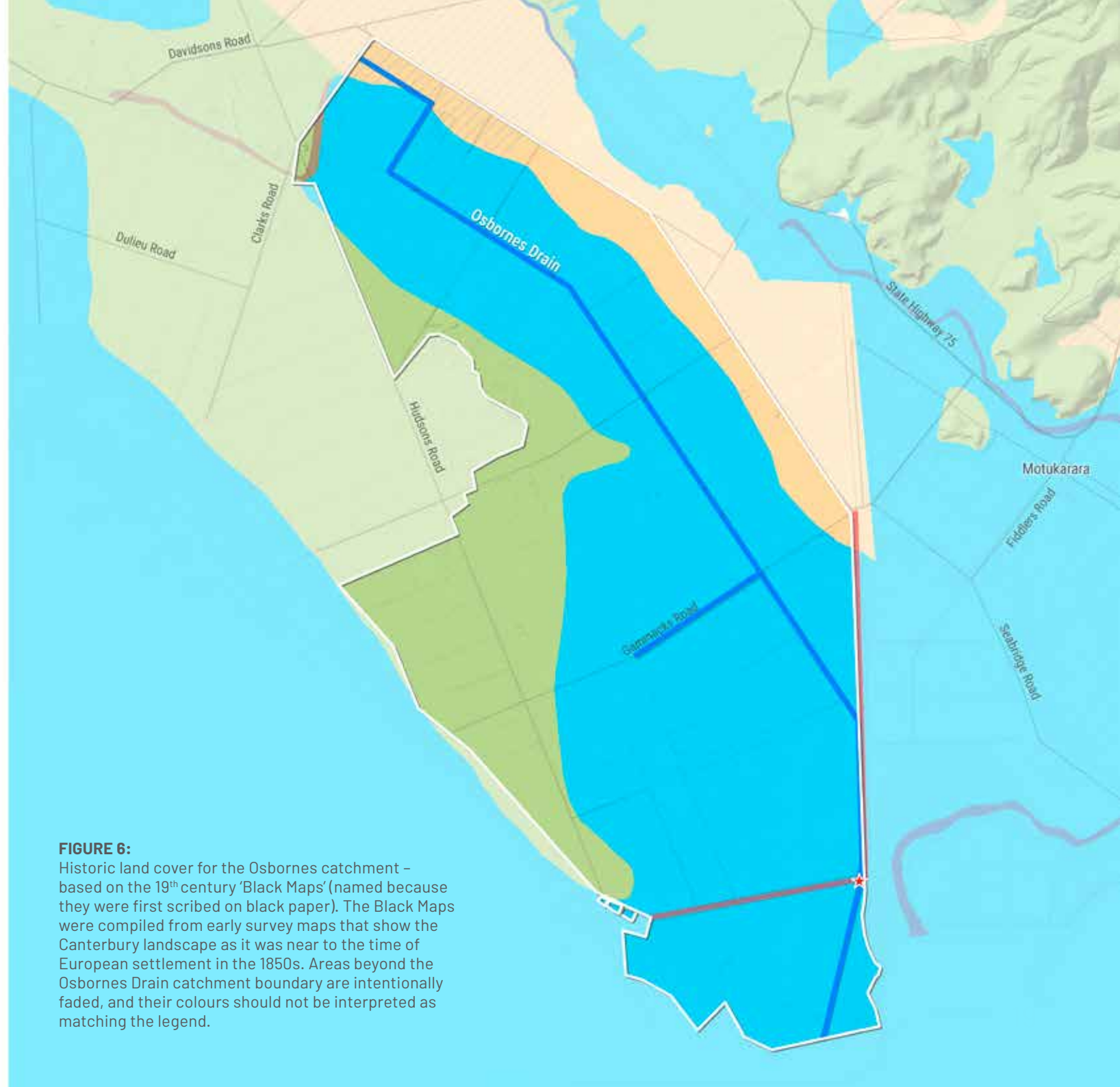
## OTHER:

-  Land drainage catchment
-  Rated drain
-  Embankment (1889 estimate)
-  Roads
-  Pump station



Map © EOS Ecology, 2025 / [www.eosecology.co.nz](http://www.eosecology.co.nz)

Layer source: Land cover (Black Maps; CanterburyMaps), waterways & pump station (EOS Ecology), Osbornes rated drain & land drainage catchment (Selwyn District Council), hillshade (Land Information New Zealand; LINZ), roads (Esri vector tile service), embankment (Maw & Main; 1989)



**FIGURE 6:** Historic land cover for the Osbornes catchment – based on the 19<sup>th</sup> century ‘Black Maps’ (named because they were first scribed on black paper). The Black Maps were compiled from early survey maps that show the Canterbury landscape as it was near to the time of European settlement in the 1850s. Areas beyond the Osbornes Drain catchment boundary are intentionally faded, and their colours should not be interpreted as matching the legend.

## 3.2 Present State

### 3.2.1 Present Land Cover/Vegetation Types

The Osbornes catchment covers an area of around 1,780 ha of predominantly flat land, consisting entirely of rural land use (Figure 7). There are no urban areas within the catchment, although lifestyle properties are scattered throughout the catchment. The land cover is dominated by high producing exotic grassland (90%), with a small proportion of exotic forestry (<1%) in the upper catchment and with open water (8%) and herbaceous freshwater vegetation (<1%) on the margins of Te Waihora/Lake Ellesmere to the south of the embankment. Within the rated drainage catchment, land uses include dairy and dairy support, dry stock, contract grazing, and lifestyle blocks (Pattle Delamore Partners, 2013). At the time of the discharge consent application for Osbornes catchment in 2013, predominant land uses within the catchment included sheep and beef (44%), dairy (25%), deer (11%), and sheep (6%).

**TABLE 2:**

Summary of the land cover types present within the Osbornes catchment.

Category	Proportions in Osbornes Catchment		Land Cover Database version 5 (LCDB5) map layers combined into the category shown in map
	ha	%	
<b>Farming – exotic grassland/cropping/ horticulture</b>	1,598	89.8	High producing exotic grassland, low producing grassland, orchard vineyard & other perennial crops, short-rotation cropland.
<b>Water bodies</b>	149	8.4	Estuarine open water, lake or pond, river.
<b>Forest – exotic</b>	12	0.7	Deciduous hardwoods, exotic forest, forest harvested.
<b>Other herbaceous</b>	12	0.7	Flaxland, herbaceous freshwater vegetation, herbaceous saline vegetation.
<b>Scrub/shrubland – indigenous</b>	6	0.3	Fernland, mangrove, manuka and/or kanuka, matagouri or grey scrub, sub alpine shrubland.
<b>Artificial bare – urban</b>	2	0.1	Built up area (settlement), surface mine or dump, transport infrastructure, urban parkland/open space.








# Osbornes Catchment Present Land Cover

## LAND COVER/VEGETATION TYPES:

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

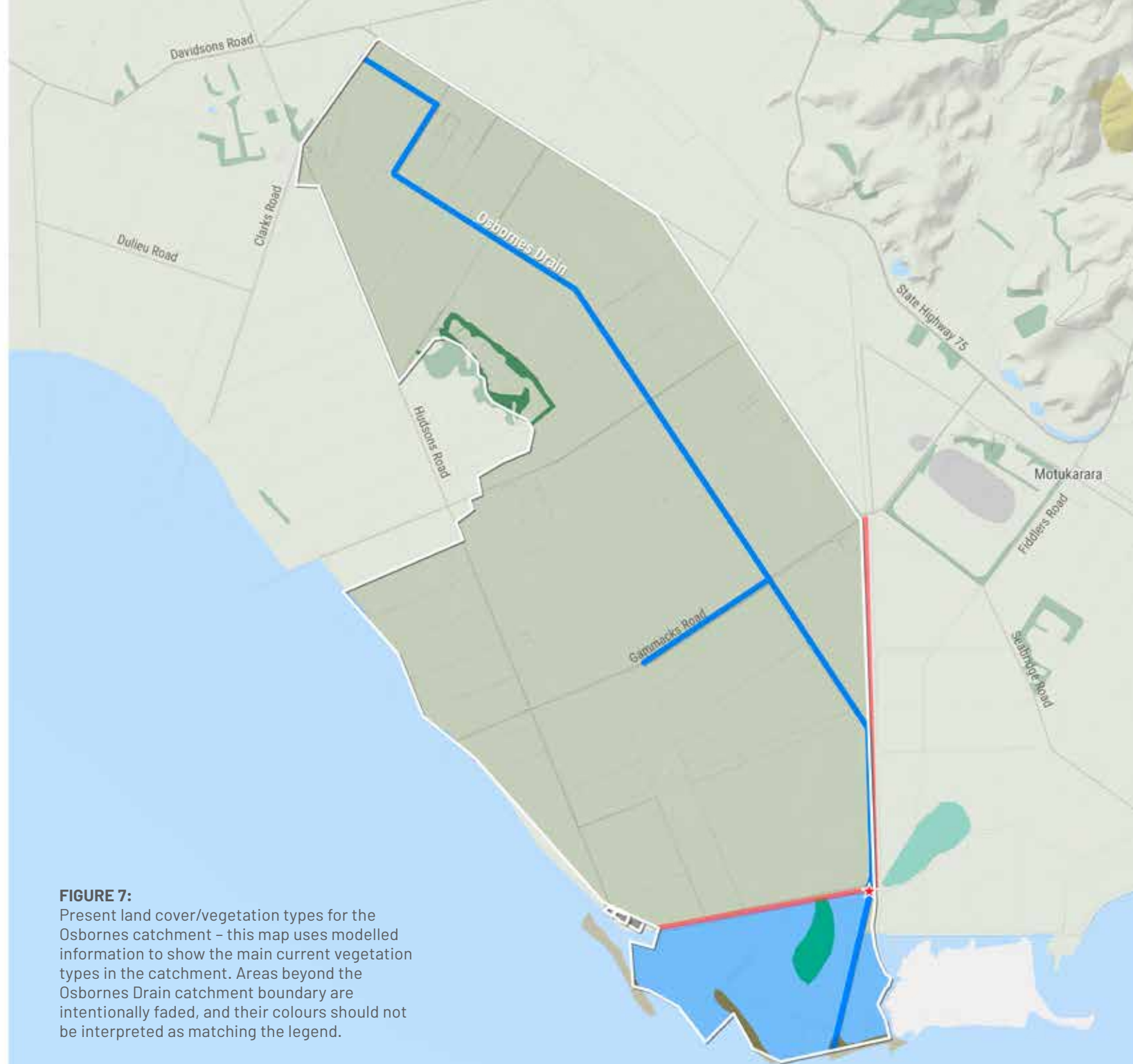
## OTHER:

-  Land drainage catchment
-  Rated drain
-  Embankment (1889 estimate)
-  Roads
-  Pump station



Map © EOS Ecology, 2025 / [www.eosecology.co.nz](http://www.eosecology.co.nz)

Layer source: Vegetation types (Manaaki Whenua/Landcare Research), waterways (EOS Ecology), Osbornes rated drain & land drainage catchment (Selwyn District Council), hillshade (Land Information New Zealand; LINZ), roads (Esri vector tile service), embankment (Maw & Main; 1989)



**FIGURE 7:**

Present land cover/vegetation types for the Osbornes catchment – this map uses modelled information to show the main current vegetation types in the catchment. Areas beyond the Osbornes Drain catchment boundary are intentionally faded, and their colours should not be interpreted as matching the legend.

### **3.2.2 Irrigation & Discharge Permits**

Most of the land in the Osbornes catchment is irrigated in some way (Dark, 2020). The most common form of irrigation is rotorainer, although some centre pivots are present (Figure 8). There are also several areas with active dairy discharge consents, where dairy effluent may be irrigated onto the land (Figure 8). The upper and mid-catchment areas also contain numerous onsite wastewater management systems, many of which are septic tanks serving homes within the catchment.



# Osbornes Catchment Irrigated Areas & Dairy Discharges

## IRRIGATION TYPE:

- Gun
- Pivot
- Rotorainer
- Unknown

## OTHER:

- Land drainage catchment
- Effluent dairy discharge areas
- Rated drain
- Embankment (1889 estimate)
- Roads
- Onsite wastewater management systems (Consented)
- ▲ Onsite wastewater management systems (Estimated)
- ★ Pump station



Map © EOS Ecology, 2025 / [www.eosecology.co.nz](http://www.eosecology.co.nz)

Layer source: Irrigated areas (Environment Canterbury), onsite wastewater management systems (Environment Canterbury (consented); ESR (estimated)), waterways & pump station (EOS Ecology), Osbornes rated drain & land drainage catchment (Selwyn District Council), hillshade (Land Information New Zealand, LINZ), roads (Esri vector tile service), embankment (Maw & Main, 1989), imagery (LINZ)



**FIGURE 8:** Irrigated areas, onsite wastewater, and dairy effluent discharges for the Osbornes catchment – the irrigated areas on this map are based on the irrigated area mapping of Dark (2020), updated with 2025 imagery. Note that irrigated areas were mapped as part of a national-scale project using desktop methods without any field verification.

### 3.2.3 Soil Types

According to modelled information from the New Zealand Soils Classification (NZSC), the main soil orders present within the Osbornes catchment are gley, brown, recent, and raw (Table 3; Figure 9). Soil orders are a generalised classification of soils that provide a national overview, with 15 soil orders identified within Aotearoa New Zealand (Hewitt, 2013). Gley soils are the dominant soil type, covering around 89% of the catchment area (Table 3). These gley soils are indicative of the former extent of lakebed/wetland within the catchment and tend to be waterlogged during winter and spring. Gley soils are typically characterised by poor leaching and low soluble salts, but as much of the Osbornes catchment was once part of the lakebed of Te Waihora/Lake Ellesmere, the soil here is also salt enriched.

**TABLE 3:**

Summary of the soil groups present with the Osbornes catchment, based on modelled data from the S-map Soil Classification (accessed August 2025).

NZSC Soil Order	Proportions in Osbornes Catchment Area		Description  See this URL for further information on soil classifications <a href="https://soils.landcareresearch.co.nz/topics/soil-classification">https://soils.landcareresearch.co.nz/topics/soil-classification</a>
	ha	%	
<b>Gley</b>	1,583	89.0	Light grey subsoils that together with 'organic' soils represent the original extent of our wetlands. High groundwater tables and strongly affected by waterlogging in winter/spring but can remain wet all year. Chemically reduced, high organic matter, soil organisms restricted due to anaerobic conditions.
<b>Brown</b>	107	6.0	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 Aotearoa New Zealand.
<b>Recent</b>	65	3.6	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. The highest recorded carrot production in the world was from 'Recent Soil' on the Taieri Plain.
<b>Raw</b>	21	1.2	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).



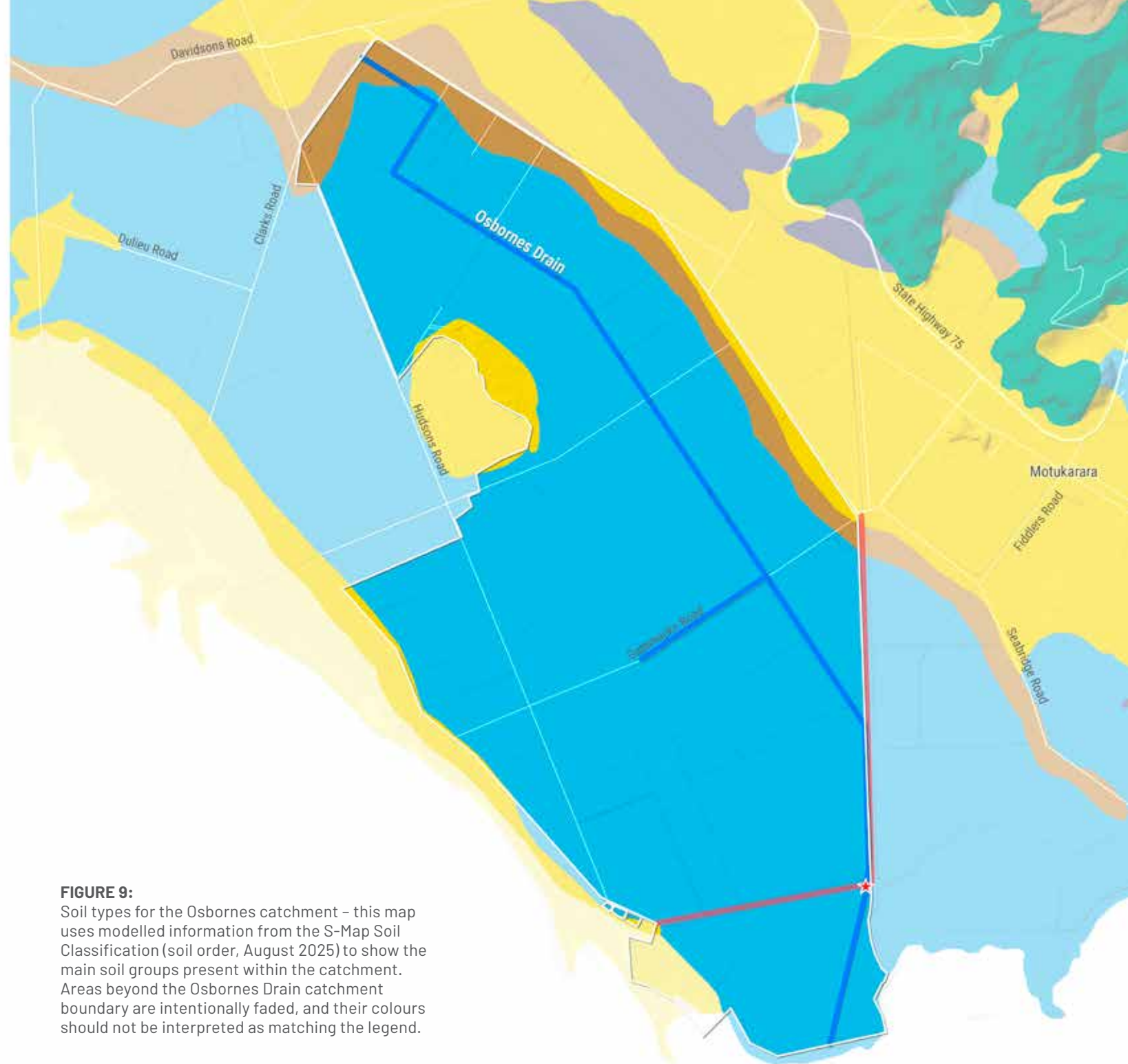
# Osbornes Catchment Soil Types

## SOIL GROUP:

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

## OTHER:

- Land drainage catchment
- Rated drain
- Embankment (1889 estimate)
- Roads
- Pump station



Map © EOS Ecology, 2025 / [www.eosecology.co.nz](http://www.eosecology.co.nz)

Layer source: Soil group (Manaaki Whenua/Landcare Research (S-map)), waterways & pump station (EOS Ecology), Osbornes rated drain & land drainage catchment (Selwyn District Council), hillshade (Land Information New Zealand; LINZ), roads (Esri vector tile service), embankment (Maw & Main, 1989)

**FIGURE 9:** Soil types for the Osbornes catchment - this map uses modelled information from the S-Map Soil Classification (soil order, August 2025) to show the main soil groups present within the catchment. Areas beyond the Osbornes Drain catchment boundary are intentionally faded, and their colours should not be interpreted as matching the legend.

### 3.2.4 Soil Drainage

According to modelled information from S-Map Online (Bioeconomy Science Institute, formerly Manaaki Whenua – Landcare Research), the soil drainage characteristics within the Osbornes catchment include poorly drained, imperfectly drained, and well drained soils (Table 4; Figure 10). The soils of the catchment are dominated by low draining soils, with poorly drained (90%) or imperfectly drained (3%) soils aligning with the majority of the catchment’s gley soils (waterlogged soils that can indicate past or present wetlands) (Figure 10) and with much of the area that was formerly wetland or past lake bed (Figure 5; Figure 6). In contrast, there is a strip of well drained, sandy soil along the northeast margin of the catchment, which aligns with ‘brown’ soils (Figure 9) as well as the ‘tussockland/flaxland/rushland’ area identified in the Black Maps (Figure 6; Figure 10).

**TABLE 4:**

Summary of the soil drainage characteristics present within Osbornes catchment, based on modelled data from the S-map Soil Classification (accessed August 2025).

Category	Proportions in Osbornes Catchment Area		Description
	ha	%	
Poorly drained	1,603	90.4	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.
Well drained	116	6.5	Soils that have no horizon within 90 cm of the mineral soil surface with more than 2% or more redox segregations.
Imperfectly drained	55	3.1	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.



# Osbornes Catchment Soil Drainage

## SOIL DRAINAGE:

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

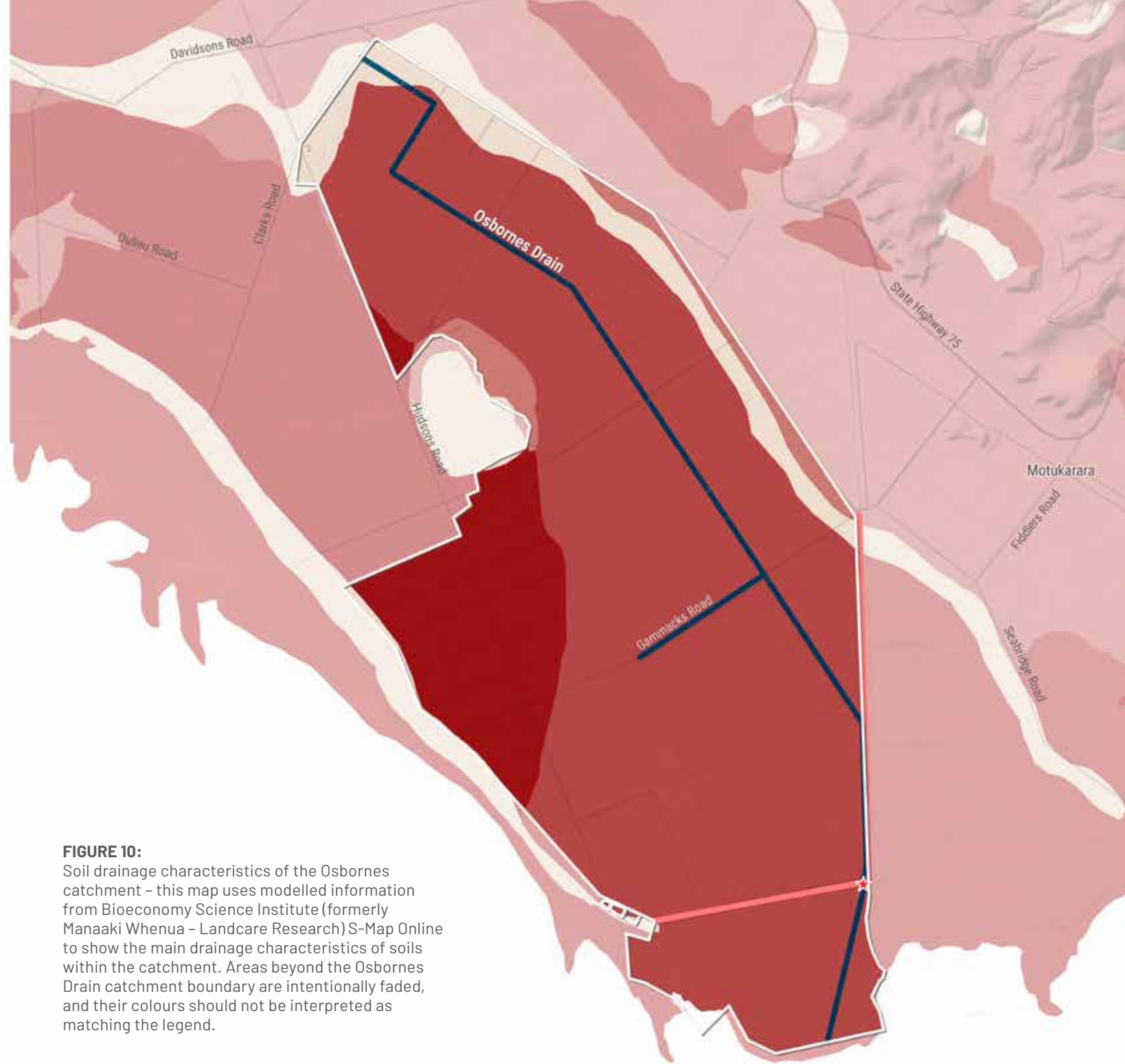
## OTHER:

- Land drainage catchment
- Rated drain
- Embankment (1889 estimate)
- Roads
- Pump station



Map © EOS Ecology, 2025 / [www.eosecology.co.nz](http://www.eosecology.co.nz)

Layer source: Soil drainage (Manaaki Whenua/Landcare Research), waterways & pump station (EOS Ecology), Osbornes rated drain & land drainage catchment (Selwyn District Council), hillshade (Land Information New Zealand; LINZ), roads (Esri vector tile service), embankment (Maw & Main; 1889)



**FIGURE 10:**

Soil drainage characteristics of the Osbornes catchment - this map uses modelled information from Bioeconomy Science Institute (formerly Manaaki Whenua - Landcare Research) S-Map Online to show the main drainage characteristics of soils within the catchment. Areas beyond the Osbornes Drain catchment boundary are intentionally faded, and their colours should not be interpreted as matching the legend.

### 3.2.5 Protected Areas

Within the Osbornes catchment, the area south of the embankment and pump station is designated as a conservation area, representing approximately 9% of the total catchment area (Table 5; Figure 11). Although this area is technically within the rated drainage catchment, it lies downstream of the pump station and is therefore outside the zone that is actively managed for drainage. The conservation area is not included in this CMP, and a separate wetland habitat enhancement project is underway for this location. The area is included here for context because it forms part of the receiving environment for discharge from the Osbornes catchment.

**TABLE 5:**

Summary of the protected areas present within the Osbornes catchment.

Protected Area Type	Proportions in Osbornes Catchment	
	Area	Area
	ha	%
<b>Reserve</b>	-	-
<b>Conservation area</b>	165	9.3
<b>Marginal strip</b>	-	-
<b>Wildlife area</b>	-	-
<b>National Park</b>	-	-
<b>Other</b>	-	-



# Osbornes Catchment Protected Areas

## PROTECTED AREA TYPE:

- Conservation area
- Marginal strip
- Marine area
- National Park
- Reserve
- Wildlife area

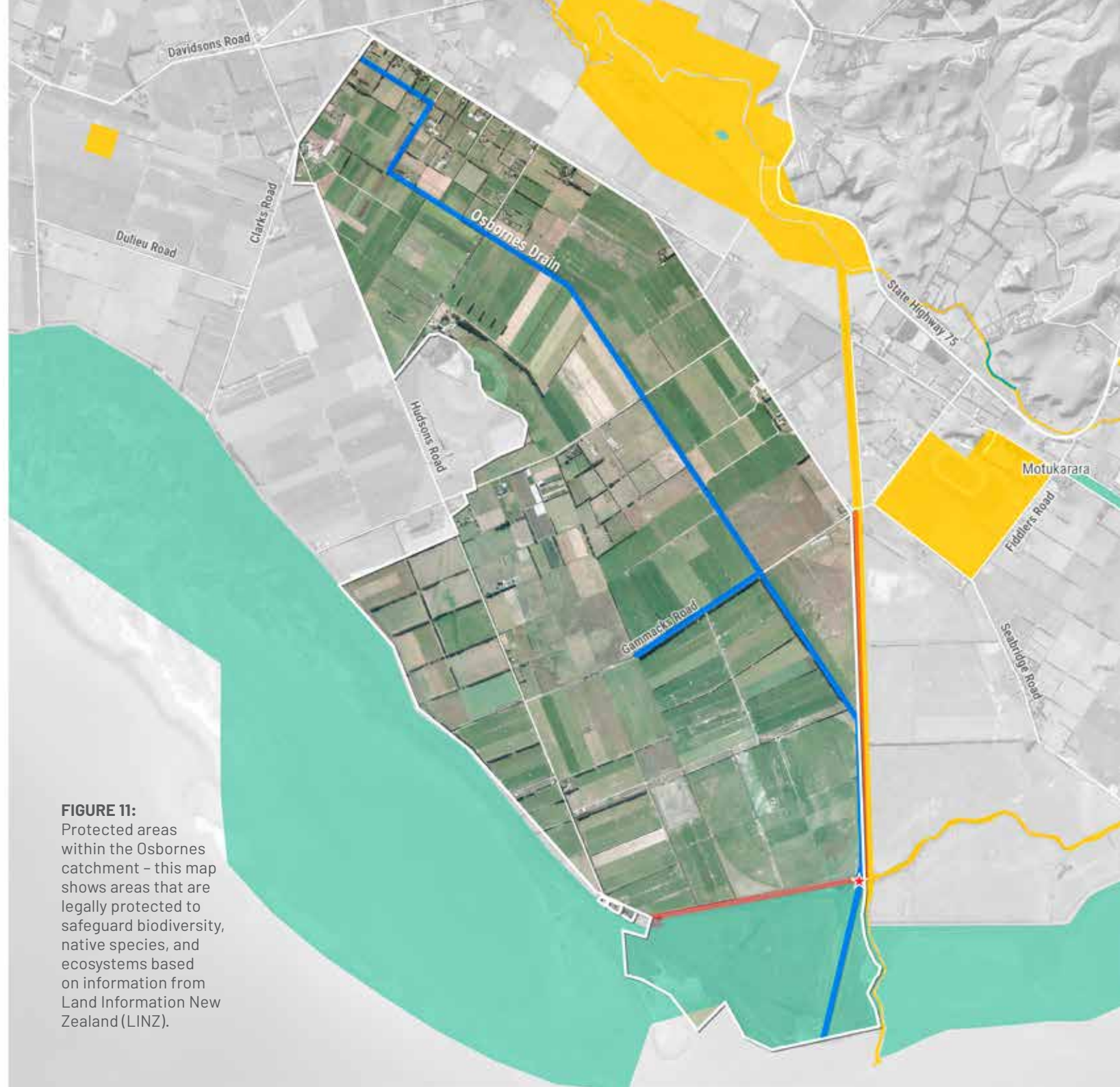
## OTHER:

- Land drainage catchment
- Rated drain
- Embankment (1889 estimate)
- Roads
- ★ Pump station



Map © EOS Ecology, 2025 / [www.eosecology.co.nz](http://www.eosecology.co.nz)

Layer source: Protected areas (Land Information New Zealand; LINZ), waterways & pump station (EOS Ecology), Osbornes rated drain & land drainage catchment (Selwyn District Council), hillshade (LINZ), roads (Esri vector tile service), embankment (Maw & Main; 1989)



**FIGURE 11:** Protected areas within the Osbornes catchment - this map shows areas that are legally protected to safeguard biodiversity, native species, and ecosystems based on information from Land Information New Zealand (LINZ).

### 3.2.6 Waterway Types

The Osbornes catchment is a relatively isolated and flat catchment that is intermittently pumped out to the receiving environment of Te Waihora/Lake Ellesmere, rather than continuously draining by gravity. As such, the Osbornes catchment consists of a network of artificial drainage waterways, with smaller lateral drains feeding into the main channel of Osbornes Drain, which discharges to Te Waihora/Lake Ellesmere via the pump station and outlet channel. These drains collectively lower the groundwater table for land drainage purposes and collect surface runoff from the catchment. The main channel and forebay area upstream of the Osbornes pump station provide some capacity for storage of water, which is periodically discharged by pump out of the catchment into a channel that leads to Te Waihora/Lake Ellesmere.<sup>1</sup>

As part of developing this CMP, a more accurate spatial dataset of waterways was created for the Osbornes catchment, with ground-truthing playing a key role in the process (Painter & Dow, 2024). Existing waterway layers tend not to be accurate enough for the purposes of catchment management planning at this scale, where suitable locations for placing tools/solutions/interventions need to be established. While existing layers indicate that there are around 48 km of drainage waterways within the Osbornes catchment, deriving channels from digital elevation model (DEM) data combined with field confirmation has identified almost 100 km of waterways (Table 6; Figure 12). We note that the accuracy of this DEM-derived layer may change over time as some of the intermittent or ephemeral drainage waterways are not permanently located, being moved as paddock layouts and use in the catchment change.

The classification of waterway types and their spatial distribution within the Osbornes catchment have been assembled based on spatial data, field surveys, and discussions with the local community. Within the Osbornes catchment we have categorised several waterway types, which can be distinguished by how frequently they hold water and some habitat characteristics. These include different classifications of the channelised waterways (perennial drainage waterways<sup>2</sup> (rated/unrated), intermittent drainage waterways (rated/unrated), ephemeral drainage waterways (unrated), and informal/overland flow paths that would deliver surface water runoff to the drainage waterways during prolonged or heavy rainfall (Table 6; Figure 12; Figure 13). As the catchment has no remnant natural waterway channels and much of the area was previously a shallow bay of Te Waihora/Lake Ellesmere, the current drainage waterways are the dominant surface water features in this area. However, with very flat land across the catchment and little fall from the upper to lower catchment, and a pump station that only periodically discharges water to the lake, water in the channels is often standing rather than flowing and may reside in the system for prolonged periods of time. Each waterway type is described in more detail in the following sections.

The proportion of rated waterways is relatively small (~9 km or 10% of all drainage waterways) compared to the lineal length of unrated waterways (~86 km or 90% of all drainage waterways), highlighting the importance of unrated waterways in implementing the proposed tools and solutions in this catchment. Furthermore, of the nearly 100 km of drainage waterways identified, just 4% appear to hold water for prolonged periods (i.e., the ‘perennial drainage waterways’), while 97% look to be dry for prolonged periods (i.e., the ‘intermittent’ or ‘ephemeral’ drainage waterways). Therefore, to be successful, the tools and solutions used in this catchment will need to be suitable for waterways that periodically dry as well as those that remain

<sup>1</sup> The waterway and wetland area downstream of the Osbornes catchment pump station is not included in this CMP. A separate project is working to enhance the wetland properties of this land downstream of the pump station.

<sup>2</sup> In the context of the Osbornes catchment, waterways are considered to be ‘perennial’ if they hold water for most of the year – noting that due to the very flat nature of the catchment and the pump station that does not always discharge water, this water may be standing water rather than flowing water.

wetted/hold water for prolonged periods of time. Interventions will also need to take into account the influence that prolonged standing (rather than flowing) water has on water quality within the drainage network, with longer water residence times contributing to a release of contaminants from the sediment and organic material entrained in the system, as well as considering contaminants that may enter the system from overland flow. This is discussed further in Section 3.2.8.

The catchment also contains a network of informal flow paths, which are normally dry but carry surface water runoff to the drainage waterways during prolonged or heavy rainfall. It is estimated that there may be as many as 75.5 km of informal flow paths within this catchment. When the lineal length of informal/overland flow paths is considered, they represent 44% of the flow paths and drainage waterways within the catchment (Table 6). Given the large proportion of informal/overland flow paths, we have also taken these into account when developing suitable interventions.

Whilst there are no officially recorded springs in this catchment, and it is generally accepted that there are no large artesian springs originating from deep groundwater, there may be spring zones originating from localised shallow groundwater, particularly at times when groundwater levels are at their highest.

The waterways downstream of the pump station are managed differently to those upstream of the pump station, with those downstream of the pump station being excluded from the solutions put forward as part of this CMP. A separate project is working to enhance the wetland properties of this land downstream of the pump station.

**TABLE 6:**  
Waterway types present within the Osbornes catchment.

Waterway Type		Length <sup>1</sup> km	Length % of Drainage Waterways	Length
				% of Drainage Waterways & Overland Flow Paths
<b>Perennial drainage waterways</b>	Rated	4.10	4.30	2.40
	Unrated	0.00	0.00	0.00
<b>Intermittent drainage waterways</b>	Rated	4.99	5.23	2.92
	Unrated	16.77	17.59	9.82
<b>Ephemeral drainage waterways</b>	Unrated	69.47	72.87	40.67
<b>Downstream of pump station not part of CMP<sup>2</sup></b>	Rated	Not included	Not included	Not included
<b>Informal/overland flow paths</b>		75.50	<b>not included in calculation</b>	<b>44.20</b>

<sup>1</sup> Channel lengths have been calculated from a combination of GIS analysis of 2023 Light Detection and Ranging (LiDAR) data and field data interpretation.

<sup>2</sup> The waterway and wetland area downstream of the Osbornes catchment pump station is not included in this CMP. A separate project is working to enhance the wetland properties of this land downstream of the pump station.



# Osbornes Catchment Waterway Types

## FLOW PERMANANCY:

- Looks ephemeral
- - - Looks intermittent
- Looks perennial

## OTHER:

- Land drainage catchment
- ▬ Rated drain
- ▬ Embankment (1889 estimate)
- Roads
- ★ Pump station



Map © EOS Ecology, 2025 / [www.eosecology.co.nz](http://www.eosecology.co.nz)

Layer source: Waterways & pump station (EOS Ecology), Osbornes rated drain & land drainage catchment (Selwyn District Council), hillshade (Land Information New Zealand; LINZ), roads (Esri vector tile service), embankment (Maw & Mair; 1989), imagery (LINZ)



**FIGURE 12:**





Different waterway types present within the Osbornes catchment today. Note that the area downstream of the pump station was not mapped for waterway types as it does not form part of the CMP.



# Osbornes Catchment Informal/Overland Flow Paths

— Informal/overland flow paths

OTHER:

-  Land drainage catchment
-  Rated drain
-  Embankment (1889 estimate)
-  Roads
-  Pump station



Map © EOS Ecology, 2025 / [www.eosecology.co.nz](http://www.eosecology.co.nz)

Layer source: Waterways, overland flow & pump station (EOS Ecology), Osbornes rated drain & land drainage catchment (Selwyn District Council), hillshade (Land Information New Zealand; LINZ), roads (Esri vector tile service), embankment (Maw & Main, 1989), imagery (LINZ)



**FIGURE 13:** Informal/overland flow paths present within the Osbornes catchment - this map was generated using LiDAR to identify low points or depressions in the landscape that may act as flow paths during heavy rainfall.

# Flow Types

## Overland/Informal Flow Paths

These depressions in the landscape are the paths that water follows during and shortly after rainfall. They may appear as low areas or depressions on the landscape without a clearly defined channel, making them difficult to detect during dry weather. In the Osbornes catchment, these overland or informal flow paths have been identified using aerial imagery and LiDAR. Based on this analysis, it is estimated that the catchment contains approximately 75.5 km of informal flow paths.

**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 drains during wet weather, as well as their widespread distribution in this catchment.



Informal flow paths are low areas or depressions on the landscape and are difficult to observe during dry weather.



During rainfall, water accumulates in depressions and follows informal flow paths to reach nearby drains.



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

*Note: these images illustrating overland/informal flow paths are from outside of the Osbornes catchment but are considered indicative of what occurs.*

## Ephemeral Drainage Waterways

Channels that only hold water temporarily, during and briefly after rainfall. The channels of ephemeral waterways in this catchment often follow fencelines and are typically straight and channelised. Ephemeral waterways are found throughout the Osbornes drainage catchment and exist on-farm within private land as well as along road margins. These temporary waterways are not usually fenced or separated from stock access and may be relocated periodically to suit changes in farm layout.

**ISSUES** for these waterways include stock access, periodic relocation, and the potential to act as a source of fine sediment and organic material during rain events.



Ephemeral drainage waterways may be a source of fine sediment if not well vegetated.



Ephemeral drainage waterways typically follow fencelines but may be relocated if required when farm layout changes.



Ephemeral drainage waterways are typically straight and may look like grassed swales.

## Intermittent Drainage Waterways Rated & Unrated

Channels that only hold water during wetter parts of the year when soil moisture and groundwater levels are high, and tend to be dry during the peak of summer. They hold water for longer periods of time than ephemeral drainage waterways, and tend to have wider, more deeply incised channels. The channels of intermittent waterways in this catchment often follow fence lines or run along road margins and are typically straight and channelised. Intermittent waterways are scattered throughout the Osbornes catchment but cover substantially less channel length than ephemeral waterways. Many of these waterways are fenced to prevent stock access, although this comes with additional maintenance or weed control requirements. Like ephemeral waterways, sometimes these channels are relocated to suit changes in farm layout.

**ISSUES** for these waterways include fine sediment accumulation, high requirements for weed and sediment control/removal, steep banks, periodic relocation, and water quality issues in part due to the prolonged standing (i.e., stagnant) nature of the water.



Intermittent waterways flow during the wetter seasons of the year and are typically more channelised than ephemeral waterways.



Weed control can be an issue for intermittent waterways in this catchment.



Water often looks stagnant, being anoxic and often stained/coloured due to a high organic content.

## Perennial Drainage Waterways Rated & Unrated

Channels that hold water for most of the year. The waterway known as Osbornes Drain runs the length of the catchment in a straight channel with few bends, and the lower half of this waterway appears to hold water perennially. For several kilometres upstream of the pump station, the channel retains a trapezoidal profile with a width of around 5 m and depth of 1–3 m (GHD, 2015), and so can hold a large volume of water. Instream habitat quality is poor, being composed of soft fine organic and inorganic sediments, and seasonally excessive growths of macrophytes (mainly monkey musk (*Erythranthe guttata*), water cress (*Nasturtium officinale*), *Lemna*, and floating grasses (*Glyceria*)). The perennial channel acts as storage for holding back drainage water when the pump is not operating. There are also several low weirs along the channel upstream of the pump station forebay that were constructed in recent years, but which have slumped over time and now need maintenance or reinstatement.

**ISSUES** for these perennial drainage waterways include significant water quality issues due to the prolonged standing (i.e., stagnant) nature of the water, and seasonal excessive instream vegetation in places.



The mid to lower reaches of Osbornes Drain provide storage capacity during times that the pump station is not operating. The standing water creates water quality challenges with accumulation of fine inorganic and organic sediments, low dissolved oxygen concentrations, and seasonal growth of floating and rooted macrophytes.



Excessive seasonal growth of floating grasses can exacerbate water quality issues.



Immediately upstream of the pump station the channel is further widened, and due to the standing nature of the water it is often covered by *Lemna*. Due to the high organic content in the sediments, the water is oxygen depleted and heavily/deeply stained.

## Open Water & Wetland Downstream of Pump Station

Downstream of the pump station, the channel of Osbornes Drain extends a further 1.2 km before it discharges into Te Waihora/Lake Ellesmere. The channel includes areas of open water and areas of raupō (*Typha orientalis*) wetland that occludes the channel at the point of the pump station discharge. Water is discharged from the pump station to this channel when the pump station is operating. While the pump station may operate continuously for several days to maintain water levels during wet winter months, the more typical pumping duration is around 10 minutes at a time, with pumps going on up to eight times per day depending on water levels (GHD, 2015). Note that the area downstream of the pump station is included here for context, but is not part of this CMP, as a wetland habitat enhancement project for this area is being worked on separately.

**ISSUES** for the waterway downstream of the pump station include the lack of a clear discharge channel from the pump station and poor water quality discharging from the pump station. This is the immediate receiving environment for the discharge from Osbornes Drain and flows approximately 1.2 km before discharging to Te Waihora/Lake Ellesmere.



Immediately downstream of the pump station the drainage waterway enters an area of raupō wetland that occludes the channel. The deeply stained nature of the water is evident here.












The channel downstream of the pump station alternates between raupō wetland and open water. With a very low gradient, water velocity remains very slow.

### 3.2.7 Freshwater Ecology

#### Macroinvertebrates

The waterways of the Osbornes catchment are a constructed part of the landscape, given the history of the area as a shallow lake arm or wetland. However, these drainage waterways do provide very poor freshwater habitat conditions that currently support very limited ecological values in the catchment. Macroinvertebrate and eDNA survey work that has been completed as part of the Osbornes land drainage discharge consent application (CRC172231) and through the development of this CMP has shown that the intermittent and perennial reaches of the catchment support a community of freshwater invertebrates that is limited to species that are tolerant of poor habitat and water quality conditions (Table 7). The most abundant macroinvertebrate taxa in the intermittent drainage waterways are crustaceans (Ostracoda and Cladocera) and worms (Oligochaeta), while the perennial drainage waterways contain snails (*Potamopyrgus* and *Physa*) and crustaceans (Ostracoda). A slightly more diverse invertebrate community is found downstream of the pump station, although this area is still only dominated by tolerant species such as snails (*Potamopyrgus*) and midge larvae (*Chironomus* and Orthoclaadiinae). For all waterway types in the Osbornes catchment, biotic indices including the macroinvertebrate community index (MCI), quantitative macroinvertebrate community index (QMCI), and taxon independent community index (TICI) indicate that the waterways are in poor condition (Table 7; Figure 14).

**TABLE 7:** Summary of aquatic invertebrates found in the Osbornes catchment waterways, based on surveys by Boffa Miskell (2015) and EOS Ecology (for this CMP).

	Intermittent Drainage Waterways	Perennial Drainage Waterways	Downstream of Pump Station
<b>Average taxa richness</b> (conventional sampling)	12	11	17
<b>Average Macroinvertebrate Community Index (MCI)</b> – with Stark & Maxted (2007) water quality interpretation classes	37 (Poor)	44 (Poor)	52 (Poor)
<b>Average Quantitative Macroinvertebrate Community Index (OMCI)</b> – with Stark & Maxted (2007) water quality interpretation classes	2.3 (Poor)	2.0 (Poor)	2.5 (Poor)
<b>Average Taxon Independent Community Index (TICI)</b> – with Wilkinson <i>et al.</i> , (2024) interpretation bands	86 (Poor)	81 (Poor)	No eDNA data available
<b>Three most abundant taxa</b>	 Ostracoda	 <i>Potamopyrgus antipodarum</i>	 <i>Potamopyrgus antipodarum</i>
	 Oligochaeta	 <i>Physa acuta</i>	 Chironomus
	 Cladocera	 Ostracoda	 Orthoclaadiinae
<b>Mega invertebrates present</b> (conventional or eDNA data)	None recorded	None recorded	None recorded



# Osbornes Catchment Invertebrate Indices

MCI/QMCI BAND:  
Stark & Maxted (2007)



Poor

TICI Band



Poor

FLOW PERMANANCY:

Looks ephemeral

Looks intermittent

Looks perennial

OTHER:

Land drainage catchment

Rated drain

Embankment (1889 estimate)

Roads

Pump station



Map © EOS Ecology, 2025 / [www.eosecology.co.nz](http://www.eosecology.co.nz)

Layer source: Invertebrates (EOS Ecology, Boffa Miskel (2015)), waterways & pump station (EOS Ecology), Osbornes rated drain & land drainage catchment (Selwyn District Council), hillshade (Land Information New Zealand; LINZ), roads (Esri vector tile service), embankment (Maw & Main; 1989), imagery (LINZ)



**FIGURE 14:**

Macroinvertebrate indices for survey sites within the Osbornes catchment – sites sampled with conventional macroinvertebrate survey techniques (e.g., kick-net and laboratory sample processing) are represented by the macroinvertebrate community index (MCI) and quantitative macroinvertebrate community index (QMCI), with data points being coloured according to the interpretation bands of Stark & Maxted (2007), while sites sampled by environmental DNA (eDNA) are represented by the taxon independent community index (TICI) with data points being coloured according to the interpretation bands of Wilkinson et al., (2024).



Tuna/Shortfin eel (*Anguilla australis*)

Image source: EOS Ecology





## Fish

Fish information was obtained from fish surveys recorded in the New Zealand Freshwater Fish Database (NZFFD), additional fish surveys completed as part of the Osbornes land drainage consent application (Boffa Miskell, 2015), fish salvage work by NIWA (2017, 2018, 2020, 2021a, 2022), and eDNA surveys undertaken as part of the development of this CMP. These data indicate that at least 11 fish species have been recorded within waterways upstream and downstream of the pump station, with eight fish species having been recorded in waterways upstream of the pump station (Table 8). Most of the fish species that have been recorded upstream of the pump station have been found within the perennial reaches of the catchment, although shortfin tuna/eel and longfin tuna/eel have also been detected in waterways that are likely to be intermittent (Table 8; Figure 15).








Of the fish species recorded, four have some form of threat classification. These are īnanga which are considered *Threatened – Nationally Vulnerable*, longfin tuna/eel and common smelt (only recorded downstream of the pump station) which are considered *At Risk – Declining*, and upland bully which are considered *At Risk – Naturally Uncommon* according to the most recent threat classifications of Dunn *et al.*, (2025) (Table 8). Of the introduced fish species recorded, both rudd and tench were only recorded during the fish rescue work completed by NIWA during 2018 (as a condition of resource consent CRC172231; NIWA, 2018). These fish were euthanised and no further individuals of these species were found in subsequent sampling rounds (NIWA, 2020, 2021a, 2022). Goldfish have also been recorded occasionally in the catchment, both upstream and downstream of the pump station (Table 8). Both brown trout and perch have only been recorded downstream of the pump station.

Structures that may impede fish passage in the catchment include culverts, bridges, and the pump station (Figure 16). Many of these structures were identified during fieldwork as part of the development of this CMP but have not been assessed in terms of their likely impact on fish passage. However, the pump station certainly presents both an upstream and downstream impediment to safe and accessible fish passage. Te Waihora/Lake Ellesmere is also an intermittently closing and opening lake (ICOL), which means it has an intermittent opening to the ocean that would also have an influence on migratory fish populations.

**TABLE 8:** Fish species found in the Osbornes catchment waterways. Fish data was obtained from the New Zealand Freshwater Fish Database (NZFFD; records from 1980 onwards), and sampling undertaken as part of this CMP (eDNA data), Boffa Miskell (2015), and NIWA fish salvages (2017–2022) and includes both conventional fish surveys and eDNA data. The conservation status from Dunn et al., (2025) and migratory status is given for each species.

Common Name		Longfin eel	Shortfin eel	Common bully	Upland bully
Species Name		<i>Anguilla dieffenbachii</i>	<i>Anguilla australis</i>	<i>Gobiomorphus cotidianus</i>	<i>Gobiomorphus breviceps</i>
Conservation Status		At Risk – Declining	Not Threatened	Not Threatened	At Risk – Naturally Uncommon
Migratory Status		Diadromous–Catadromous	Diadromous–Catadromous	Diadromous–Amphidromous	Non-diadromous
Description		 <ul style="list-style-type: none"> <li>• Widespread throughout NZ in a variety of habitats from sea level to 1,150 m elevation.</li> <li>• Excellent climbers as juveniles.</li> <li>• Significant taonga species and a very important mahinga kai resource.</li> </ul>	 <ul style="list-style-type: none"> <li>• Widespread across NZ.</li> <li>• While they can penetrate inland as far as longfin eel, they are more commonly found at low elevation lakes, wetlands and rivers.</li> <li>• Significant taonga species and a very important mahinga kai resource.</li> </ul>	 <ul style="list-style-type: none"> <li>• The most prevalent and widespread native freshwater fish in NZ.</li> <li>• Found in streams and lakes throughout the country.</li> <li>• Typically has seven first dorsal spines, occasionally eight.</li> </ul>	 <ul style="list-style-type: none"> <li>• Thrives in various habitats, often in slow streams along the East Coast of the South Island.</li> <li>• Some populations also inhabit lakes.</li> <li>• Distinctive orange spots covering the entire head, especially on the cheeks.</li> </ul>
Waterway Types	Ephemeral/Intermittent	✓	✓		
	Perennial	✓	✓	✓	✓
	Downstream of Pump Station	✓	✓	✓	

**TABLE 8:**  
...continued...

Īnanga	Common smelt	Goldfish	Rudd	Tench	Perch	Brown trout
<i>Galaxias maculatus</i>	<i>Retropinna retropinna</i>	<i>Carassius auratus</i>	<i>Scardinius erythrophthalmus</i>	<i>Tinca tinca</i>	<i>Perca fluviatilis</i>	<i>Salmo trutta</i>
Threatened – Nationally Vulnerable	At Risk – Declining	Introduced & Naturalised	Introduced & Naturalised	Introduced & Naturalised	Introduced & Naturalised	Introduced & Naturalised
Diadromous–Amphidromous	Diadromous–Anadromous	Non-diadromous	Non-diadromous	Non-diadromous	Non-diadromous	Anadromous-capable
						
<ul style="list-style-type: none"> <li>• Most common whitebait species, naturally widespread in freshwater systems worldwide.</li> <li>• Highly valued as a food source in its whitebait juvenile stage.</li> <li>• Prefers gentle-flowing lowland rivers, lakes, and streams.</li> <li>• Limited inland penetration due to poor climbing. Habitat degradation is a risk for this species.</li> </ul>	<ul style="list-style-type: none"> <li>• Widely distributed at low elevations throughout NZ. Capable of inland penetration when stream gradients are low.</li> <li>• Forms land-locked populations in lakes as well.</li> </ul>	<ul style="list-style-type: none"> <li>• Introduced in the 1860s as ornamental pond fish, goldfish are now widespread in NZ, often descendants of dumped aquarium fish.</li> <li>• They thrive in still waters, consuming aquatic plants and insects.</li> </ul>	<ul style="list-style-type: none"> <li>• Illegally smuggled and naturalised, rudd spread throughout northern North Island and Canterbury in the 1960s, with further illegal releases in the lower North Island and upper South Island.</li> <li>• Classified as a noxious fish species (Freshwater Fisheries Regulations, 1983), except in Auckland and Waikato, where it is considered a sports fish.</li> </ul>	<ul style="list-style-type: none"> <li>• Introduced in 1868 for coarse fishing, tench has a patchy distribution throughout the North Island and around Oamaru, Christchurch, and Nelson in the South Island.</li> <li>• Classified as a sports fish (Freshwater Fisheries Regulations, 1983).</li> </ul>	<ul style="list-style-type: none"> <li>• An exotic fish introduced in the 1860s for coarse fishing.</li> <li>• Exhibits aggression as a predator with a diverse diet, turning piscivorous when larger.</li> <li>• Prefers gentle flowing waters abundant with aquatic vegetation.</li> </ul>	<ul style="list-style-type: none"> <li>• 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.</li> <li>• Highly territorial, they out-compete other fish species for available food sources.</li> </ul>
✓		✓	✓	✓		
✓	✓	✓			✓	✓

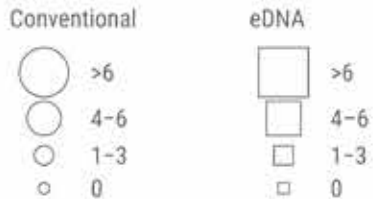


# Osbornes Catchment Fish Diversity

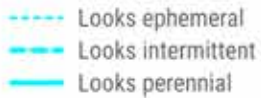
## % THREATENED SPECIES:



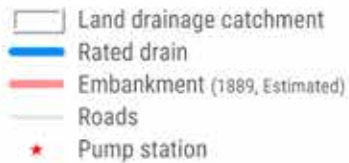
## SPECIES DIVERSITY:



## CHANNEL FLOW PERMANANCY:

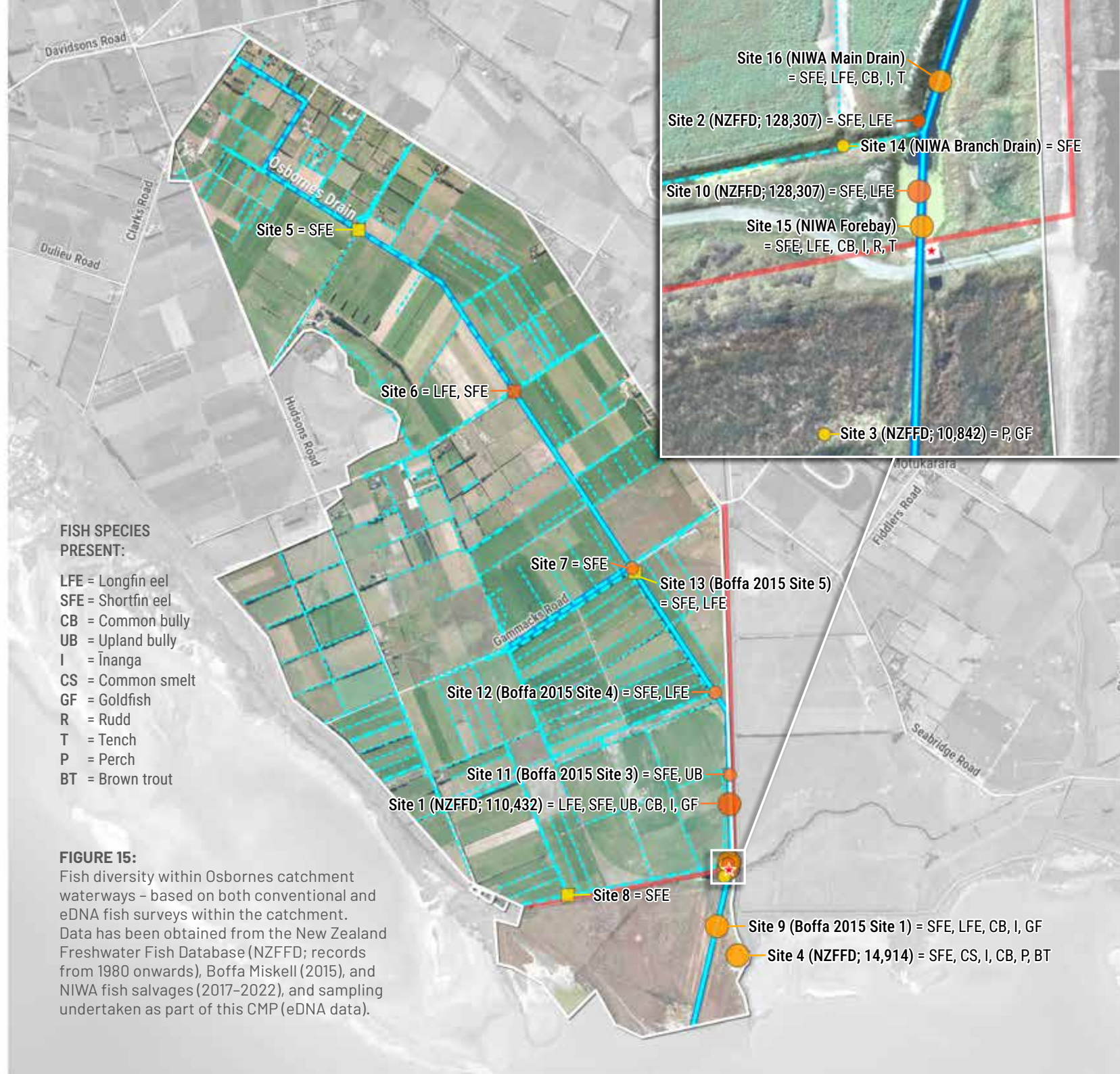


## OTHER:



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

Layer source: Fish (EOS Ecology, NZFFD, Boffa Miskell 2015), waterways & pump station (EOS Ecology), Osbornes rated drain & land drainage catchment (Selwyn District Council), hillshade (Land Information New Zealand; LINZ), roads (Esri vector tile service), embankment (Maw & Main, 1989), imagery (LINZ)



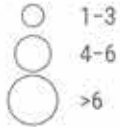
**FIGURE 15:**

Fish diversity within Osbornes catchment waterways - based on both conventional and eDNA fish surveys within the catchment. Data has been obtained from the New Zealand Freshwater Fish Database (NZFFD; records from 1980 onwards), Boffa Miskell (2015), and NIWA fish salvages (2017-2022), and sampling undertaken as part of this CMP (eDNA data).



# Osbornes Catchment Fish Passage

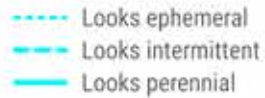
## MIGRATORY FISH DIVERSITY:



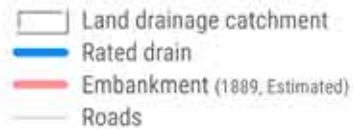
## STRUCTURES BY WATERWAY TYPE:



## CHANNEL FLOW PERMANANCY:



## OTHER:



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

Layer source: Fish diversity (EOS Ecology; NZFFD, Boffa Miskell 2015; NIWA), waterways & structures (EOS Ecology), Osbornes rated drain & land drainage catchment (Selwyn District Council), hillshade (Land Information New Zealand; LINZ), roads (Esri vector tile service), embankment (Maw & Main; 1989), imagery (LINZ)



**FIGURE 16:**

The location of in-stream structures that may present a risk to fish passage within the catchment. In-stream structures were identified based on digital elevation models (DEM) and aerial photography followed by a ground truthing process (Painter & Dow, 2024). The diversity of migratory fish is shown for conventional fishing sites that are recorded on the NZFFD.

### 3.2.8 Water Quality

Unlike the other waterways that discharge into Te Waihora/Lake Ellesmere, Osbornes Drain has a controlled discharge via a pump station, meaning that water within the catchment's waterways has a significantly longer residence time than in other catchments. This prolonged residence time along with the flat nature of the catchment and the legacy of a higher soil salt content (from when the area formed part of the brackish lake) all have a complex interrelationship with water quality. As such, the interpretation of water quality data and identification of solutions to water quality issues must not only take into account what may be entering the drainage channels from the land, but also how conditions within the channel itself (such as legacy organic and inorganic sediments that are entrained in the system and low oxygen levels caused by lack of aeration and bacterial activity in the organic-rich sediments) can influence water chemistry and thus water quality.

Water quality monitoring is undertaken at a range of sites throughout the catchment by Environment Canterbury and SDC (Figure 17). As detailed in Section 2.2, SDC holds resource consent (CRC172231) to discharge stormwater and land drainage water from the Osbornes catchment into Te Waihora/Lake Ellesmere, subject to water quality limits and targets for a subset of parameters. Water quality sampling at the pump station is used to represent the discharge from the catchment and this has indicated that water quality is generally very poor. Several monitoring parameters regularly fail to comply with the targets identified in the consent conditions (Selwyn District Council, 2023a; 2023b; 2024), while others raise similar concern despite not being directly regulated. Whilst the discharge consent requires monitoring of a subset of indicator contaminants which are summarised here, there may also be other water quality parameters that directly affect this catchment and receiving environment, whether through losses from surrounding land use or by mobilisation within the catchment waterways.

Over a four-year period of monthly water quality monitoring at the pump station, water quality compliance reports show that annual medians for dissolved reactive phosphorus (DRP), *Escherichia coli* (*E. coli*), and dissolved oxygen consistently fail to meet target concentrations, with DRP and *E. coli* greatly exceeding target concentrations and dissolved oxygen falling below the target for consent compliance. In contrast, concentrations of total suspended solids (TSS), nitrate nitrogen (nitrate-N), and total ammoniacal nitrogen generally meet consent targets as slow flowing or standing water promotes fine sediment settling, and low oxygen conditions encourage denitrification. Five-year medians and 95<sup>th</sup> percentiles from the same pump station monitoring sites show that DRP, *E. coli*, and TSS exceed at least one of the relevant local or national guidelines, and dissolved oxygen does not meet the minimum guidelines (Table 9).



# Osbornes Catchment Water Quality: Sampling Site Locations

## WATER QUALITY MONITORING SITE:

- ECan investigation site
- SDC routine monitoring site

## CHANNEL FLOW PERMANANCY:

- - - Looks ephemeral
- · - Looks intermittent
- Looks perennial

## OTHER:

- Land drainage catchment
- Osbornes Drain (rated)
- Embankment (1889 estimate)
- Roads
- ★ Pump station



Map © EOS Ecology, 2025 / [www.eosecology.co.nz](http://www.eosecology.co.nz)

Layer source: Water quality monitoring site (Environment Canterbury, Selwyn District Council), waterways & pump station (EOS Ecology), Osbornes rated drain (Selwyn District Council), hillshade (Land Information New Zealand, LINZ), roads (Esri vector tile service), embankment (Maw & Main; 1989), imagery (LINZ)



**FIGURE 17:** Locations of water quality sampling sites monitored by Environment Canterbury (ECan) and Selwyn District Council (SDC) within the Osbornes catchment. The names for the SDC routine monitoring sites are also given.

**TABLE 9:** Five-year summary of measured water quality at the Osbornes pump station. Samples collected monthly between July 2019 and June 2024 (data collected by Selwyn District Council). Targets from the Osbornes discharge consent (CRC172231), along with national objectives framework attributes (NPSFM, 2020) and relevant guidelines from ANZG (2018) and the Canterbury Land and Water Regional Plan (LWRP), are included for comparison.

- 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	Five Years of Data (2019–2024) Pump Station Site		Assessment Against Relevant Guidelines	
	Median	95 <sup>th</sup> Percentile	Green shading indicates that the water quality parameter meets the listed guideline, while red indicates that it does not	
			Osbornes Drain Consent (CRC172231)	Other Guidelines
pH	7.8	8.2		Between 6.5 – 8.5 (LWRP Table S5A)
Dissolved oxygen (%)	28.4	72.4	5 <sup>th</sup> percentile 50% (year 0–5 target); 60% (year 6–10 target)	
Dissolved oxygen (mg/L)	3.21	7.70		7.0 mg/L (LWRP Schedule 8 – spring-fed plains)
Nitrate-nitrite nitrogen (mg/L)	0.01	1.11	Median 2 mg/L (year 0–5 target); 1.5 mg/L (year 6–10 target)	0.265 mg/L (ANZG for cool dry low elevation) 3.8 mg/L (LWRP Schedule 8 – spring-fed plains)
Ammoniacal nitrogen (mg/L)	0.12	0.55	Differs by pH: 1.18 mg/L at pH 7.8	0.01 mg/L (80 <sup>th</sup> percentile, ANZG for cool dry low elevation)
Dissolved inorganic nitrogen	0.19	1.40		1.5 mg/L (LWRP Table S5A – spring-fed plains)
Dissolved reactive phosphorus (mg/L)	1.63	5.52	Median 1 mg/L (year 0–5 target); 0.1 mg/L (year 6–10 target)	0.016 mg/L (LWRP Table S5A – spring-fed plains) 0.008 mg/L (ANZG for cool dry low elevation)
Total phosphorus (mg/L)	1.92	5.73		0.014 mg/L (ANZG for cool dry low elevation)
<i>E. coli</i> (cfu/100mL)	83	2420	Median 80 cfu/100mL (year 0–5 target); 50 cfu/100mL (year 6–10 target)	550 <i>E. coli</i> /100mL (LWRP Table S5A – spring-fed plains)
Total suspended solids (mg/L)	6.0	179.6	Median 30 mg/L (year 0–5 target); 25 mg/L (year 6–10 target)	2.1 mg/L (ANZG for cool dry low elevation)
Turbidity	3.1	22.3		1.3 NTU (ANZG for cool dry low elevation)

The presence of *E. coli* in water is indicative of faecal pollution and associated human health risks, such as exposure to pathogens like *Campylobacter*. Faecal contamination affects the suitability of waterways for mahinga kai, swimming, and other recreation, but is likely to be more of an issue for the discharge to Te Waihora/Lake Ellesmere than for Osbornes Drain itself. The NPSFM 2020 attribute bands for *E. coli* (A to E) indicate the risk of infection, with Osbornes catchment showing high-risk bands (D or E) from 2017 to 2022 because of frequent exceedances of the relevant *E. coli* concentrations at the three sampling sites in the catchment (Alexander, 2023).

Dissolved oxygen (DO) concentration is an important physical parameter for maintaining the chemical oxic state of waterbodies that affects carbon, nitrogen, and phosphorus cycling (Figure 18; Figure 19), and is essential for the survival of aquatic organisms. Dissolved oxygen may drop to critically low levels in warm, slow flowing or stagnant water with excessive plant growth and/or high organic matter. Measured DO levels in Osbornes catchment are very low, with a five-year median of 3 mg/L (Alexander, 2023), which is likely to cause significant stress to a range of aquatic organisms. An intensive water quality sampling programme undertaken by Environment Canterbury during 2011–2012 deployed dissolved oxygen at several sites in the catchment to gain a better understanding of the temporal changes to DO. They found periods of anoxia and very high dissolved organic carbon (DOC) levels, which is a measure of decomposed organic matter in the water (Robinson & Meredith, 2013). The study found that high inputs of organic matter to the drain were likely contributing to the anoxic conditions and that in turn, the anoxic conditions were influencing nutrient concentrations within the drain, resulting in elevated levels of ammoniacal nitrogen and very high phosphorus concentrations for much of the summer and autumn (Robinson & Meredith, 2013). 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, nitrogen, and phosphorous concentrations and prolonged anoxia causing sediments to become a source of phosphorus and organic carbon rather than a sink (Carey *et al.*, 2022).

Nitrogen and phosphorus are important nutrients for plant growth, but too much in waterways can cause unwanted plant or algae growth and at very high concentrations, nitrate-N and ammonia nitrogen can have toxic effects (reduced survival or death of sensitive species). The five-year median DRP (2017 to 2022) for three sites within the catchment is 2 mg/L (Alexander, 2023), which exceeds the discharge consent target and falls within the NPSFM 2020 D attribute band (>0.018 mg/L), indicating potential ecological impacts and increased risk of excessive algae and plant growth, particularly in downstream receiving environments (Te Waihora/Lake Ellesmere). Sources of DRP include the natural weathering of rocks, agricultural or urban runoff, eroding soils, and sewage discharges, but can also be released from *in situ* organically rich sediments when dissolved oxygen levels are low. Meanwhile, nitrate-N (median: 0.13 mg/L; Alexander, 2023) meets both the consent's 10-year target and is within the A attribute band of the NPSFM 2020 for nitrate-N toxicity, while ammoniacal nitrogen (median: 0.22 mg/L) is just under the national bottom line (0.24 mg/L; NPS-FM, 2020) but well below the consent target. Nitrate-N and ammoniacal nitrogen are soluble forms of nitrogen that commonly enter waterways through runoff or leaching of effluent or fertiliser on pastures, or directly from sewage discharges or stock in waterways. Under anoxic conditions, dissolved inorganic nitrogen (DIN) and ammonium ( $\text{NH}_4^+$ ) 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 18; Figure 19). The strong influence of oxygen levels on biochemical cycles highlights the importance of monitoring all types of nitrogen in this currently oxygen-limited system.

Given the non-compliances with the water quality standards in the resource consent, SDC initiated an investigation report as required by condition 34(c) of consent CRC172231. An analysis of trends over time and space showed that there has been a decreasing (and worsening) trend in DO (i.e., lower DO levels) between 2014 and 2021, at the same time as an increasing (and worsening) annual trend in DRP (i.e., higher DRP levels) (GHD, 2021). The lowest values of dissolved oxygen

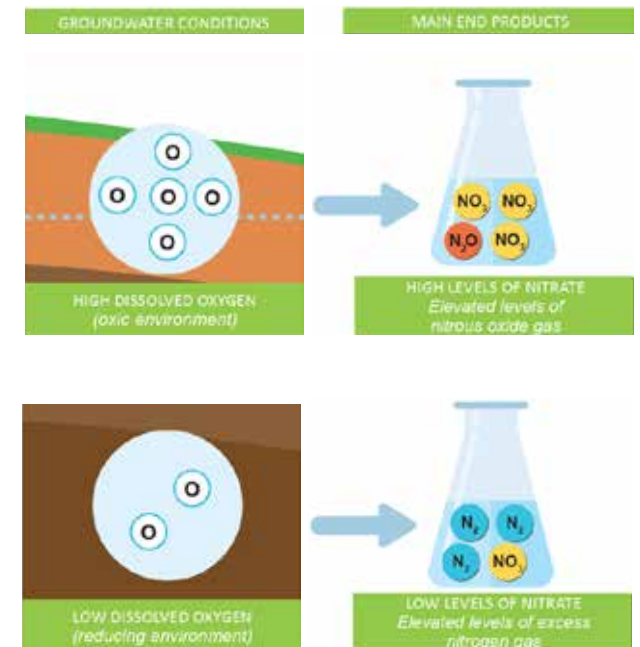
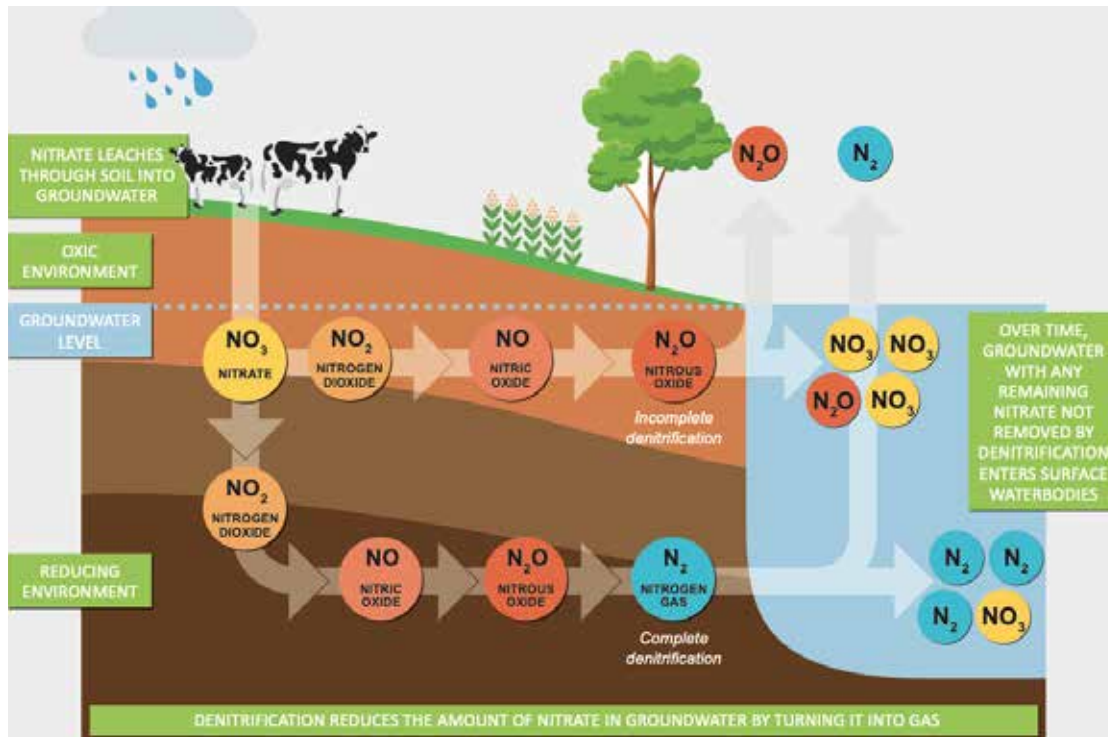
occur during the summer months, which is also when the highest concentrations of DRP occur. The investigation concludes that decomposing organic matter is likely to be responsible for the low dissolved oxygen concentrations, which in turn lead to higher concentrations of DRP, since low dissolved oxygen levels tend to promote the release of phosphorus from sediments.

Based on the water quality monitoring results, phosphorus is currently the plant-available nutrient of most concern for this catchment. However, the low oxygen conditions will also be contributing to artificially low nitrate and high DRP in the water and could mean that with any improvement in dissolved oxygen there may be an increase in nitrate concentrations (and decrease in DRP). Such interactions also make it difficult to pinpoint the source of nutrients (i.e., from land use inputs or release from entrained sediment). The low natural flushing of sediment from the catchment's waterways (due to their low gradient and slow flowing nature and a controlled outlet at the downstream end of the catchment) will also contribute to these factors, retaining sediment that could be rich in organic material and nutrients and creating low oxygen conditions that release carbon and phosphorus previously trapped in the sediment. Under such conditions, sediment traps and treatment wetlands could be good options to improve the quality of water discharging from the catchment into Te Waihora/Lake Ellesmere.

There also appears to be some spatial trends for water quality in the Osbornes catchment. Elevated concentrations of total suspended solids, total nitrogen, total phosphorus (TP), and *E. coli* at the upper end of the catchment (sample site at Matthews Road; Figure 17) show a decreasing (improving) trend down the catchment (GHD, 2021). Results indicate that high sediment loads, organic sources of nitrogen (such as plant or animal material), and particulate phosphorus inputs may be issues originating in the upper part of the catchment. Of the water quality parameters that are not meeting the limits and targets of consent CRC172231 (DO, DRP, *E. coli*), water quality monitoring across the catchment indicates that while DO is low at all locations upstream of the pump station, it is especially low in the intermittent upper reaches of the catchment (Figure 20). In contrast, *E. coli* concentrations decline

somewhat down the catchment, although the median concentrations remain below the Land and Water Regional Plan (LWRP) receiving water standard of 550 *E. coli* per 100 ml at all monitoring sites (Figure 21). The median concentrations of DRP and TP also tend to be highest in the intermittent upper reaches of the catchment and decrease somewhat downstream, while remaining very high and well above guideline values at all sites (Figure 22; Figure 23).

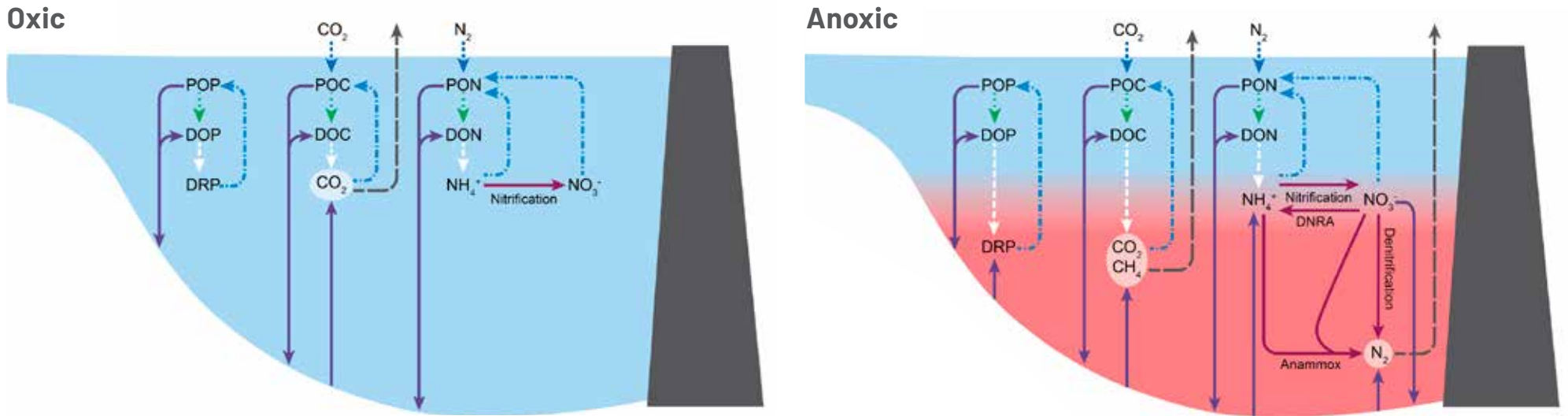
## Denitrification Process



**FIGURE 18:**

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>



**FIGURE 19:** 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<sub>2</sub>), dissolved organic carbon (DOC), methane (CH<sub>4</sub>), and particulate organic carbon (POC).

**Nitrogen processes** include cycling of dissolved organic nitrogen (DON), nitrogen gas (N<sub>2</sub>), ammonium (NH<sub>4</sub><sup>+</sup>), nitrate (NO<sub>3</sub><sup>-</sup>), 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 = particular organic phosphorus



Excessive nutrients provide for the prolific growth of algae and macrophytes throughout the Osbornes catchment waterways.



Sediment-laden runoff contributes contaminants such as *E. coli* and phosphorus to the drainage network and promotes high rates of fine sediment deposition.

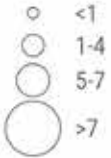


Water quality sampling at the pump station is used to represent the water quality of discharge from the catchment. Resource consent compliance reports indicate that DRP and *E. coli* are highly elevated in the discharge, while dissolved oxygen levels are very low. The discharge is also highly stained, with elevated levels of dissolved organic carbon.

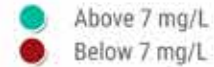


# Osbornes Catchment Water Quality: Dissolved Oxygen

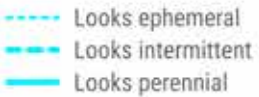
MEDIAN DISSOLVED OXYGEN (mg/L):



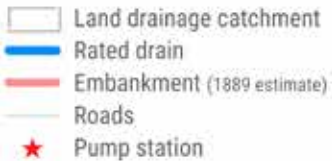
DISSOLVED OXYGEN (mg/L): Using LWRP spring fed plains



CHANNEL FLOW PERMANANCY:



OTHER:



Map © EOS Ecology, 2025 / [www.eosecology.co.nz](http://www.eosecology.co.nz)

Layer source: Water quality monitoring site (Environment Canterbury; Selwyn District Council), waterways & pump station (EOS Ecology), Osbornes rated drain & land drainage catchment (Selwyn District Council), hillshade (Land Information New Zealand; LINZ), roads (Esri vector tile service), embankment (Maw & Main; 1989), imagery (LINZ)

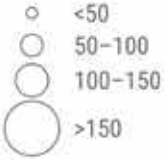


**FIGURE 20:** Spatial trends in dissolved oxygen (DO) concentrations within the Osbornes catchment. Median values are based on monthly monitoring by Selwyn District Council (2019–2024) and additional data from Environment Canterbury (2011–2012). Symbols are coloured according to Land and Water Regional Plan (LWRP) region wide limits for dissolved oxygen, with brown indicating values that do not meet the specified limit: above 7 mg/L for DO.

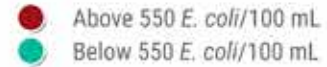


# Osbornes Catchment Water Quality: *E. coli*

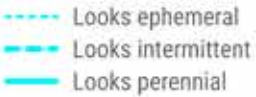
MEDIAN *E. coli* (PER 100 mL):



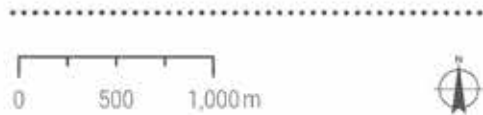
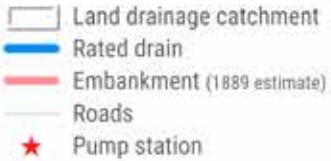
*E. coli* (PER 100 mL): Using LWRP spring fed plains



CHANNEL FLOW PERMANANCY:



OTHER:



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

Layer source: Water quality monitoring site (Environment Canterbury; Selwyn District Council), waterways & pump station (EOS Ecology), Osbornes rated drain & land drainage catchment (Selwyn District Council), hillshade (Land Information New Zealand; LINZ), roads (Esri vector tile service), embankment (Maw & Main; 1989), imagery (LINZ)

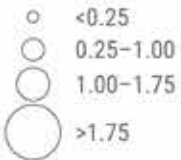


**FIGURE 21:** Spatial trends in *E. coli* concentration within the Osbornes catchment. Median values are based on monthly monitoring by Selwyn District Council (2019–2024) and additional data from Environment Canterbury (2011–2012). Symbols are coloured according to Land and Water Regional Plan (LWRP) receiving water standards for *E. coli*, with brown indicating values that do not meet the specified standard: below 550 *E. coli*/100 mL for *E. coli*.



# Osbornes Catchment Water Quality: Dissolved Reactive Phosphorus (DRP)

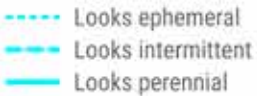
MEDIAN DRP (mg/L):



DRP (mg/L): using LWRP spring fed plains:



CHANNEL FLOW PERMANENCY:



OTHER:



Map © EOS Ecology, 2025 / [www.eosecology.co.nz](http://www.eosecology.co.nz)

Layer source: Water quality monitoring site (Environment Canterbury, Selwyn District Council), waterways & pump station (EOS Ecology), Osbornes rated drain & land drainage catchment (Selwyn District Council), hillshade (Land Information New Zealand; LINZ), roads (Esri vector tile service), embankment (Maw & Main; 1989), imagery (LINZ)



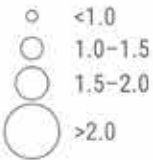
**FIGURE 22:**

Spatial trends in dissolved reactive phosphorus (DRP) within the Osbornes catchment. Median values are based on monthly monitoring by Selwyn District Council (2019-2024) and additional data from Environment Canterbury (2011-2012). Symbols are coloured according to Land and Water Regional Plan (LWRP) receiving water standards for DRP, with brown indicating values that do not meet the specified standard: below 0.016 mg/L for DRP.



# Osbornes Catchment Water Quality: Total Phosphorus (TP)

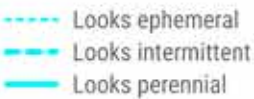
MEDIAN TP (mg/L):



TP (mg/L): using ANZG 2018 - cool dry low elevation



CHANNEL FLOW PERMANANCY:



OTHER:



Map © EOS Ecology, 2025 / [www.eosecology.co.nz](http://www.eosecology.co.nz)

Layer source: Water quality monitoring site (Environment Canterbury; Selwyn District Council), waterways & pump station (EOS Ecology), Osbornes rated drain & land drainage catchment (Selwyn District Council), hillshade (Land Information New Zealand; LINZ), roads (Esri vector tile service), embankment (Maw & Main; 1989), imagery (LINZ)



**FIGURE 23:**

Spatial trends in total phosphorus (TP) within the Osbornes catchment. Median values are based on monthly monitoring by Selwyn District Council (2019-2024) and additional data from Environment Canterbury (2011-2012). Symbols are coloured according to the New Zealand Guidelines for Fresh and Marine Water Quality (ANZG) default guideline values for TP, with brown indicating values that do not meet the specified guideline: below 0.014 mg/L for TP.

### 3.3 Cultural Values

Te Waihora (Lake Ellesmere) is a significant tribal taonga and mahinga kai of the utmost cultural importance to Ngāi Tahu Whānui. The bed of Te Waihora is owned by Te Rūnanga o Ngāi Tahu, following it being returned to the iwi as part of the Ngāi Tahu Claims Settlement Act 1998. The adjoining conservation land administered by the Department of Conservation, along with the Ngāi Tahu lakebed, is managed jointly under the Te Waihora Joint Management Plan 2005.

Te Taumutu Rūnanga, Te Ngāi Tūahuriri Rūnanga, Wairewa Rūnanga, Te Rūnanga o Koukourāta, Te Hapū o Ngāti Wheke Rūnanga, and Ōnuku Rūnanga are recognised as the kaitiaki Papatipu Rūnanga of Te Waihora, and work together with Te Rūnanga o Ngāi Tahu in managing Te Waihora and its catchment (formerly through the Te Waihora Management Board).

The Whakaora Te Waihora Co-Governance Agreement was first signed in 2012 and provides for a partnership between the Kaitiaki Papatipu Rūnanga, Te Rūnanga o Ngāi Tahu, Environment Canterbury, SDC, Christchurch City Council and the Department of Conversation. The Co-Governance partners implement a joint work programme, of which the Osbornes catchment is one element, led by the SDC.

Te Waihora and its surrounding tributaries continue to sustain a plentiful amount of taonga species and habitats, including many mahinga kai species. They represent a highly valued cultural landscape. Protecting, restoring and protecting this cultural landscape is of significant importance to manawhenua.

As a key mahinga kai resource for Ngāi Tahu (and especially the kaitiaki rūnanga), the health and amount of mahinga kai present within Te Waihora and its tributaries is a significant issue. Within the Osbornes catchment, plant, fish, and bird taonga species are found within or adjacent to the drainage system.

The discharge of contaminated and poor-quality water from Osbornes Drain into Te Waihora has adversely affected the lakebed and the broader ecosystem. This has been formally acknowledged as a significant concern by Ngāi Tahu, and particularly Te Taumutu Rūnanga, through the Cultural Impact Assessment<sup>1</sup> that was prepared for SDC's resource consent application for discharges related to land drainage activities in the Osbornes catchment.

The health and abundance of taonga species and mahinga kai have been compromised by land drainage and associated activities, threatening the cultural landscape and the ability to maintain traditional practices.

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<sup>1</sup> Te Taumutu Rūnanga, Tipa & Associates (2015). Cultural Impact Assessment for Osbornes Drain Discharge Consent Application.

Infrastructure such as drains, culverts, and the pump station impede the migration of taonga fish species. This disrupts their life cycles and diminishes their presence in the ecosystem.

There is ongoing concern from Te Taumutu Rūnanga and other kaitiaki rūnanga that simply improving the quality of water entering Te Waihora is not enough. The quality of water within the drainage network and leaving individual properties must also be addressed, requiring both catchment-level and on farm interventions and mitigation.

The Cultural Impact Assessment from the Osbornes Drain resource consent application identifies the following priorities for manawhenua:

- Protecting the quality of the waters of the Te Waihora and its tributaries.
- Restoration of lands and waters around Osbornes Drain which potentially could have an impact on Te Waihora.
- Establishing or restoring native habitats of taonga species, including mahinga kai.
- Breaking down the mitigations into measurable milestones so that improvements can be monitored.
- Identifying the individual on farm interventions that are going to reduce the inputs to the drainage system.
- Protecting indigenous biodiversity, in particular taonga species – restoring or enhancing native biodiversity leads to cultural outcomes.

To achieve these priorities, manawhenua are committed to the following:

- Protecting and restoring the quality of the waters of Te Waihora.
- Protecting the wāhi taonga or wāhi tapu present within and adjacent to Osbornes Drain.
- Protecting sites of significance within Te Waihora.
- Protecting, increasing and enhancing waterways and waterbodies with native species. This in turn creates native habitat for taonga species and provides cultural outcomes.



Aerial photo of Te Waihora/Lake Ellesmere

Image source: Department of Conservation

## 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 processes under which the lake is able to be opened. The level of Te Waihora/Lake Ellesmere is managed relative to mean sea level. 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, 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 Osbornes catchment in the future.

National climate projections for Aotearoa New Zealand were updated by NIWA 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](http://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://d11pepq1a2249p5.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 for areas close to Te Waihora/Lake Ellesmere (such as the Osbornes catchment). An increase in sea level would either increase the lake levels or would result in the lake needing to be opened more frequently to maintain the lower lake levels, with higher lake levels being expected to reduce the effectiveness of the land drainage network around the lake (Dudley Ward *et al.*, 2023). Higher lake levels would influence the drainage network by flooding of land adjacent to the lake, by causing backwater effects that would propagate further up the land drainage waterways (Dudley Ward *et al.*, 2023), and by reducing the effectiveness of pumped drainage operations. 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 Osbornes catchment, and it is evident that the drainage scheme has limited capacity to cope with this during extreme events (Table 10; Figure 24).

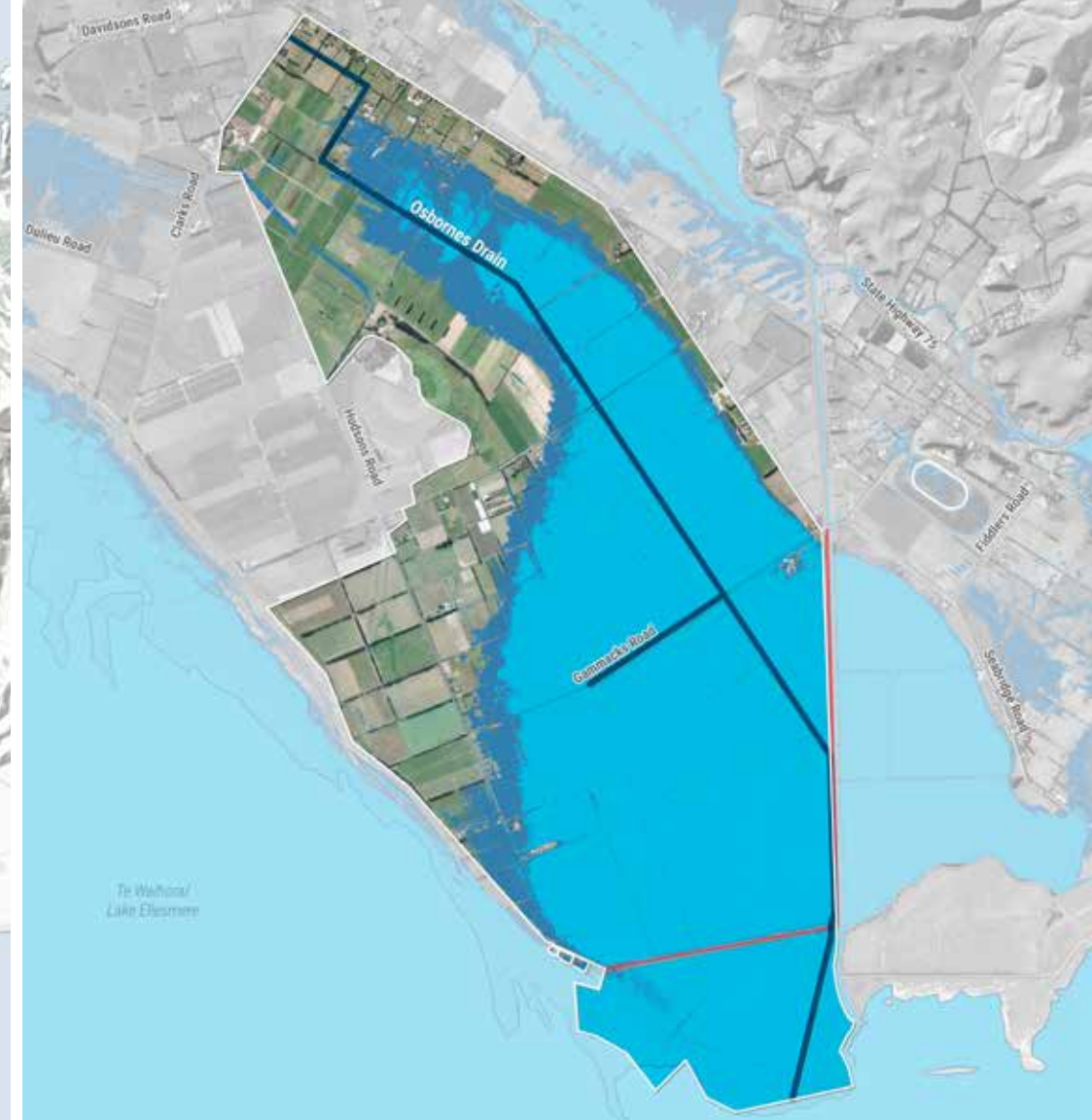
**TABLE 10:**

Indicative area and percentage of Osbornes catchment that was subject to inundation during the June/July 2013 flood event, and indicative area and percentage of Osbornes catchment land that would be inundated under the median projected sea level rise for the Te Waihora/Lake Ellesmere catchment at 2050 (under SSPS-8.5). *Note: based on district-scale modelling and not ground-truthed in the Osbornes catchment.*

	Area ha	% of Osbornes Catchment
<b>2013 flood extent</b>	1,000	56
<b>2050 median projected sea level rise under SSPS-8.5</b>	1,200	68

**FIGURE 24:** ▶▶▶▶▶

Indicative extent of land inundation during the June/July 2013 flood event that affected the Osbornes catchment and surrounding areas, from district-scale analysis. Also shown is the indicative extent of inundation with a similar event for Osbornes catchment, 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>).



## 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



Map © EOS Ecology, 2025 / [www.eosecology.co.nz](http://www.eosecology.co.nz)

Layer source: June/July 2013 flood extent, sea level rise projection (Aqualinc), hillshade (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)

## Osbornes Catchment Sea Level Rise

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

OTHER:

- Land drainage catchment
- Rated drain
- Embankment (1889 estimate)
- Roads



Map © EOS Ecology, 2025 / [www.eosecology.co.nz](http://www.eosecology.co.nz)

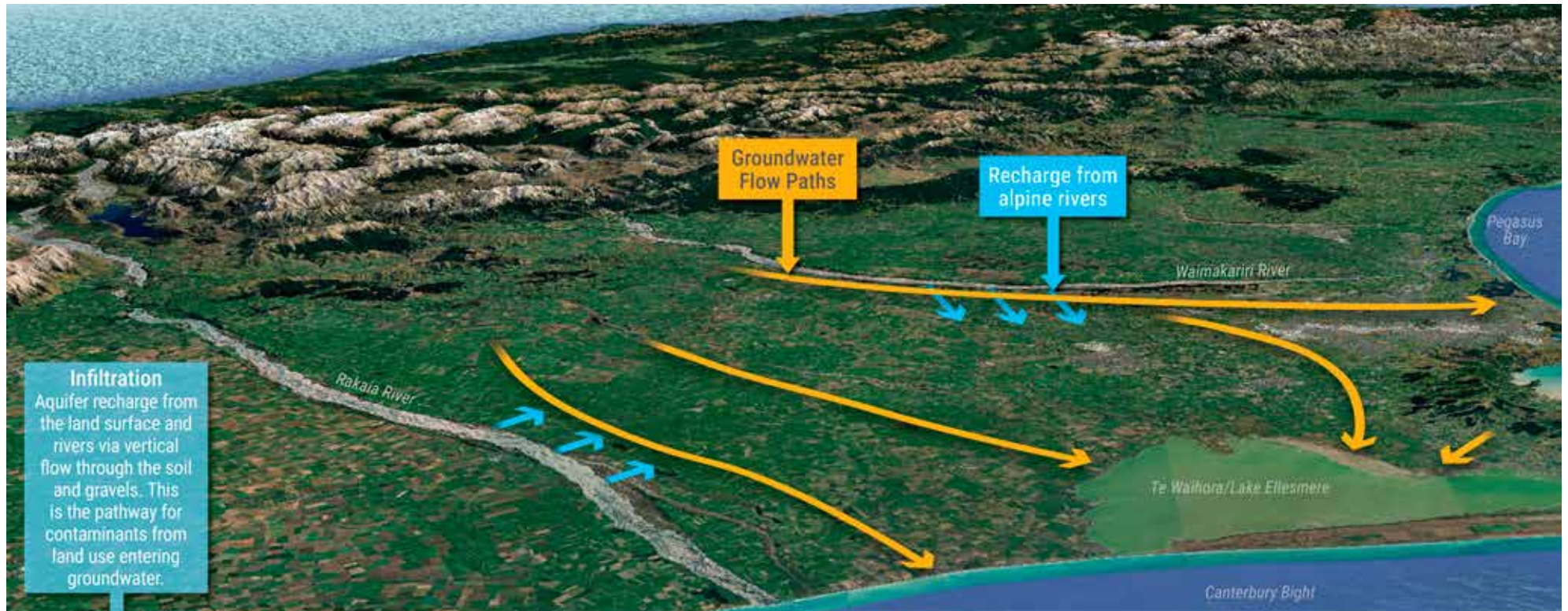
Layer source: June/July 2013 flood extent, sea level rise projection (Aqualinc), waterways (EOS Ecology), Osbornes rated drain & land drainage catchment (Selwyn District Council), hillshade (Land Information New Zealand; LINZ), roads (Esri vector tile service), embankment (Maw & Main; 1989), imagery (LINZ)

## 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 25). 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 east 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 25). Artesian aquifers underlie most of the lowland drainage schemes within the Selwyn District (Dudley Ward *et al.*, 2024). Osbornes catchment differs from these 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 Osbornes catchment shallow unconfined aquifer are closely linked to the level of Te Waihora/Lake Ellesmere.

The surface water catchment and the rated drainage catchment for the Osbornes catchment are a similar size and shape. The groundwater catchment boundaries are difficult to define clearly; while it is likely to be larger than the surface catchment, it is probably connected to a smaller area of the Plains than other drainage catchments further to the west around Te Waihora/Lake Ellesmere. Plains groundwater is unlikely to significantly discharge into the catchment and affect surface water quality (Figure 24) to a significant extent. 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 surface water catchment level. This issue is discussed in greater detail in Section 5.5.1.

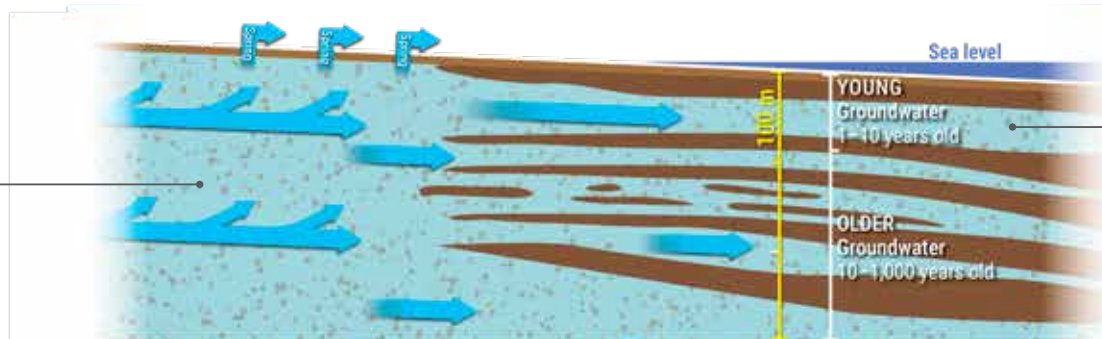
**FIGURE 25:**  Hydrological context of the Te Waihora/Lake Ellesmere catchment in relation to groundwater interactions.



**Infiltration**  
 Aquifer recharge from the land surface and rivers via vertical flow through the soil and gravels. This is the pathway for contaminants from land use entering groundwater.

**Groundwater Flow Paths**

**Recharge from alpine rivers**



**UNCONFINED AQUIFER**  
 Aquifers with an underground layer of rock/sediment that groundwater flows through. Water flows through the small spaces between sand and stones. It flows downhill like water above ground, but at a much slower pace – perhaps a few metres a day.

**CONFINED AQUIFERS**  
 Confined aquifers occur between densely-packed fine sediment deposits. This means that smaller quantities of water moves between layers.



Channel maintenance

Image source: Aqualinc

## 5 Pressures & Current Challenges/Issues

### 5.1 Communication

The Osbornes rated drainage scheme area covers an area of 1,781 ha, with 82 rated properties contributing to the costs of operating the scheme for the 2023/2024 financial year (SDC, 2024a). This includes 35 large properties (>4 ha), 43 medium-sized properties (>2.33 and <4 ha), and four smaller properties (<2.33 ha). Among these rated properties there is a range of land uses (see Section 3.2.1), from large scale irrigated dairy farms to much smaller scale lifestyle farming. There is also a wide range of landowner experience within the catchment and the depth of local knowledge that landowners in the catchment hold is highly variable. There are opportunities to improve communication with landowners in this catchment; this will enhance the ability to achieve the vision that the Osbornes Drain Catchment Management Working Party have set out for this catchment.

Effective management of the Osbornes drainage waterways relies on a shared understanding of environmental responsibilities. Some of the challenges encountered include the filling of drains that may frequently appear dry but play a crucial role in the drainage scheme during wetter years. Similarly, new drains are sometimes created without full awareness of their potential downstream effects or the need for resource consent. Clarifying the division of waterway maintenance responsibilities between SDC and private landowners may help to support a well-functioning drainage system.

There can be uncertainty around what maintenance activities are appropriate in waterways outside the rated drainage system. This can be more pronounced when land ownership changes, as new owners take time to familiarise themselves with local requirements. Providing guidance and support can help landowners make informed decisions, such as adopting vegetation management practices that maintain channel stability and minimise erosion. Differing expectations about what the rated drainage scheme does and does not provide is another challenge in the Osbornes catchment. For example, the function of the Osbornes rated drainage scheme is primarily land drainage and not flood control, but this difference can be misunderstood.

Another challenge for this catchment is communicating the unique water quality issues affecting Osbornes Drain to landowners. Contaminants not only originate from land runoff in this catchment, but also from processes within the slow flowing or ponded reaches of the drainage waterways, where anoxic conditions can develop and lead to high contaminant concentrations. Communicating these processes to landowners in a clear and accessible manner, and outlining practical steps that landowners and the SDC can take to reduce these impacts, presents a valuable opportunity for community engagement

## 5.2 Localised Flooding & Wet Ground

The low-gradient drainage waterways in this low-elevation catchment contribute to persistent challenges around localised flooding and wet ground within Osbornes catchment (Section 4.1; Figure 26). Most of the catchment is occupied by farming land uses (Figure 7; Table 2), while over 90% of the soils within the catchment are classified as poorly drained (Figure 10; Table 4). Therefore, the land drainage network is essential for maintaining the productive capacity of farmland in this catchment. However, localised flooding is still an issue in some parts of the catchment, and some parts of the catchment are more sensitive to water level changes than others. Shallow ephemeral or intermittent drains in the upper catchment tend to have low water storage capacity and localised blockages of these waterways can create surface water flooding of surrounding areas when water is unable to flow away fast enough during rain events. For these small unrated drains with temporary flow, there may be no routine/preventative maintenance and it can be difficult to identify blockages and issues during dry weather. Even when localised flooding occurs during wet weather, the causes may not be evident and can sometimes be misinterpreted. Increased understanding of the locations of formalised drains and informal flow paths in this catchment, as well as some maintenance guidance for the ephemeral or temporary waterway types, may improve this situation. For example, maintaining fence lines free of obstructions will be an important tool for these temporarily flowing waterways, as they are often crossed by fence lines that can obstruct the flow during rain events.

The operation of the pump station has a significant effect on water levels throughout the catchment, but particularly in the downstream sections of the drainage waterways. In the absence of pumping, water pools upstream of the pump station and backs up the drainage waterways at the lower end of the network. Therefore, the pumping schedule and the waterway levels in the drainage waterways have a strong influence on flooding or wet ground for the land adjacent to these sections of the waterway network. Higher water levels within the drainage waterways potentially result in more waterlogged soils, greater soil pugging, and more sediment entering waterways.



**FIGURE 26:** Significant rainfall during June 2013 resulted in significant inundation of low-lying land in the Osbornes catchment. Image source: Selwyn District Council

## 5.3 Maintenance

The low-gradient drainage waterways in this low-elevation catchment contribute Selwyn District Council commissions regular maintenance of the rated drains within the Osbornes catchment. This work has recently been guided by a standard operating procedure (Wilson, 2024) which includes requirements around the timing and methods to be used for silt and macrophyte removal with an excavator, the trimming of riparian vegetation to allow access for the excavator, and the requirements around spraying within the riparian area. However, land drainage maintenance records are not currently captured within SDC's Asset Management System and as a result this knowledge is limited to those who are commissioning or doing the work. This becomes an issue if an individual leaves the maintenance team, as they take the knowledge with them.

The purpose of the SDC maintenance work is to maintain the drainage function of the waterways in the face of challenges such as excessive fine and organic sediment and instream plant growth (Figure 27). Even so, during periods of heavy rainfall, farmland in parts of the catchment may become inundated with water, as the drains do not always convey the increased volumes of water quickly enough to prevent this. During wet weather, bare ground adjacent to the drains tends to become a major source of fine and organic sediment, contributing to the excessive quantities of sediment that accumulate within the land drainage waterways.

It is estimated that the network of rated drains within Osbornes catchment make up around 9% of the waterway length in the catchment, with the remainder of the almost 120 km of waterways in the catchment being unrated (Table 6). This presents a substantial challenge in terms of the consistency and suitability of maintenance practices across the catchment, with individual landowners being responsible for such a large proportion of the catchment's drainage waterways. To achieve the vision of the CMP, many of the tools and solutions proposed will need to be implemented on unrated drains. Collaboration with landowners will be key to ensuring these interventions are effective and sustainable. By factoring maintenance requirements into the design from the outset and working closely with landowners, these solutions can be successfully integrated into existing drainage management practices. Developing private maintenance plans in partnership with landowners will help ensure long-term success, with landowners playing a key role in maintaining records and upkeep of these interventions. This highlights the importance of establishing smart systems for scheduling and recording maintenance, as this information is likely to be crucial for measuring the success of the CMP and for meeting the requirements of existing and potential future consents to discharge from the Osbornes catchment.

Standard operating procedure dictates that contractors must maintain the streambed profile and retain bank vegetation when cleaning drainage waterways.



The primary purpose of maintenance work within the drainage network is to maintain the drainage function of the waterways, but bare ground adjacent to waterways may become a source of fine sediment.



Rated drains make up only 9% of the waterway length within the Osbornes catchment, so the maintenance of unrated and private drains is a challenge for this catchment.



**FIGURE 27:** Images illustrating maintenance issues in Osbornes catchment.

## 5.4 Sediment Accumulation & Removal

The low-gradient drainage waterways in this low-elevation catchment contribute Selwyn District Council Another major challenge for management in the Osbornes catchment is excessive quantities of deposited fine inorganic and organic sediment. Fine sediments accumulate on the bed of the drainage channels, with ongoing sediment supply provided by the erosion of steep/slumping banks, runoff from farms via informal flow paths (also known as critical source areas), runoff from gravel roads, and stock access to drainage waterways (Figure 28). Fine sediment consists of both organic material, such as decaying plant matter, algae, and animal waste, and inorganic particles such as silt and clay. As a result of the input of fine sediment and the lack of regular flushing potential due to slow-flowing or standing water and a discharge controlled by a pump station, channel substrates typically include a deep layer of fine sediments, with significant accumulations extending throughout the catchment waterways and downstream to the pump station forebay. The accumulated fine sediment impacts on both the water quality and habitat of these drainage waterways.

The sediment that accumulates in these waterways is mechanically removed as effectively as possible to maintain the drainage function of the waterways. However, fine sediment is also a major source of dissolved contaminants. Mechanical removal of fine sediment therefore has an additional role in improving water quality in this catchment. Yet conventional sediment removal methods are often ineffective at removing these fine, ooze-like sediments and present additional challenges for the catchment, particularly in parts of the drainage network that hold permanent water. The mechanical removal of sediment has the potential to cause over-steepening of banks and to remove bank vegetation, but these issues can be minimised by following relevant guidance. To reduce the potential for maintenance to exacerbate existing issues within the catchment, SDC has recently updated their standard operating procedure (SOP) for drain maintenance in Osbornes catchment (Wilson, 2024). The SOP includes guidance on undertaking drain cleaning when the

waterway is dry if possible, removing cut weed from the channel, maintaining the channel profile, retaining bank vegetation, using a slotted bucket for silt removal, and not depositing sediment within 1 m of the top of the bank (Wilson, 2024). Fish salvage and relocation to the Halswell River is also detailed as part of the SOP, to be undertaken when cleaning of a wet drain is unavoidable, as it will be for the perennial sections of the drainage network .

Although sediment removal has been occurring within the Osbornes drainage waterways for much of its history, there is a lack of clarity around how much of the existing fine sediment load in the drainage network is legacy sediment, compared with what is coming off the catchment under present day management. For this reason, SDC completed a comprehensive sediment removal programme during November 2024, which will enable the setting of benchmarks for the monitoring of ongoing sediment accumulation at key locations in the catchment. The quality of this sediment has been tested to confirm its suitability for placing back on the surrounding farmland. Given the influence of organic sediment on water quality, it would also be helpful to have the proportion of inorganic versus organic sediments confirmed.

# Sediment Inputs



Steep banks without vegetation cover are a source of fine sediment to the drainage waterways.



Banks that are regularly sprayed are an ongoing source of sediment to the drainage channel.



Runoff from farm tracks and gravel roads becomes a source of fine sediment during and after rainfall.



Ephemeral drainage waterways that are dry most of the time become sources of sediment during rainfall as they channel overland runoff to downstream waterways.

**FIGURE 28:**  
Images illustrating sediment inputs to waterways in the Osbornes catchment.

## 5.5 Water Quality

### 5.5.1 Relative Influence of Issues from Outside vs Inside the Catchment

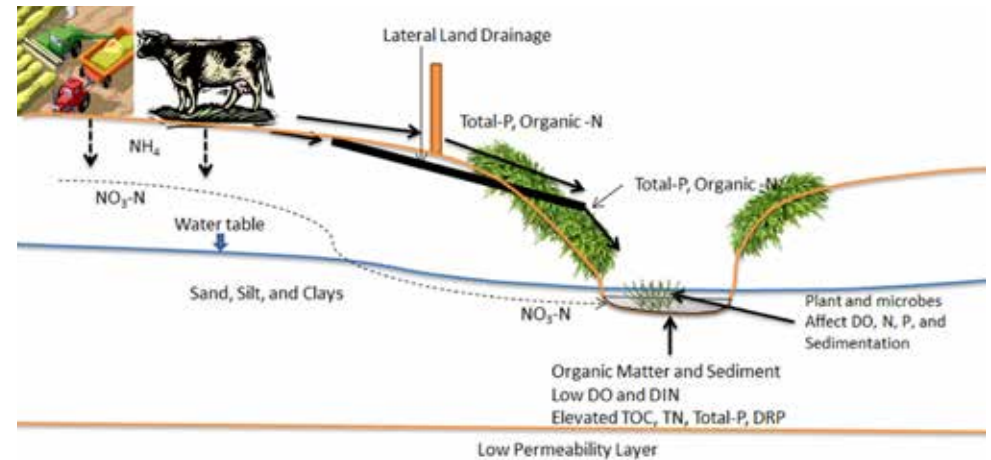
Rural land use dominates the catchments that flow into Te Waihora/Lake Ellesmere and there has been substantial intensification and an increase in irrigated area over the last three decades. In Aotearoa New Zealand, the number of dairy cattle has increased by 70% between 1994 and 2017 (MfE & Stats NZ, 2020), with dairy farm conversions and intensification accommodating this increase in animal numbers. With farm intensification, there has also been a need to maintain soil moisture levels to maintain agricultural production. In the Canterbury Region, there has been an over 200% increase in total irrigated area for dairy farms between 2002 and 2019 (Stats NZ, 2022). The increased use of synthetic fertilisers also typically follows on from farm intensification, and this has contributed to water quality declines in many catchments. Acknowledging that catchments typically contain a mixture of activities and land cover types, MfE & Stats NZ (2020) provides categories based on the dominant land cover in a catchment. Based on this system, the Osbornes catchment is classified as pastoral, with no urban land cover, and with pastoral land covering the largest proportion of the catchment. In Aotearoa New Zealand, most of the rivers in the pastoral category are polluted with excess nutrients, suspended sediments, and pathogens (MfE & Stats NZ, 2020; MfE & Stats NZ, 2023). Although water quality trends are improving for some pastoral areas, there is still declining or unchanged water quality evident for most pastoral catchments.

Land use change and intensification within the wider Te Waihora/Lake Ellesmere catchment generally has an influence on groundwater quality that may cross the boundaries of surface water drainage catchments. Although shallow groundwater and springs monitoring sites within the wider Te Waihora/Lake Ellesmere catchment do show elevated concentrations of nitrate-N (Alexander, 2023), the lack of springs and the hydrological context of the Osbornes catchment suggest that it may function largely independently of the greater catchment (see Section 4.2). Research for the Osbornes catchment agrees that based on the water chemistry and hydrology of the catchment, significant groundwater inflow from the regional system is unlikely (GHD, 2015). Further, rainfall runoff is likely to account for greater than 60% of the discharge of the drainage network (GHD, 2015). Despite this, there is a perception within the Osbornes catchment community that external land use and water quality issues are having a major effect on water quality within the catchment, which is a concern that should be addressed through engagement with the local community (see Section 5.1).

## 5.5.2 Discharge of Poor-quality Water to the Receiving Environment

Land drainage water from within the Osbornes catchment area flows within both rated and unrated drainage waterways to a pump station at the downstream boundary of the catchment. Water discharges from the pump station into a channel that leads to Te Waihora/Lake Ellesmere (Figure 29). This discharge into Te Waihora/Lake Ellesmere is authorised by resource consent CRC172231, which commenced in February 2017 and expires during February 2027 (Section 2.2). Under this consent, water discharged to Te Waihora/Lake Ellesmere must meet the water quality limits set out in the resource consent (Section 3.2.7). However, the objectives for the discharge extend beyond these compliance parameters. The intent is to also ensure that the discharge does not appear conspicuous (e.g., highly coloured) or contain a broad range of contaminants harmful to Te Waihora/Lake Ellesmere, such as high concentrations of dissolved organic carbon (DOC) or total nitrogen (TN).

Within the Osbornes drainage waterways, the key compliance contaminants of concern are phosphorus and nitrogen, although low dissolved oxygen and high turbidity are also issues for water quality and nutrient concentrations are also elevated in sediments (GHD, 2015). While the volume of water discharged from Osbornes catchment is small in comparison to the volumes entering Te Waihora/Lake Ellesmere from other waterways such as the Waikirikiri/Selwyn, Ararira/LII, Waitatari/Harts Creek, and Huritini/Halswell, pumping data suggests that most of the discharge volume from Osbornes catchment originates from overland flow, rather than base flow and lateral seepage from the groundwater system (GHD, 2015). Further, the water chemistry in Osbornes catchment differs from that of other nearby spring-fed streams that discharge into Te Waihora/Lake Ellesmere, as the spring fed streams receive much more inflow from groundwater, while Osbornes drainage waterways are estimated to receive greater than 60% of their volume from runoff from the surrounding land (GHD, 2015). Consequently, water quality in the drain is strongly influenced by organic matter, nutrients, and sediment entering the drain from surrounding land during rain events. These components also accumulate within the drainage network, where stagnant conditions promote the generation of even higher contaminant concentrations.



Conceptual model of inputs to Osbornes catchment – from GHD (2015).



Water is discharged from Osbornes catchment via a pump station and passes through an area of raupō wetland before it reaches Te Waihora/Lake Ellesmere.

**FIGURE 29:** Images illustrating poor water quality entering the receiving environment.

### 5.5.3 Water Quality Issues Related to Land Use Legacy & Standing Water

Much of the land area within the Osbornes catchment was once a shallow bay flooded by the waters of Te Waihora/Lake Ellesmere (Figure 5; Figure 6). While constructed embankments protected this very low gradient land from inundation by the lake, there was a need for drainage of both rainfall and groundwater from the catchment, and for the leaching of legacy salt from soils to improve pasture for grazing. For this reason, many of the waterways in the Osbornes catchment are ephemeral (only flow temporarily, during and briefly after rainfall) or intermittent (flow during the wetter seasons of the year when groundwater levels are higher and tend to be dry during the summer). Only the main Osbornes Drain retains water year-round (i.e., has a perennial ‘flow’) in this drainage catchment, and even this waterway has a very low gradient, very low water velocities, long lengths of standing water, and appears to be intermittent in its upper reaches (Table 6; Figure 12).

Extended periods of dry weather and low groundwater levels in recent years have demonstrated how dry these waterways can be, and newer members of the community may see this as the normal state for this catchment. However, longer-term residents of the catchment will have observed how much higher groundwater levels can get and how necessary the drains are during wetter years. These changes over time will only get more challenging as climate change brings greater extremes of both wet and dry periods to this area.

The predominance of standing (rather than flowing) water in the perennial reaches of the drainage waterways is also a key factor that contributes to poor water quality (Figure 30). In this flat catchment with a pump station controlling the discharge to the lake, standing water and high organic sediment content contributes to low dissolved oxygen levels and high water temperatures, as well as affecting nutrient cycling (causing a greater release of some nutrients and binding of others).

Many of the drainage waterways within the Osbornes catchment are dry for much of the time, as they are ephemeral or intermittent waterways.



Low water velocities encourage instream vegetation such as floating sweetgrass in perennial drainage waterways.



Prolonged standing water and high organic content in sediments contributes to low dissolved oxygen levels, elevated water temperatures, high plant growth, and contaminants generated under anaerobic (reducing) conditions.



**FIGURE 30:** Images illustrating the challenges of low flows in waterways in the Osbornes catchment.

## 5.6 Macrophytes

Many parts of the Osbornes catchment experience excessive growth of macrophytes within the channel (Figure 31). Excessive macrophyte growth tends to be associated with slow-flowing or standing water but has also been observed in intermittent waterways. The most commonly observed macrophytes include monkey musk (*Mimulus* sp.), watercress (*Nasturtium* sp.), couch/twitch (*Elytrigia repens*), as well as floating grasses that frequently obscure the water surface. Free floating duckweed (*Lemna* sp.) is also common where there is standing water, such as in the forebay upstream of the pump station. Excessive macrophyte growth usually indicates a system not limited by sunlight or nutrients. When fast-growing emergent species predominate it can limit the drainage capacity of the catchment waterways, whilst blanketing floating species can limit reaeration of the water and exacerbate stagnant, anoxic conditions. Although macrophyte growth in drainage waterways can absorb nutrients and thus improve water quality, in Osbornes Drain the negative impacts of macrophytes are likely greater than the benefits. However, there is potential for the use of wetlands as a tool for improving both biodiversity values and helping with nutrient uptake (Section 7).

Floating grasses blanketing the still water in the middle reaches of Osbornes Drain.



Emergent macrophytes in an intermittent section of channel.



Free floating duckweed (*Lemna* sp.) is common where there is standing water, such as in the ponded area upstream of the pump station.



**FIGURE 31:** Images illustrating the abundant growth of macrophytes within the Osbornes catchment.

## 5.7 Temporary Location of Drainage Waterways

Within the Osbornes catchment, there are many ephemeral or intermittent drains that are not in a permanent location (Figure 32). 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 location 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 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 this catchment, and the general approach will be to locate interventions only on waterways that are permanently located.



Temporary waterways tend to follow fence lines within the Osbornes catchment and these waterways are dry for much of the time.

**FIGURE 32:** Images illustrating the challenges of temporary waterways in the Osbornes catchment.

## 5.8 Pump Station

The pump station at the lower end of the Osbornes catchment (Figure 33) is a unique feature in the greater Te Waihora/Lake Ellesmere catchment and presents several challenges for catchment management. The discharge from the pump station is authorised by consent CRC172231, which allows SDC to discharge drainage water from the Osbornes catchment area via the pump station into Te Waihora/Lake Ellesmere. There are two pumps operating at the Osbornes pump station, which were recently replaced; each pump currently has a potential discharge capacity of 566 L/s (from 2020 onwards) (SDC, 2024c). During the 20-month period between 1 May 2022 and 31 December 2023, the first pump was operated for 1,226.17 hours and the second pump for 386.43 hours, resulting in a total discharge volume of 3,285,834 m<sup>3</sup> (SDC, 2024c). However, the discharge from the pump station is not continuous, nor evenly distributed throughout the year. Previous reports have indicated that most of the pumping hours occur during the wetter months of the year, with up to 75% of the discharge occurring between June and September and around 50% of the pumping in the months of July and August (SDC, 2016).

The discharge consent includes several exclusions, along with water quality limits and targets. These conditions were established to address conspicuous and detrimental water quality attributes associated with the discharge from the pump station to Te Waihora/Lake Ellesmere. The consent specifies water quality targets for year five (2022) and at expiry (year ten; 2027) to ensure issues are resolved and to enable a straightforward renewal process. However, to date there has been little, if any, improvement in discharge water quality. This CMP outlines steps aimed at contributing to the required improvements .

The discharge consent also creates some challenges, such as how to exclude properties that are not authorised to discharge under this consent, and the consequences of water backup if pumping is required to cease under this consent. In addition, the intermittent operation of the pump station creates its own issues, including water stagnation, the backup of flow within the drainage network, and the inability to protect fish from impeller damage and provide for fish passage. Further challenges exist downstream of the pump station, where there is no clear dispersal path for the discharged water and the extensive raupō growth sometimes causes water to back up and put pressure on the pumps. In this area, there may be tensions between the benefits (habitat and water quality improvement) and disadvantages (drainage function) of the raupō wetland.

Pump stations are known to have significant impacts on the passage of migratory fish, particularly where there is no channel to bypass the pump (as is the case at Osbornes pump station). Pump stations may act as a complete barrier to upstream fish migration and only enable fish to move downstream by passing through the pump (Franklin *et al.*, 2024). Fish that pass through non-fish-friendly pump stations experience high levels of serious strike injury or death. The Osbornes pump station is not a fish-friendly design, lacks a bypass channel, and as a condition of the current resource consent includes an upstream inlet screen and downstream flap gate to impede the access of fish to the pump station, which should mean that there is complete barrier to upstream and downstream fish migration. The resource consent stipulated five years of fish salvage and relocation in the perennial lower reaches of the Osbornes catchment. Despite this effort, eel numbers remain stable, indicating either a substantial resident population, or ongoing recruitment pathways. The matter of fish passage into the Osbornes catchment remains a difficult one. Replacing the existing pump with a fish-friendly option would prevent injury and mortality of fish passing downstream out of the catchment. However, facilitating fish passage into the catchment may only encourage fish into an area with poor habitat and particularly low dissolved oxygen levels that could limit survival of some fish species. As such, whilst fish-friendly pump alternatives for downstream fish passage are important, facilitating fish access into the Osbornes catchment is not a short-term priority for the Osbornes Drain Catchment Management Working Party. However, as conditions in the catchment's waterways improve then providing fish passage will become more important.



Extensive raupō growth downstream of the pump station may limit the dispersal of discharged water but provides water quality and habitat benefits.



The Osbornes pump station is not a fish-friendly design, nor does it have a bypass channel. An upstream inlet screen and downstream flap gate were installed as a condition of the current consent to impede the access of fish to the pump station.

**FIGURE 33:**  
Images of the Osbornes pump station and surrounding area.

## 5.9 Lack of Space Around Drains

Within the Osbornes catchment, drainage waterways have been developed primarily through farmland and, in some cases, alongside roads and accessways (Figure 34; Figure 35). Many drains are deep, with steep banks, making interventions more challenging. Undertaking interventions within these waterways may require additional adjacent land, which may encroach on farmland. On-farm drains typically have minimal setbacks because of the high value of productive land, while roadside drains may be constrained by narrow corridors, roadways, and power poles (Figure 34; Figure 35). 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. However, there is a strip of land available for drainage management adjacent to the Osbornes main channel (Drain Reserve Survey Office Plan 1318, south of Jarvis Road) which provides an opportunity for channel reshaping without a significant contribution of private land. Throughout the Osbornes catchment, vegetation is the primary constraint on available space around drainage waterways (Table 11). Power poles and roads within 5 m of the mid-channel have a relatively minor impact, affecting less than 60 m of perennial or intermittent drainage waterways for roads, and only 118 m of intermittent waterways for power poles. In contrast, over 500 m of ephemeral waterways lie within 5 m of roads; however, these waterways are typically smaller, and interventions require less space to implement.

**TABLE 11:**  
Length of channel that is near power poles, substantial vegetation or trees, and roads for each waterway type.

Waterway Type	Length of Waterway Near Power Poles, Substantial Trees/Vegetation, Roads		
	Within 5 m Distance of Mid-channel		
	Perennial Drainage Waterways m	Intermittent Drainage Waterways m	Ephemera Drainage Waterways m
Power poles	-	118	146
Substantial vegetation or trees	678	5,328	13,499
Roads	20	35	548



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

**FIGURE 34:**  
Images illustrating the challenge of lack of space within the drainage network.



# Osbornes Catchment Waterways Adjacent to Roads & Power Poles

## POWER POLES:

- Within 5m of a waterway
- Other

## VEGETATION:

- Within 5m of a waterway
- Other

## ROADS:

- Within 5m of a waterway
- Other

## CHANNEL FLOW PERMANANCY:

- Looks ephemeral
- Looks intermittent
- Looks perennial

## OTHER:

- Land drainage catchment
- Embankment (1989 estimate)
- ★ Pump station



Map © EOS Ecology, 2025 / [www.eosecology.co.nz](http://www.eosecology.co.nz)

Layer source: Waterways, power poles, significant vegetation & pump station (EOS Ecology), lan drainage catchment (Selwyn District Council), hillshade (Land Information New Zealand; LINZ), roads (Esri vector tile service), embankment (Maw & Main; 1989), imagery (LINZ)



**FIGURE 35:**

Locations of power poles, roads, and significant vegetation within the Osbornes catchment, highlighting where these features are within a 5 m distance of waterways and may present limitations to implementation of tools and solutions.



Powerlines and fence lines limit space around this roadside channel

Image source: EOS Ecology



Misty view across  
Te Waihora/Lake Ellsemere

Image source: Stu Farrant

## 6 Solutions – Catchment-Scale Approach

With the goal of reimagining how the Osbornes 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 12). The following section (Section 7) details the specific ‘toolbox’ of interventions that are designed to mitigate some of the site-specific challenges facing the Osbornes catchment at present.

### 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 14).

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. As outlined in Section 2.2.1, properties discharging drainage water under the Osbornes Drain consent require an ILDCMP-approved FEP, 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. Previous reports for the Osbornes catchment have already recommended changes to land management approaches that align with transformative practice. For instance, the suite of recommendations for the Osbornes catchment by Lowe Environmental Impact (2015) includes several actions that fit well within this framework (Table 13).

**TABLE 12:**  
Overview of the catchment wide approaches recommended for use in the Osbornes catchment.

Intervention Name	Intervention Description	Type of Catchment-wide Approach					Contributes to Meeting Existing Consent Conditions
		Land Use Change	Farm Environment Plans/Better than Best Practice	On Farm Mitigation	Drain Maintenance Practices	Monitoring	
<b>Transformative practice</b>	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, avoiding subsurface drains, 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.		✓	✓			✓
<b>Land acquisition/ strategic land use change</b>	This would include options for realigning the lower end of Osbornes Drain, retreating from some parts of the catchment, and creating large scale wetlands.	✓					
<b>Smart systems for drainage monitoring</b>	Making use of 'smart' technology for improving the way that drains are maintained and managed. This would include establishing a drain monitoring network to benchmark changes in sediment and water quality and regular sampling for nutrients, dissolved oxygen, organic matter, and sediment depth. This information may be used to help identify sediment sources.					✓	✓
<b>Changing maintenance practices</b>	Including forming a strategy for the catchment wide approach to sediment removal from drains. This should include the avoidance of depositing dredged material on riparian zones to maintain effective vegetation and prevent remobilisation of fine sediments, investigating options for the disposal or reuse of sediment on farmland, and for testing of potential contaminants in excavated sediments.				✓		✓

**TABLE 13:**

Actions recommended for inclusion in Farm Environment Plans (FEPs) and Stormwater, Drainage and Watercourse Management Plans (SDWMPs) for landholdings within Osbornes catchment.

Recommendation	Details	Reference
<b>Managing subsurface drainage for reduced contaminant leaching</b>	Subsurface or mole drains do not appear to be in use in this catchment – if they are to be used in the future then guidance should be provided, including minimum depth of soil above drains to filter leachate and ensuring that drainage is paired with reach-scale tools or interventions downstream to provide for water quality improvement before the drainage water enters open waterways.	Lowe Environmental Impact (2015)
<b>Implement low/zero tillage practices</b>	Best practices for low/zero tillage of land in the catchment should be written into FEPs to reflect this catchment wide approach to reducing soil erosion and runoff. Low/zero tillage increases infiltration and reduces erosion and is particularly important for areas adjacent to drains.	Lowe Environmental Impact (2015)
<b>Timing of fertiliser application</b>	Best practices for the timing of fertiliser application should be written into FEPs to reflect this catchment wide approach to applying fertilisers outside forecast rain periods to reduce potential losses of phosphorus and nitrogen to water.	Lowe Environmental Impact (2015)
<b>Sediment and nutrient management plans</b>	Ensuring that sediment and nutrient management are specifically dealt with in FEPs for the Osbornes catchment because of the direct connection of the drainage system with Te Waihora/Lake Ellesmere. The objective is to address the cause of contaminant release rather than to focus on fixing the consequences.	Lowe Environmental Impact (2015)
<b>Irrigation efficiency</b>	Efficient irrigation delivers water in the right amount and at the right time to ensure that soil moisture is optimal for plant growth. Some irrigation systems use soil moisture sensors and electronic irrigation management tools to maximise efficiency and minimise waste. However, over-irrigation is a strategy that is common in Osbornes catchment and is typically used to flush salts deeper into the soil profile to reduce soil salinity and improve plant growth. A downside to this strategy is that it may also enhance nutrient leaching to the drainage network and therefore it is important to address this in terms of transformational practice.	Osbornes Drain Catchment Management Working Party

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 waterways. 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. 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. There are also online tools that can help landowners identify tools relevant to their farm type and to the issues/pressures in their catchment, which have been identified in Section 5 of this CMP (see <https://ourlandandwater.nz/fep-actions/> for more information).

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 the establishment of riparian setback distances exceeding 3 m. These riparian setbacks would likely be larger than those required by local government and industry standards where feasible (i.e., where land is not constrained by a road or similar infrastructure). For example, a riparian setback should be at least 5 m in medium-sized spring-fed streams to prevent instream fine sediment entering the stream (Holmes *et al.*, 2016), although smaller riparian margins will be appropriate for ephemeral or intermittent streams. Relatively wide riparian margins will also provide space for additional interventions as outlined in Section 7 (Table 15).

**TABLE 14:**

Summary of Good Management Practice (GMP) in farming guidance, with examples to demonstrate how 'better than good practice' may look for the Osbornes catchment

Good Management Practice (GMP) Guidance Matrix of Good Management Governance Group, 2015		Examples of 'Better Than Good Practice' in Osbornes Catchment Context
Action	Implementation Guidance Examples	See Section 7 for further details of recommended interventions
<b>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.</b>	<p>Consider:</p> <ul style="list-style-type: none"> <li>• biophysical characteristics such as soil types, topography, and climate</li> <li>• physical characteristics such as waterways, artificial drainage networks, and irrigation</li> <li>• risk factors such as soil loss, nutrient loss, and damage to soil structure.</li> </ul>	<ul style="list-style-type: none"> <li>• Identify the farm characteristics and risk factors in the context of the catchment-specific state and pressures information provided in the CMP.</li> <li>• Working with your rural professional to develop your farm environment plan – utilising the information provided in this CMP or following a templated approach as discussed in Section 6.1 above.</li> </ul>
<b>Identify risk of overland flow of sediment and faecal bacteria on the property and implement measures to minimise transport of these to waterbodies.</b>	Vegetated buffer strips/riparian planting adjusted in width for slope, hydrology, bank stability, land use, and proximity to critical source areas.	<ul style="list-style-type: none"> <li>• A minimum riparian strip width of 5 m, with 10–15 m where space allows on larger perennial waterways and smaller margins on ephemeral or intermittent waterways.</li> <li>• In combination with bank reshaping/two-stage channels where appropriate.</li> </ul>
	Identify, record, and manage risk to and from critical source areas such as wallows, bank erosion, pugging, etc.	<ul style="list-style-type: none"> <li>• Reshape ephemeral waterways to form grassed vegetated swales.</li> </ul>
	Sediment traps	<ul style="list-style-type: none"> <li>• Event-based sediment traps on ephemeral/intermittent waterways.</li> <li>• Small-scale inline sediment traps in permanently flowing waterways for targeted accumulation and removal of fine sediments.</li> </ul>
<b>To the extent that is compatible with landform, stock class and intensity, exclude stock from waterways.</b>	Paddock contouring, earth bunds, raised headlands	<ul style="list-style-type: none"> <li>• Paddock-based detainment bund intervention.</li> </ul>
<b>Manage farming operations to minimise direct and indirect losses of sediment and nutrients to water, and maintain or enhance soil structure, where agronomically appropriate.</b>	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.	<ul style="list-style-type: none"> <li>• Bundle stock exclusion with other interventions where appropriate (e.g., riparian planting, two-stage channels).</li> <li>• Identify ephemeral flow paths on farm and consider temporary fencing of these during wetter months.</li> </ul>
<b>Manage the amount and timing of irrigation inputs to meet plant demands and minimise risk of leaching and runoff.</b>	Consider distance from surface waterways, effectiveness of buffers.	<ul style="list-style-type: none"> <li>• Establish riparian setback distances exceeding 3 m on all waterway types in the catchment.</li> </ul>
	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.	<ul style="list-style-type: none"> <li>• Irrigation systems are designed and maintained to operate efficiently, under normal operation. Irrigation applications do not result in leaching or drainage.</li> <li>• Soil moisture monitoring and predictive tools are actively used to schedule irrigation.</li> <li>• Farm staff are trained in the operation of irrigation systems and scheduling tools.</li> </ul>

## 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, large-scale sediment traps, and large-scale wetlands. Even smaller-scale interventions such as two-stage channels can benefit from additional space being made available around drainage waterways and these are the types of changes that can contribute to transformative or ‘better than good practice’ for the catchment.

### 6.3 '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 Geographic Information System (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.

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 rate payers with accurate information on the maintenance work completed within the drainage network.

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 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 on private land drains that are not currently part of the rated drainage network – e.g., clearing of non-rated drains.

## 6.4 Changing Maintenance Practices

### 6.4.1 A Phased Approach to Changing Maintenance

An integral part of reimagining how the Osbornes catchment 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, 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 toolbox solutions provided below are not able to be implemented. Even when fully implemented, it is likely that there will still be some areas of drains that need to be cleared in the traditional manner, although we anticipate that sediment removal will be required less frequently and to a much lesser extent than it is currently, because sediment supply will be substantially reduced with the implementation of the toolbox solutions outlined in Section 7.

There are opportunities for SDC to proactively engage with current and future landowners to enhance awareness of drainage maintenance responsibilities. This will become even more important as maintenance practices evolve in the catchment with the implementation of the tools and solutions in this CMP. Currently, there is no information on LIM reports outlining the division of maintenance responsibilities between landowners and SDC, but LIMs are just one communication channel and are generally only reviewed by landowners at the time of purchasing a property. A multi-channel approach, including direct engagement and community outreach, could help ensure that landowners are well-informed. Encouragingly, there is a willingness among landowners to engage in discussions about drainage management, and providing clear, accessible information will support their efforts to make informed decisions. Considering options for improving communication within rated drainage catchments will be important, as these challenges can likely be addressed through a targeted communication and community engagement strategy.

#### 6.4.2 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. 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, including the planted margins and areas where interventions have been implemented. 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, and this 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 36.

As is currently needed, the surveillance and clearing of blockages in channels will be an ongoing requirement for the drainage network. Vegetation such as tree trimmings that make their way into the drainage network can create blockages of the drainage waterways and culverts, which has implications for 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 to the Halswell River is an existing part of sediment removal operations within the Osbornes catchment (Wilson, 2024). The need for fish salvage and relocation will be an ongoing requirement for the drainage network, but the scale will reduce, since sediment removal activities will be focused within defined sediment traps. Although the sediment traps will be located primarily on perennial waterways, there is still the potential for them to run dry in very low rainfall years, necessitating additional fish salvage. It is expected that trap and transfer of larger tuna/eels to move them downstream of the pump station during their downstream migration period will continue until such a time that the pump station is updated with a fish-friendly pump and/or until such a time that the pump station is removed.

# Weed Species

## Terrestrial



Grey willow  
*Salix cinerea*



Elderberry  
*Sambucus nigra* Image source: Shutterstock



Pampas  
*Cortaderia selloana* Image source: Shutterstock



Everlasting pea  
*Lathyrus latifolius*



Gorse  
*Ulex europaeus* Image source: Shutterstock



Arum lily  
*Zantedeschia aethiopica* Image source: Shutterstock



Sycamore  
*Acer pseudoplatanus* Image source: DDC



African boxthorn  
*Lycium ferocissimum* Image source: Shutterstock

**FIGURE 36:** 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 catchment, not only limited to those shown here.

## Marginal & Aquatic



Yellow flag iris  
*Iris pseudoacorus* Image source: DOC



Male fern  
*Dryopteris felix-mas*



Montbretia  
*Crocosmia xrocosmiiflora* Image source: DOC



Cape pond weed  
*Aponogeton distachyo*



Beggars tick  
*Bidens frondosa* Image source: Paulo Ventura Araújo



Purple loosestrife  
*Lythrum salicaria* Image source: Gail Hampshire



Chilean/giant rhubarb  
*Gunnera tinctoria* Image source: DOC



Blue water speedwell  
*Veronica anagallis-aquatic*



Reed canary grass  
*Phalaris arundinaceum* Image source: DOC



Fenced and planted  
ephemeral channel

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 Osbornes catchment will require the implementation of reach-scale interventions to improve the existing water quality and condition of the waterways. This section details a ‘toolbox’ of interventions that are designed to mitigate some of the main issues and challenges facing the Osbornes catchment at present (Table 15).

### 7.1 Implementation of the Interventions Across Osbornes Catchment

The network of highly modified drainage waterways within the Osbornes catchment currently has low ecological value (Section 3) and faces numerous issues and challenges (Sections 4 & 5). Opportunities to enhance ecological values within the waterways of this catchment are limited, primarily because of the standing water conditions and only periodic discharge via a pump station, compounded by poor habitat conditions and very poor water quality. As this land drainage network discharges to Te Waihora/Lake Ellesmere, a coastal lagoon of high ecological and cultural significance that faces significant water quality challenges, the foremost priority of the proposed interventions/tools and solutions is to improve the quality of water discharging from the Osbornes catchment. However, such measures can also look to address issues and improve values inside the catchment, implemented over time. The need for ongoing maintenance of these interventions will be an important consideration in their design, as this should maximise their effectiveness. For example, wetlands are expected to be a crucial intervention for this catchment, but these are intended as constructed wetlands rather than natural wetlands where they are located upstream of the pump station. In contrast, the wetland enhancement already proposed for the area downstream of the pump station is not an Osbornes catchment intervention and is intended to improve habitat and acknowledge degradation of Te Waihora/Lake Ellesmere as a whole.

Our approach for this CMP was to first understand the broad catchment characteristics, the current state of the catchment, the issues and challenges it faces, and the existing drainage maintenance procedures. A key part of this process involved working closely with the Osbornes Drain Catchment Management Working Party to integrate historical and local knowledge, ensuring that the experiences and insights of those familiar with the catchment informed our understanding. This co-design approach helped shape a package of intervention options included in this CMP that focus on preventing further degradation of water quality and improving conditions in the drainage waterways, while maintaining vital drainage functions. As the first step in determining appropriate locations for the implementation of interventions within the catchment, we provide guidance on the types of waterways that would be suitable for each intervention, and where these interventions should have the greatest impact (Table 15). With this guidance in mind, more specific locations will be identified during the master planning stage.

*Note: the interventions in Table 15 are a list of all possible interventions that could be implemented, but this does not mean that all will be relevant to use at any one time – as such, an indication of staging is also provided.*

**TABLE 15:**

Guidance on the waterway types suitable for each of the reach scale tools/solutions/interventions recommended for use in the Osbornes catchment.

			Waterway Types							
Interventions		Timeframe Early/Medium Term/Future	Perennial Drainage			Intermittent Drainage		Ephemeral Drainage	Temporarily Located Intermittent/ Ephemeral Drainage	Informal Flow Paths
			Rated Osbornes mainstem	Rated	Unrated	Rated	Unrated			
1	BANK/ CHANNEL IMPROVEMENTS	Vegetated wwale						✓	✓	
2		Two-stage channel	✓	✓	✓	✓	✓			
3		Two-stage channel (large-scale)	✓	✓						
4		Waterway realignment	Potential Future Option	✓						
5		Woody material	Medium Term	✓						
6		Fibre rolls for bank edgeprotection	Early	✓	✓	✓	✓	✓	✓	
7		Stock exclusion	Early	✓	✓	✓	✓	✓	✓	✓
8	WETLANDS	Off-channel large-scale	✓	✓	✓	✓	✓	✓		
9		Inline lineal		✓	✓	✓	✓	✓		
10		Small-scale		✓	✓	✓	✓	✓		
11		Floating	Early	✓						

**TABLE 15:**  
...continued...

			Waterway Types							
Interventions		Timeframe Early/Medium Term/Future	Perennial Drainage			Intermittent Drainage		Ephemeral Drainage	Temporarily Located Intermittent/Ephemeral Drainage	Informal Flow Paths
			Rated Osbornes mainstem	Rated	Unrated	Rated	Unrated			
12	SEDIMENT MANAGEMENT	Off-channel sediment trap	Medium Term	✓	✓					
13		Inline sediment trap	Early		✓	✓	✓	✓		
14		Inline event-based sediment trap & water level control	Early				✓	✓	✓	
15		Detainment bund	Early						✓	✓
16		Woody material	Early							
17	OTHER	Aeration pumps to prevent significant reductions in dissolved oxygen	Potential Future Option							
18		Low flow use for irrigation/land discharge	Early							
19	PUMP STATION MODIFICATIONS	Fish-friendly pumps	Potential Future Option							
20		Pump station removal	Potential Future Option							

## 7.2 Information on Interventions

### 7.2.1 INTERVENTION 1: BANK/CHANNEL IMPROVEMENTS – Vegetated Swale

Vegetated swales are shallow channels lined with dense 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 only vegetated with grass, they will be more suitable than riparian planting for drainage waterways that are ephemeral or temporarily located, where the establishment of a permanent riparian buffer zone would not be appropriate.

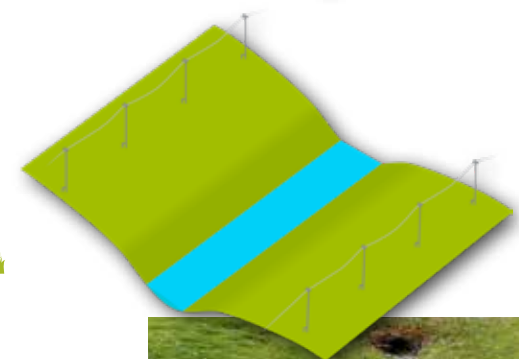
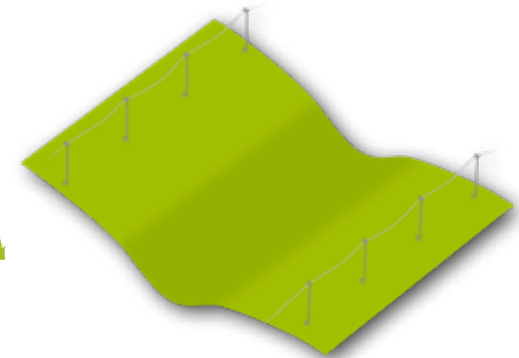
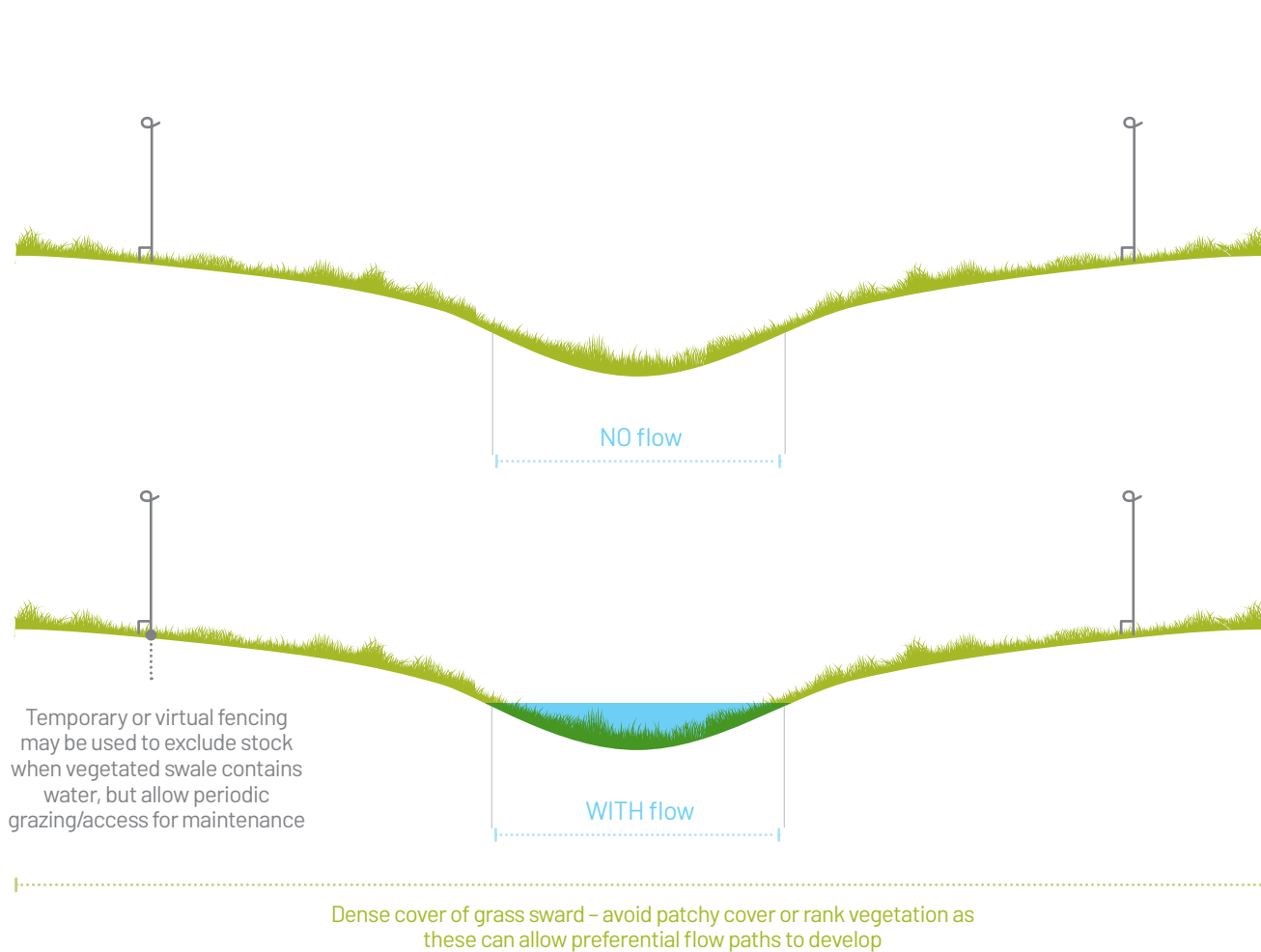
Simple channel reshaping of existing (or new) ephemeral channels to form a stable vegetated swale is most suitable for ephemeral drainage waterways or those ephemeral (or smaller intermittent) channels that are temporarily located within the catchment. This tool would be expected to contribute to reducing the amount of sediment that these waterways release into the drainage system. In most situations, minimal reshaping will be required to implement this tool, as many of the drainage waterways that will be suitable for this tool already have broad and shallow channel geometry. The important features of vegetated swales in the context of Osbornes catchment are that the channels are well vegetated with dense groundcover (most likely grass) and that stock are excluded when these 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, 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, with temporary fencing used to exclude stock as needed, to retain grass cover and avoid pugging.

#### Key Features

- Only suitable for smaller channels/flow paths.
- Channel is grassed and accessible to allow for maintenance.
- Needs maintenance to maintain thick sward of vegetation.
- Stock is usually excluded from channel but may be used to help manage the vegetation cover.

#### Core Benefits

- Reducing sediment inputs to waterways by improving bank stability and reducing slumping.
- 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 that are established 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 can increase water velocity (when there is sufficient longitudinal gradient) and water depth during low flows if there is a narrowed low flow channel, which can decrease sedimentation and improve water depth for fish during low flow conditions. Conversely, during high flows the flood water can extend over the low banks that provide increased flow capacity, reducing water velocity across the wider fresh plain. Two-stage channels provide a much more stable lower bank that is less prone to erosion and bank slumping/collapse. They also increase flood capacity, absorb nutrients, and may trap fine sediment on their fresh plain (i.e., the first channel stage), as sediment is typically deposited or trapped via vegetation on the lower bench during high flows.

Two-stage channel/bank reshaping will be suitable for the perennial and larger/deeper intermittent or ephemeral channels within this catchment. If implemented across multiple locations, two-stage channels may provide cumulative water quality improvements in terms of reduced turbidity, phosphorus, and nitrogen. Two-stage channels typically have greater benefits than simple bank reshaping for bank stabilisation, and we recommend that they are used where space is available. Where there is flowing water, some heavy shading provided by *Carex* planted along the bank edge will help to reduce the growth of emergent macrophytes

such as monkey musk and watercress. However, in Osbornes Drain the flat gradient and pump station controlling the discharge of water from the catchment means that for the mid-lower reaches flow tends to back up through the system rather than be controlled by channel hydraulics – meaning the use of *Carex* to shade out emergent macrophytes is unlikely to work. Riparian planting of the lower bench will instead provide for plant uptake of subsurface nutrients (McKergow *et al.*, 2022) and help to trap fine suspended particulates when inundated. However, riparian planting needs to be carefully planned and closely monitored to ensure successful outcomes – in the case of the Osbornes catchment, with a prevalence of standing rather than flowing water, the planting of wetland vegetation in the channel along with a two-stage bank profile may be more appropriate in most locations where there is not deep water (i.e., lineal wetlands as described in Section 7.2.9). There is detailed advice and guidance available for two-stage channel design in Roznowski (2015), Natural Resources Conservation Service (2007), and on the Living Water website<sup>1</sup>.

The addition of a much wider low bench in the mid-lower reaches of Osbornes Drain will also serve dual functions of increased flood flow storage capacity (through storage of the backup of flow from the pump station), along with trapping of fine particulates and nutrient uptake by vegetation on the planted bench. Altering the pump station operation to draw down the water level until these low benches are exposed following inundation will be needed to maximise benefit and function.

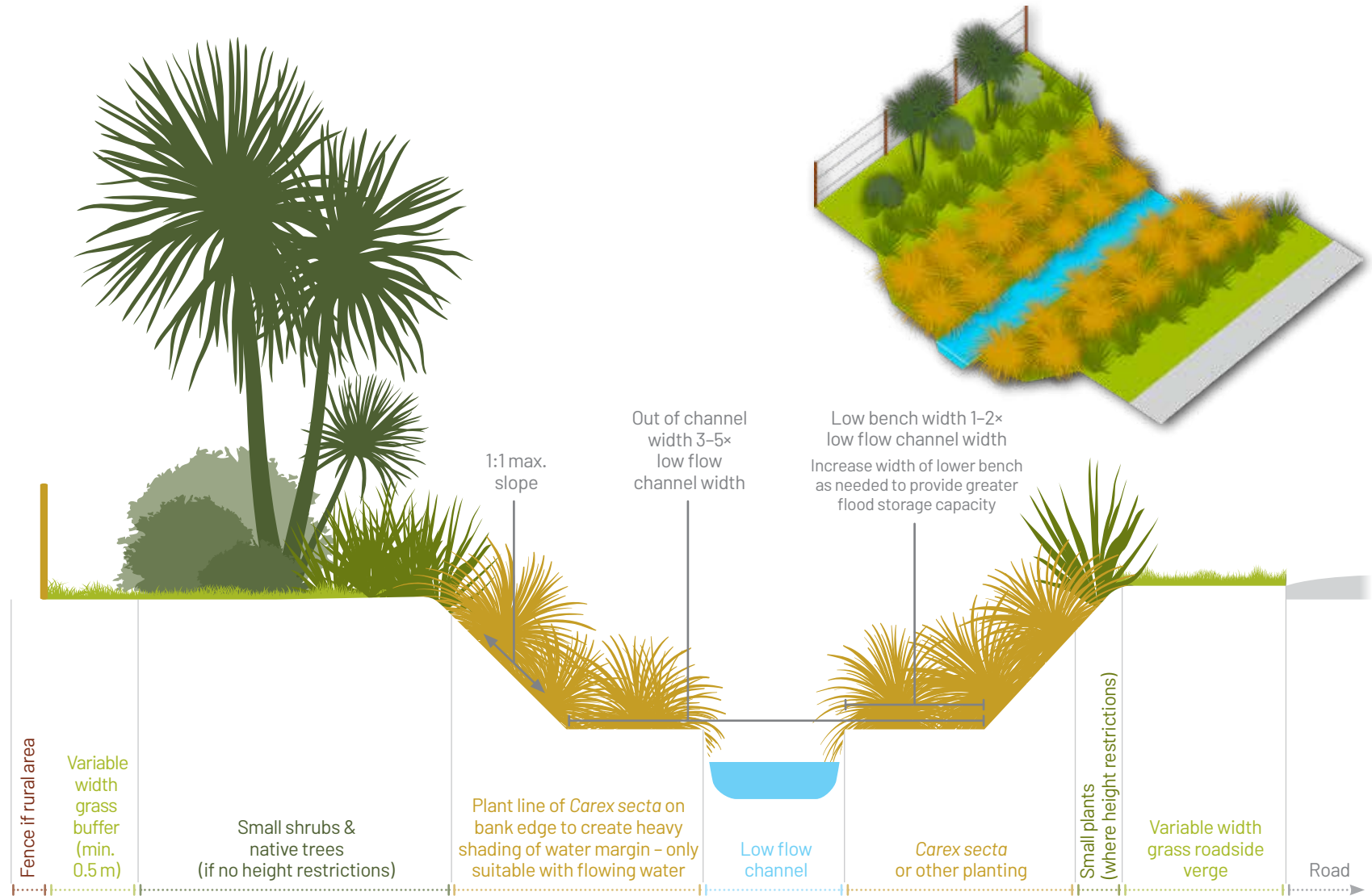
### Key Features

- Instream 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.

<sup>1</sup> [www.livingwater.net.nz/im:46358cf6-1e1b-4911-8aa7-2d4dab40551f](http://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.

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

Two-stage channels (as described in Section 7.2.2 previously) may be used at a larger scale on the mainstem of the Osbornes Drain, where space allows. In this setting, the two-stage channel would increase flood flow channel capacity and improve bank stability by reshaping the river margins to include a much larger floodplain. The much larger floodplain would create space for riparian planting, which will be dominated by wetland plants but may include larger tree/shrub species, along with low overhanging or emergent vegetation (i.e., rushes and sedges) at the margins of the channel. The purpose of the low riparian planting on the floodplain is to slow water and trap sediment when the flood plain is inundated, rather than to provide shade to the channel. It is envisaged that this intervention would be suitable for the lower-most reaches of Osbornes Drain.

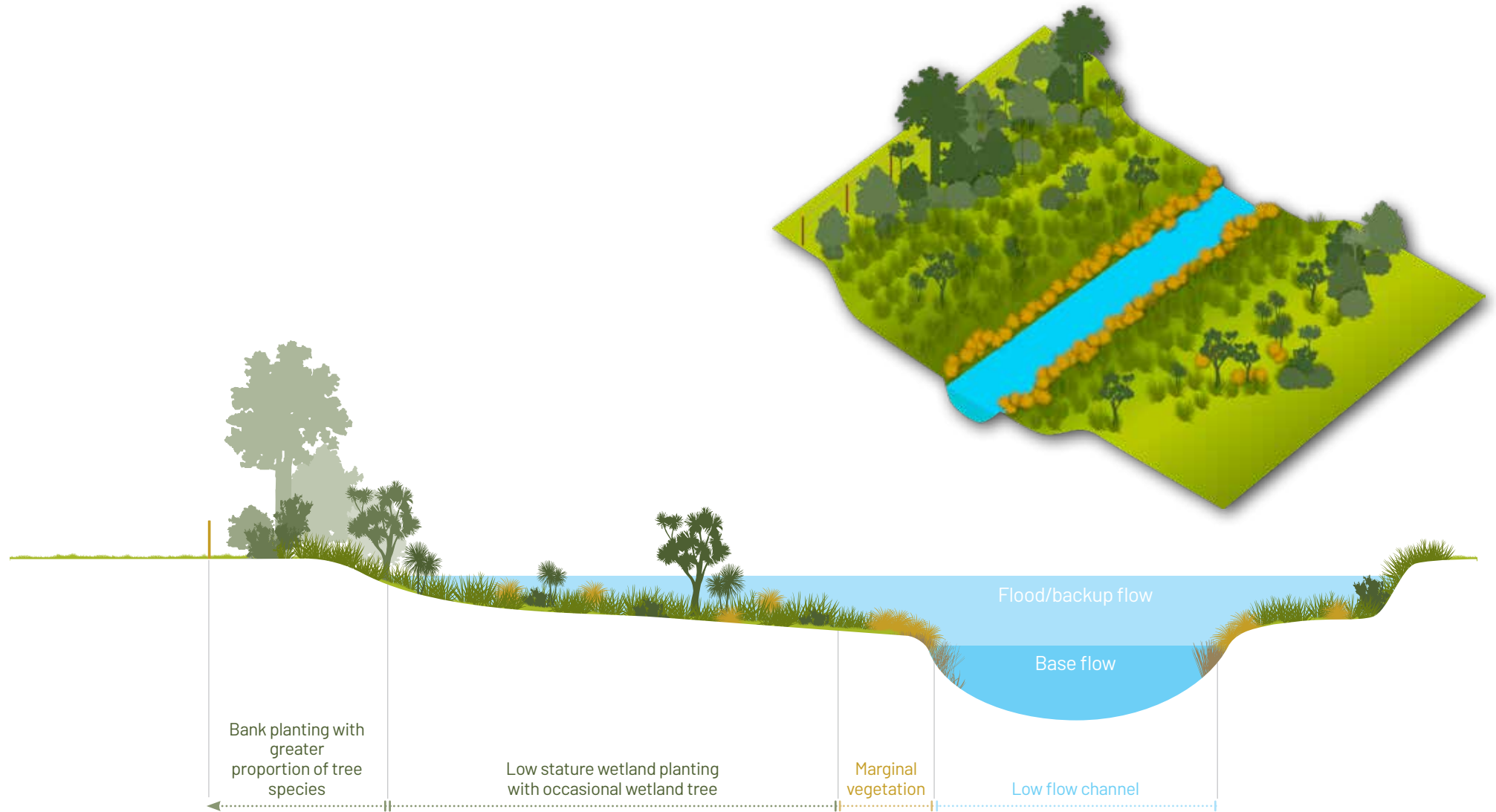
Osbornes Drain catchment was once part of the Te Waihora lakebed; it has a particularly flat gradient with a pump station that operates only periodically to pump water out of the catchment. This means water levels rise and fall via pump drawdown rather than being controlled by channel hydraulics. By creating a much larger low bench in the lower reaches of Osbornes Drain, it can provide the dual function of increased flood flow storage capacity (through storage of the backup of flow from the pump station), along with trapping of fine particulates and nutrient uptake via the vegetation on the planted bench. This will help to create a form of intermittent reservoir in the lower reaches of the catchment that can treat the water prior to it being discharged via pump to Te Waihora. Altering the pump station operation to draw down the water level until this large low bench is exposed following inundation will help to maximise benefit and function of this intervention.

#### 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) on Osbornes Drain.

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## 7.2.4 INTERVENTION 4: BANK/CHANNEL IMPROVEMENTS – Waterway Realignment

Large-scale channel realignment is one option for the lower reaches of Osbornes Drain, where low dissolved oxygen levels and legacy sediment issues remain a concern. This type of option is a major undertaking and will require landowner discussions/agreement and land purchase to realise it. As such, it may be more of a medium to long-term option, to be implemented if the smaller-scale interventions and catchment-wide land management approaches recommended in this CMP fail to improve water quality as much as is needed. It might also be appropriate to consider this option if water quality is improved in the catchment, leading to the modification (Section 7.2.19) or removal (Section 7.2.20) of the pump station from the scheme. At that point, instream habitat of the drainage waterways would become an important consideration for the catchment, since the waterways would be more readily accessible to fish, and a realignment would be one way to improve the habitat values of the waterways. Implementing the realignment in advance would ensure the habitat has matured by the time the pump station is removed.

As we know, much of the lower part of the Osbornes catchment was inundated in the past when Te Waihora/Lake Ellesmere levels were high (see Section 3.1) and so there is no original waterway alignment to return to in this situation. However, it is possible to scope potential channel alignments using LiDAR mapping tools to identify existing low topography that may be suitable for realignment purposes. Alternatively, the location for channel realignment could be determined by discussions with adjacent landowners and maximise opportunities in areas of land that they may be open to selling.

### Key Features

- Requires large areas of land and significant earthworks.
- Potential fall-back option if smaller scale interventions fail to provide adequate water quality improvement.
- Opportunity to improve habitat within the catchment if there is future modification or removal of the pump station.

### Core Benefits

- Improved instream habitat values.
- Reduces sediment inputs to waterways by improving bank stability and reducing slumping.
- Improves nutrient uptake with lower bank planting and some filtration of overland flow.
- Resolves legacy sediment issues in the lower reaches of Osbornes Drain, reducing environmental impacts.
- Increased flood capacity.
- Increased treatment potential if integrated with a large-scale wetland.



Example of a waterway realignment

### 7.2.5 INTERVENTION 5: BANK/CHANNEL IMPROVEMENTS – Woody Material

The addition of woody material such as stumps and logs to waterways can be used as a type of constructed instream habitat, with the purpose of improving habitat and flow diversity for fish and invertebrates. Adding woody debris to streams can provide a variety of ecosystem benefits, including enhancement of instream habitat (which is particularly lacking in soft bottomed streams), 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) found that the areas of stream bed around (installed) large logs had substantially higher diversity and biomass of native fish compared to similar areas upstream without logs. There is now detailed advice and guidance available for working with woody materials in an Aotearoa New Zealand context (Barrett *et al.*, 2024; <https://storymaps.arcgis.com/stories/b0ef87cf6feb405e836b580c75fa894b>).

Although ecological values are currently limited in the Osbornes catchment and water quality is not suitable for encouraging instream life, there may be short- to medium-term benefits in using woody debris to create instream habitat. With a long-term view toward improving the ecological state of the catchment and considering the potential removal of the pump station, woody debris could be used effectively in combination with other interventions such as bank/channel improvements and treatment wetlands.

The addition of woody debris would be suitable for the mainstem of Osbornes Drain (perennial flow, within the rated network), where they may also help to stabilise banks and reduce sediment input from bank erosion. Other waterways within the catchment are likely to be too small for this intervention and the scale of the woody debris needs to be suitable for the intended location. Woody debris is only appropriate where sufficient hydraulic capacity exists or can be created through bank reshaping, to ensure that drainage function is not compromised by these instream features. It is also crucial that woody material is anchored to prevent them floating away and damaging downstream structures.

To maximise the potential benefits of these instream habitat features, the lower reaches of Osbornes catchment should be prioritised for woody debris installation, once issues such as sediment accumulation and poor water quality have been addressed.

#### Key Features

- Large woody debris such as tree stumps or small logs are positioned in the stream such that they are partially submerged during low flows.
- Should be installed in combination with two-stage bank reshaping to ensure channel capacity is maintained and woody debris do not cause bank erosion.

#### Core Benefits

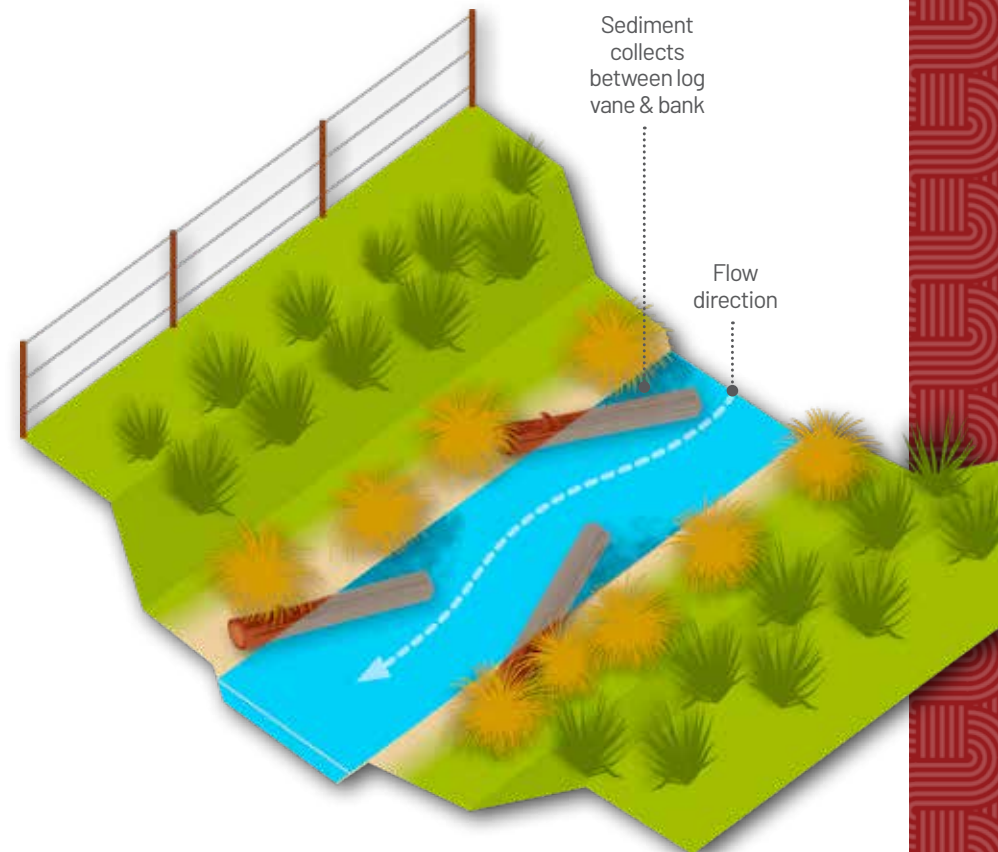
- Increased instream habitat availability and diversity for fish and invertebrates.
- Provides improved habitat for native fish, including taonga species such as longfin eels.
- Provides aesthetic benefits and roosting sites for waterfowl.
- Stabilises banks and reduces bank erosion.



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, with the low water velocity of the Osbornes catchment they might not realise their full potential of creating varied water velocity and stable scour pools.



Woody material is most suited to the larger perennial sections of the Osbornes mainstem. Large woody debris such as tree stumps or small logs would be partially submerged during low flows.



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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## 7.2.6 INTERVENTION 6: BANK/CHANNEL IMPROVEMENTS – Fibre Rolls for Bank Edge Protection

There are various types of fibre rolls available that can be used to stabilise stream bank edges, providing erosion protection and reducing the input of fine sediments to the waterway. Fibre rolls also provide a suitable substrate for the establishment of streamside vegetation, which provides additional protection from erosion and sediment inputs. Fibre rolls may be especially useful in locations where the stream banks are high, steep, and prone to erosion, but where there is insufficient space available to improve this with an intervention such as a two-stage channel (Sections 7.2.2 and 7.2.3). Fibre rolls can be a useful tool where space to extend out the wider channel into the surrounding land is not available due to the presence of existing infrastructure. In such situations, fibre rolls can be installed into the existing bank edge to help with stability or can be used to build out into the existing low-flow channel to create a low bench/fresh plain within which to plant. With additional bank edge protection, steeper banks can be improved, so that they are less prone to contributing fine sediments to the waterway system.

Fibre rolls are typically made of biodegradable materials such as coconut fibre, which breaks down over a period of three to five years, providing enough time for vegetation to become established in their place (e.g., <https://cirtexcivil.co.nz/products/silt-control/biocoir-coir-logs/>; [www.geofabrics.co.nz/products/biomac-waterlog-biodegradable-coir-log](http://www.geofabrics.co.nz/products/biomac-waterlog-biodegradable-coir-log)). However, there are more durable materials now available, with potential lifespans of up to 30 years. For example, xylit rolls are made from a durable woody fibre that is derived from lignite. The material is a by-product of the coal industry and is normally destined for landfill.

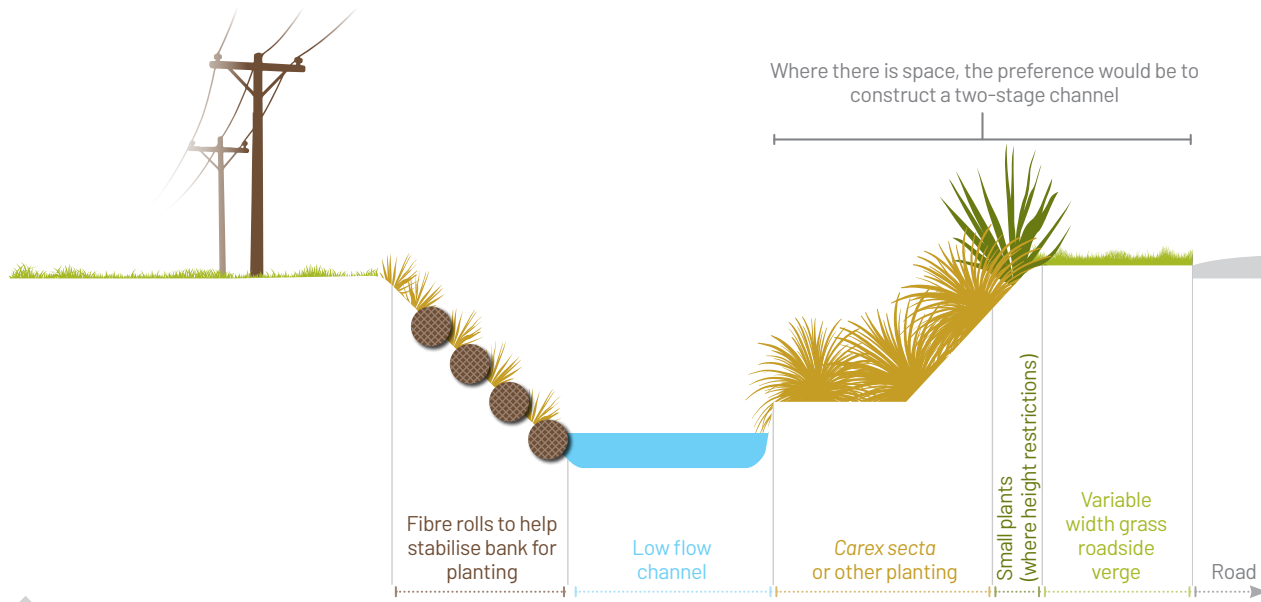
The benefits of fibre rolls include the ability of water to pass through them, their potential to trap sediments and contaminants before they enter waterways, the addition of habitat along the waterway margins, and that they do not require major earthworks for installation. In the Osbornes catchment, fibre rolls for bank edge protection may be useful as a tool on their own, or in combination with other interventions such as channel 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.

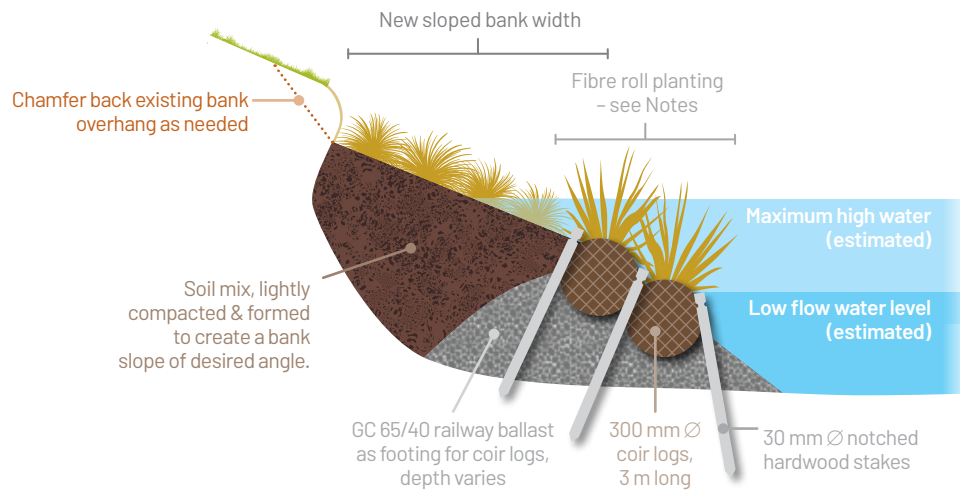


Where there is insufficient space to construct a two-stage channel, fibre rolls could be used for providing some bank stability, and planting media for vegetation.

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Fibre rolls are often made of natural materials that gradually degrade over 3-5 years, but some woody fibre materials should last around 30 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.

### 7.2.7 INTERVENTION 7: BANK/CHANNEL IMPROVEMENTS – Stock Exclusion

Where perennial waterways in the catchment do not already have stock excluded, this should be a priority intervention. With the substantial challenges that fine sediment poses in this catchment, this is a basic intervention that can help reduce sediment inputs through the exclusion of stock to the channel. This intervention is best bundled with other interventions (e.g., bank/channel improvements, treatment wetlands, sediment management interventions), but could be a standalone intervention in some cases such as where there are gaps in existing stock exclusion. Priority areas would be the perennial waterways as well as sediment traps and treatment wetlands, but there will also be substantial benefits to be gained from excluding stock from ephemeral/intermittent drainage waterways and temporary exclusion from informal flow paths and temporary ephemeral channels during wet periods of the year.

Stock exclusion does not always mean fencing – there are other technologies becoming more available such as virtual fencing collars/GPS collars/smart collars that allow for greater flexibility for areas where fence location may change over time. With stock exclusion comes a requirement for ongoing maintenance of fenced-off areas to ensure weed species do not become established.

#### Key Features

- To be used in locations where stock have access to waterways.
- Suitable for all waterway types.
- Fencing setbacks should aim for a ‘better than good practice’ approach as described in Section 6.1.1.

#### 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.



A fenced waterway within private farmland in the Osbornes catchment. Fenced off riparian areas will benefit from some riparian planting and weed management.



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.

## 7.2.8 INTERVENTION 8: 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 of NIWA (2021b), wetlands treating agricultural runoff and drainage flows should be sized between 1–5% of their contributing catchment (i.e., 100–500 m<sup>2</sup> of wetland per ha), but often large-scale wetlands are implemented and sized to the land that is available. If the optimal size is not able to be achieved as a single large-scale wetland, then the creation of many small-scale wetlands in the wider catchment will be important to add to the overall treatment area at the catchment scale. Large-scale off-channel wetlands treat base flows and the majority of flood flows, while allowing a portion of larger flood flows to continue down the existing stream channel. This provides more consistent flows to the wetland, provides fish passage along the existing channel, and reduces flood damage to the wetland. However, if all water is needing to be treated then inline systems may be preferred, although provision for a larger flood flow bypass may be needed. In the case of the Osbornes catchment, large-scale inline wetlands are covered in the ‘lineal wetlands’ solution (Section 7.2.9). Wetland design should discourage preferential flow paths and can be constructed as a single cell/elongated channel or as a series of smaller cells (two or more cells is 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 bundled with a large-scale sediment trap upstream (Section 7.2.12). This will reduce the volume of sediment reaching the wetland and extend its life. The design of large-scale wetlands will be contingent on the site conditions, and whether it is an infiltration wetland or open water wetland. Innovative options for incorporating additional filter mediums such as floating wetlands (see also Section 7.2.11) or mussel shells<sup>1</sup> 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. As such, the design should be undertaken by specialists that are experienced in large-scale wetland design and are familiar with the Osbornes catchment.

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

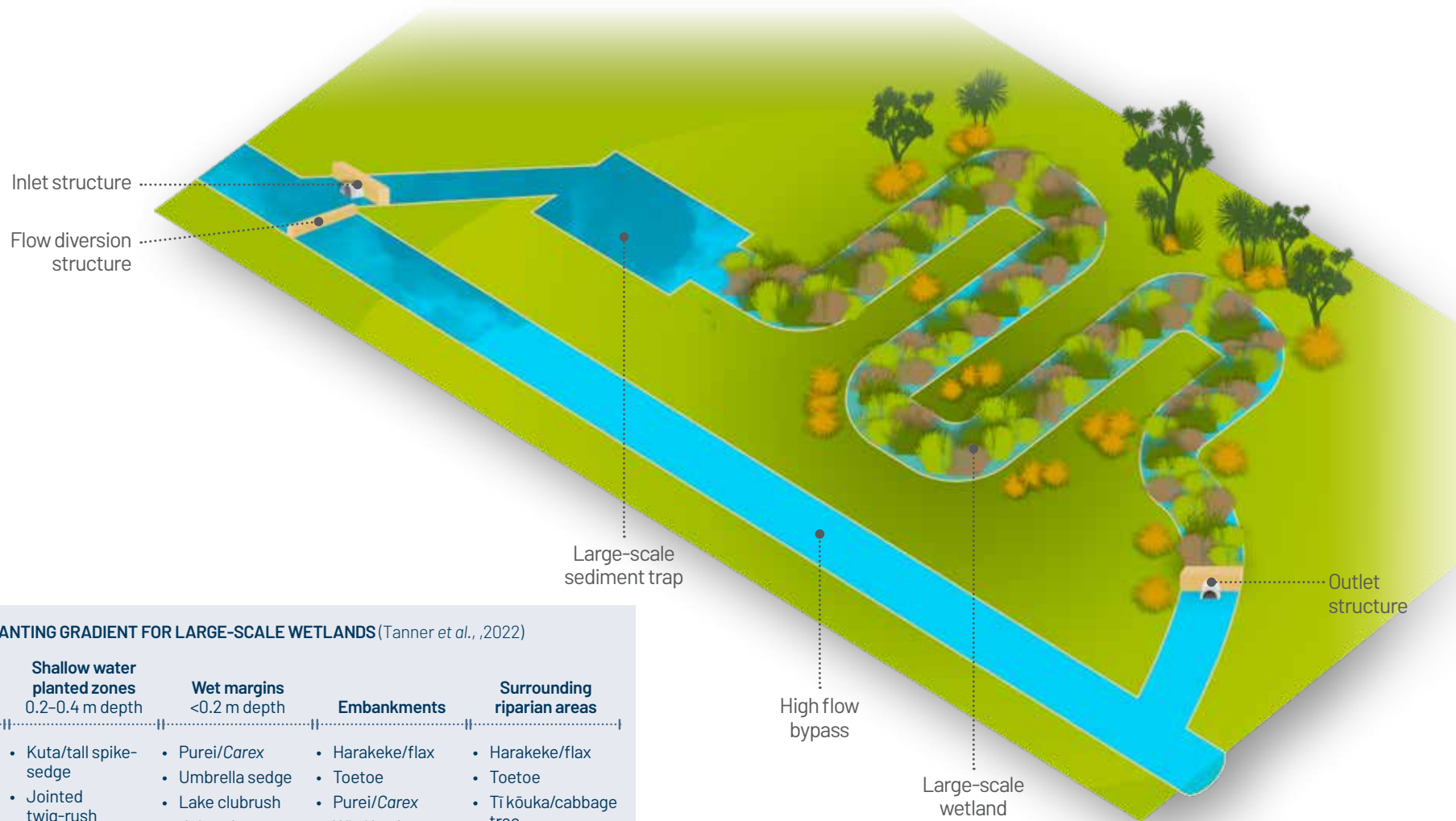
### Key Features

- Requires large area of land and earthworks, and custom designs.
- Suitable for lower catchment, upstream of the Osbornes pump station, where it could benefit water quality prior to discharge from the drainage network.
- 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).
- 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.

<sup>1</sup> Mussel shells are known to be effective for the removal of zinc from stormwater runoff ([www.sciencedirect.com/science/article/pii/S2352186422002802](http://www.sciencedirect.com/science/article/pii/S2352186422002802); [www.newsline.ccc.govt.nz/news/story/mussel-shells-helping-filter-contaminants](http://www.newsline.ccc.govt.nz/news/story/mussel-shells-helping-filter-contaminants)).



**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
<ul style="list-style-type: none"> <li>No planting</li> <li>Self colonised by submerged plants</li> </ul>	<ul style="list-style-type: none"> <li>Kuta/tall spike-sedge</li> <li>Jointed twig-rush</li> <li>Lake clubrush</li> <li>Raupō</li> </ul>	<ul style="list-style-type: none"> <li>Purei/<i>Carex</i></li> <li>Umbrella sedge</li> <li>Lake clubrush</li> <li>Jointed twig-rush</li> <li>Harakeke/flax</li> </ul>	<ul style="list-style-type: none"> <li>Harakeke/flax</li> <li>Toetoe</li> <li>Purei/<i>Carex</i></li> <li>Wiwi/rushes</li> </ul>	<ul style="list-style-type: none"> <li>Harakeke/flax</li> <li>Toetoe</li> <li>Ti kōuka/cabbage tree</li> <li>Mānuka</li> <li>Coprosma</li> <li>Kahikatea</li> <li>Māhoe</li> </ul>

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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## 7.2.9 INTERVENTION 9: TREATMENT WETLANDS – Inline Lineal

Inline lineal wetlands are envisaged as an opportunity to create wetlands within the existing drainage waterways, particularly where the existing drainage channels are relatively deep, but water depth is relatively shallow. The Osbornes catchment has a large network of straight and often incised drainage channels, with 26 km of perennial and intermittent channels. Where there is insufficient room 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 a two-stage profile<sup>1</sup>) 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 also offers inherent flexibility, allowing these structures to be installed at any time without the need for heavy earthmoving machinery.

Given the very flat gradient in the catchment and the pump station controlling the discharge of water from the catchment, flood flows tend to 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. The creation of a large-scale wetland at the downstream end of the catchment (i.e., just upstream of the pump station) would also help with improving flood flow holding capacity.

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 channel works, as legacy sediments can cause a net release of nutrients during the initial years of wetland establishment (Rebecca Eivers, pers. comm.).

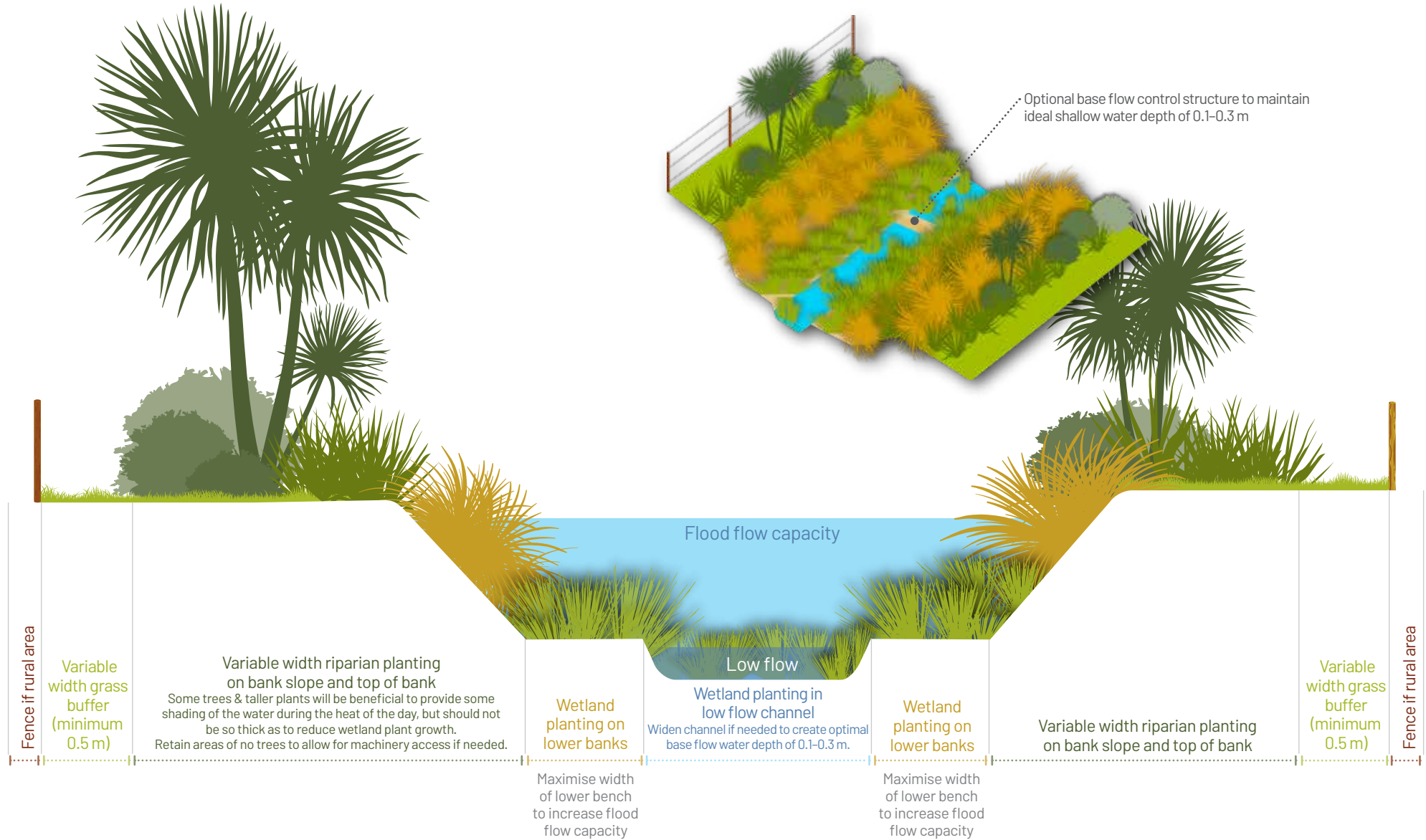
### Key Features

- 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.

<sup>1</sup> See Intervention 2: Bank/Channel Improvements – two stage channel.



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

### 7.2.10 INTERVENTION 10: TREATMENT WETLANDS – Small-Scale

Small-scale wetlands are envisaged as an on-farm opportunity. Their small size means they may be able to be implemented without the need for a resource consent, depending on the volume of earthworks required and the volume of water dammed or diverted. They work best when used to treat small sub-catchments, with a wetland to sub-catchment ratio of around 1–5% recommended in national guidelines (NIWA, 2021b) and around 1.5% by more recent work being done in the Waikato region for treatment wetland design in headwater catchments (Rebecca Eivers, pers. comm.). As such, the use of many small wetlands in the smaller sub-catchments of the Osbornes catchment would be an obvious 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 a wetland design that has 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 low gradient of the Osbornes catchment, it is well suited for such wetland treatment systems.

Wetland design should consider the potential for nitrate-N conversion to ammonium-N under oxygen-limited (anaerobic) sediment conditions and where the availability of organic carbon is high. For this reason, Eivers (2018) recommends using a multi-cell/module design to assist with ammonium-N removal. The use of an infiltration outlet is also recommended by Eivers (2018) for improved phosphorus attenuation. Plant species selection will need to be carefully considered. Eivers (2018) notes that short-lived annual and perennial plants should be avoided as they can become a source of nutrients, and that macrophytes greatly increase removal efficiencies in small treatment wetlands. Regardless of the species selected, meticulous weed management is needed to ensure the wrong species do not establish and/or become dominant in the system. There is an opportunity in the Osbornes catchment to try different small-scale wetlands designs and compare their performance before sharing the findings for the benefit of other similar catchments.

Small-scale wetlands for treatment can be either off-channel or inline but tend to work best when created off-channel (i.e., adjacent to the existing channel). However, in the Osbornes catchment with its low gradient and lack of base flow for most waterways, they could also be located at key confluence points within the existing ephemeral drainage waterways (inline), with the purpose of retaining water during rain events and improving water quality before water continues down the drainage network. Following the national guidance for treatment wetland design (NIWA, 2021b), for constructed wetlands in low gradient areas with an intensive network of surface or subsurface drains, the wetland base should be constructed to sit below the depth of the drainage network, be that underground tile drains or open drainage channels. Wetlands tend to work best with regular baseflow, but provided they are well designed they should also provide benefit for ephemeral systems as well. To improve their longevity, wetlands should be bundled with a sediment trap upstream (Sections 7.2.12 & 7.2.13), which will reduce the volume of sediment reaching the wetland and extend its life. Where space allows, a repeated treatment train of sediment trap + wetland + sediment trap + wetland could be incorporated (Eivers, 2018).

Small-scale wetlands offer potential benefits for flood management, as well as sediment control, biodiversity, and water quality improvement (particularly for nitrogen). However, they can show variable results in the first 3–5 years after 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 plans, such as the identification and retirement of wet areas or critical source areas.

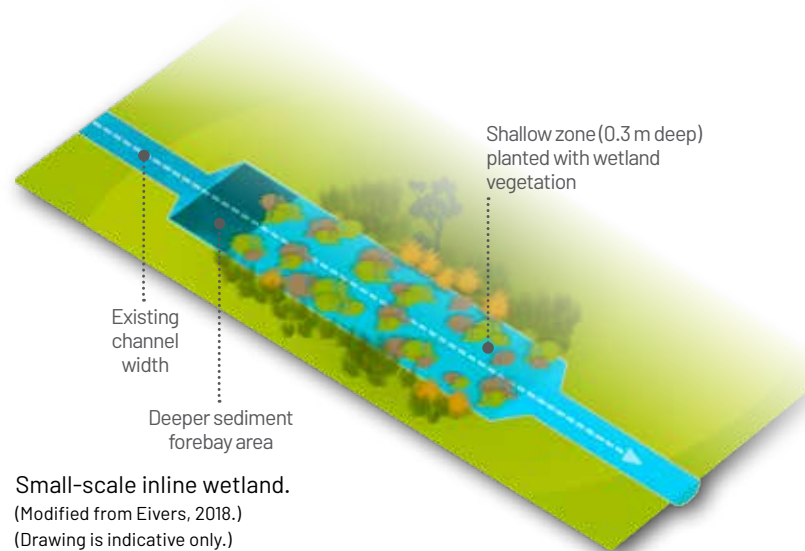
Design should be undertaken by specialists that are experienced in small-scale off-channel wetland design and are familiar with the Osbornes catchment. For further information on small scale constructed treatment wetlands, see the NIWA constructed wetland guidelines (<https://niwa.co.nz/freshwater/constructed-wetland-guidelines>),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

### Key Features

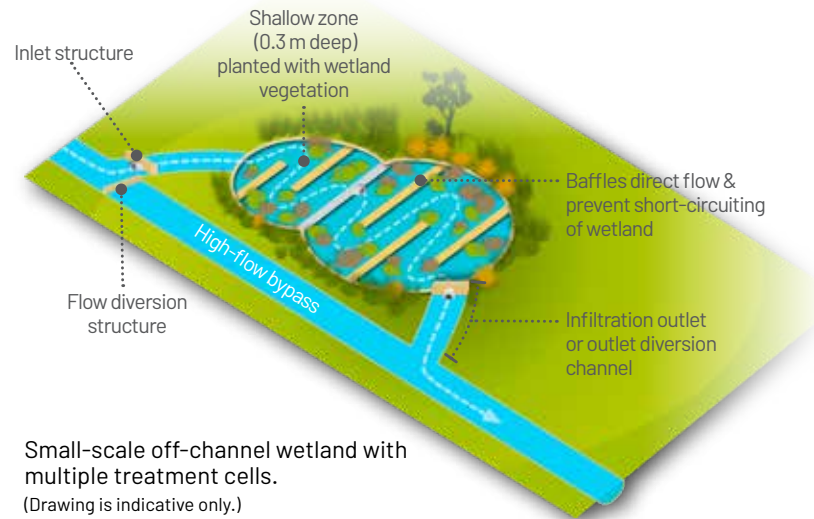
- Located on both rated and unrated drainage waterways.
- Best sited in smaller/headwater sub-catchments, and could be used around confluence points for smaller drainage channels.
- Help with flood management and improving water quality.
- Small-scale earthworks.
- Ability to create a standard design(s) 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.
- 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 and biodiversity.
- Reduced downstream transport of fine sediment and other contaminants.
- Reduced peak runoff and increased flood flow capacity.

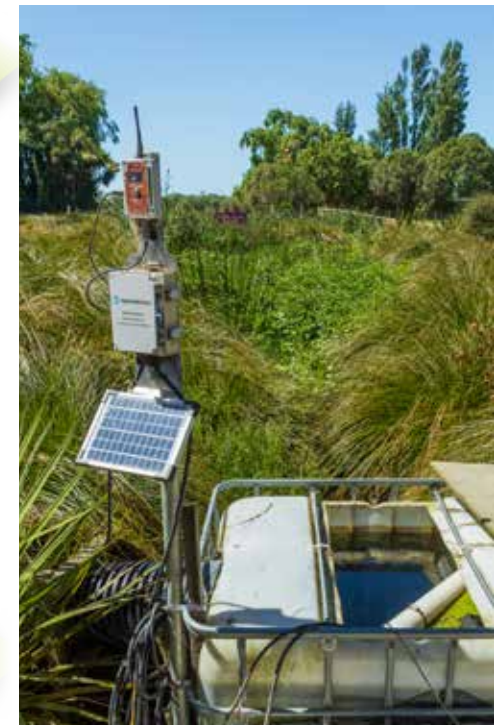


**Small-scale inline wetland.**  
(Modified from Eivers, 2018.)  
(Drawing is indicative only.)  
© EOS Ecology



**Small-scale off-channel wetland with multiple treatment cells.**  
(Drawing is indicative only.)  
© EOS Ecology

*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.

### 7.2.11 INTERVENTION 11: TREATMENT WETLANDS – Floating

Floating wetlands provide an opportunity for an ‘early works’ intervention, to help with water quality improvements whilst implementation of other interventions is still being planned out. Floating wetlands can be installed within the deeper lower reaches of Osbornes Drain and ponded area immediately upstream of the pump station. Floating wetlands require a long hydraulic residence time (i.e., 3–5 days for increased nitrogen removal) to provide time for plant uptake of nutrients – with the pump station on Osbornes Drain holding flow back for prolonged periods, the ability to achieve longer residence times is likely possible.

Floating wetlands require a water depth of 0.8–1.5 m to prevent the plant roots from growing to the streambed and attaching. The lower-most reaches of Osbornes Drain are the only area in the catchment where this would be possible and may yet require some additional excavation to achieve the optimal depth. The floating wetland matrix should be arranged to reduce preferential flow paths around the floating wetlands – although in the case of Osbornes Drain, which has more of a standing water environment, such a consideration may not be as critical as in systems with a greater flow of water. Dissolved oxygen levels under floating wetlands can be particularly low, so are not recommended for areas with fish that are not air breathers. But as Osbornes Drain has a pump station that prevents access of most fish species, and already experiences low dissolved oxygen levels, this may not be as much of a concern.

There are a range of providers of floating wetlands, including smaller modular systems, that could be useful here. The modules are anchored to prevent them floating away, but allowing them to rise and fall with a changing water level. The modules can be moved around to facilitate maintenance including removal of sediment underneath. The flexibility of the modular systems allows the network to be added to over time if monitoring shows that more wetland footprint is needed to achieve a specific nutrient reduction.

Native plant species recommended for floating wetlands include *Carex*, *Juncus*, *Ficinia*, *Schoenoplectus*, and *Machaerina* species. Maintenance for floating wetlands is important, including cutting of the floating vegetation (to promote growth and remove dead material), weeding of the floating wetlands, and removal of sediment and organic material that builds up under the floating platform.

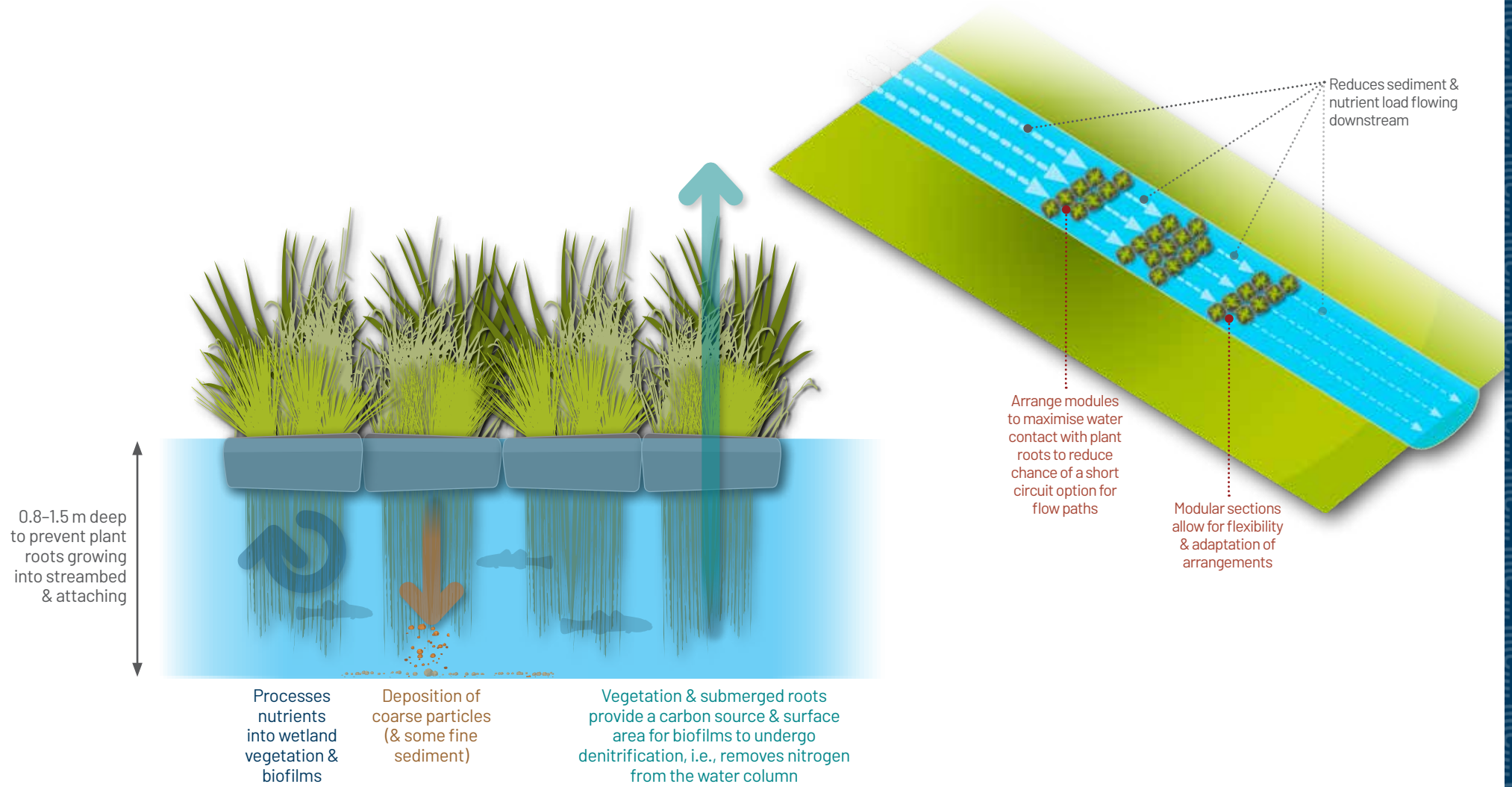
Floating wetlands are expected to reduce nutrient concentrations (through direct plant uptake of the plants and via biofilms that grow on the plant roots) and suspended sediment loads. While their effectiveness in agricultural settings is not yet well understood and can be highly variable (Waterhouse *et al.*, 2024), they are generally considered useful for removing nitrogen, phosphorus, and fine sediment since they provide for denitrification, plant uptake, and filtration. The potential benefits of small-scale floating wetlands would help with water quality improvements prior to discharge to the downstream receiving environment of Te Waihora/Lake Ellesmere, although given the proximity of the floating wetlands to the pump station, aeration of water to prevent significant reductions in dissolved oxygen levels (Section 7.2.17) prior to discharge to Te Waihora/Lake Ellesmere may be required.

#### Key Features

- Requires permanent and deep water – limited to the perennial lower-most reaches of Osbornes Drain or the pump station forebay in the lower catchment.
- 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 planting floating wetland within the channel.
- Relatively easy to install and maintain, with no earthworks required.
- Early/immediate intervention option.

#### Core Benefits

- Water quality improvement.
- Easy to install and remove.
- Modular systems allow for flexibility and ability to modify design over time.



Cross section illustrating how a floating wetland modular system works.

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### 7.2.12 INTERVENTION 12: 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. It is important to note that sediment traps are not as effective at settling out the 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 the catchment.

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 the Osbornes catchment 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](http://www.livingwater.net.nz/im:c379467d-fdcb-44bc-9a69-dc61b62460ca)).

#### Key Features

- More suitable for deeper/incised channels where there is available land adjacent to the channel.
- Suitable upstream of treatment wetlands, to reduce sediment input to wetlands.

#### Core Benefits

- Facilitating the deposition and mechanical removal of fine sediment from the waterway network. *Note: not as effective in trapping finer clay-sized material.*
- Reducing the amount of fine sediment transported down the drainage network.
- Reducing the quantity of other contaminants that may be associated with fine sediment (e.g., particulate nutrients).
- Reducing the ecological impacts of widespread drain maintenance.
- Increasing the longevity of treatment wetlands (when used in conjunction with these).

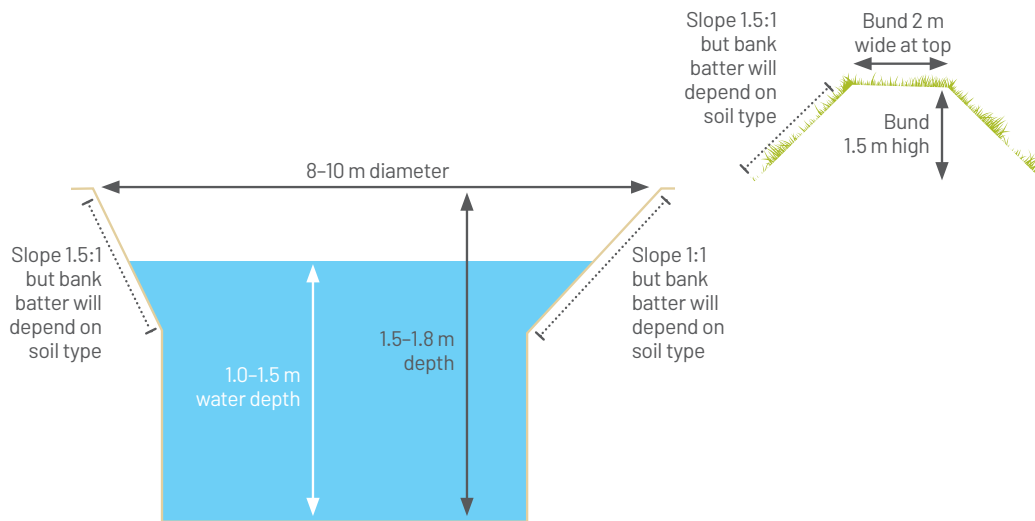
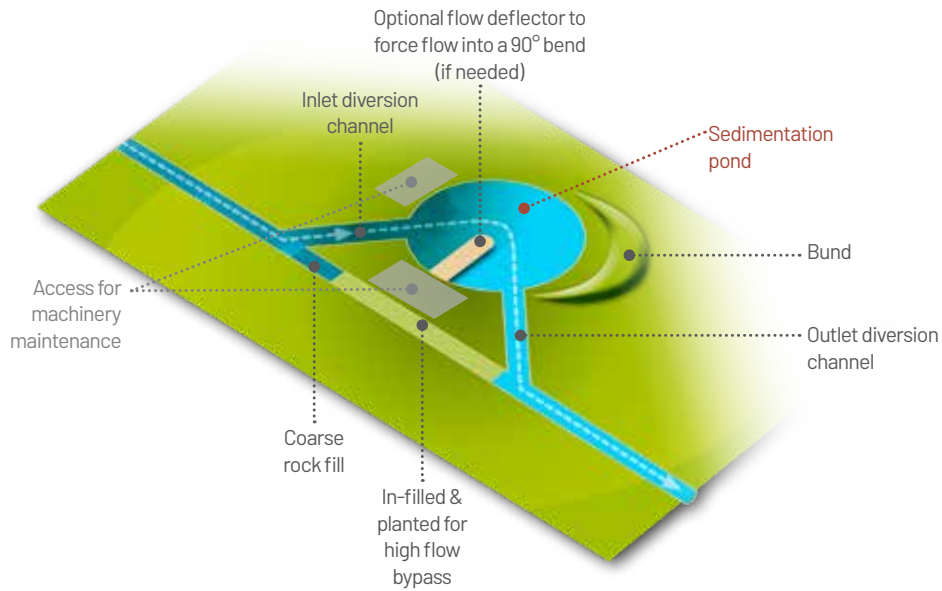


Diagram illustrating sedimentation pond.  
 (Modified from 'Sedimentation Pond' design in Eivers (2018).)  
 © EOS Ecology

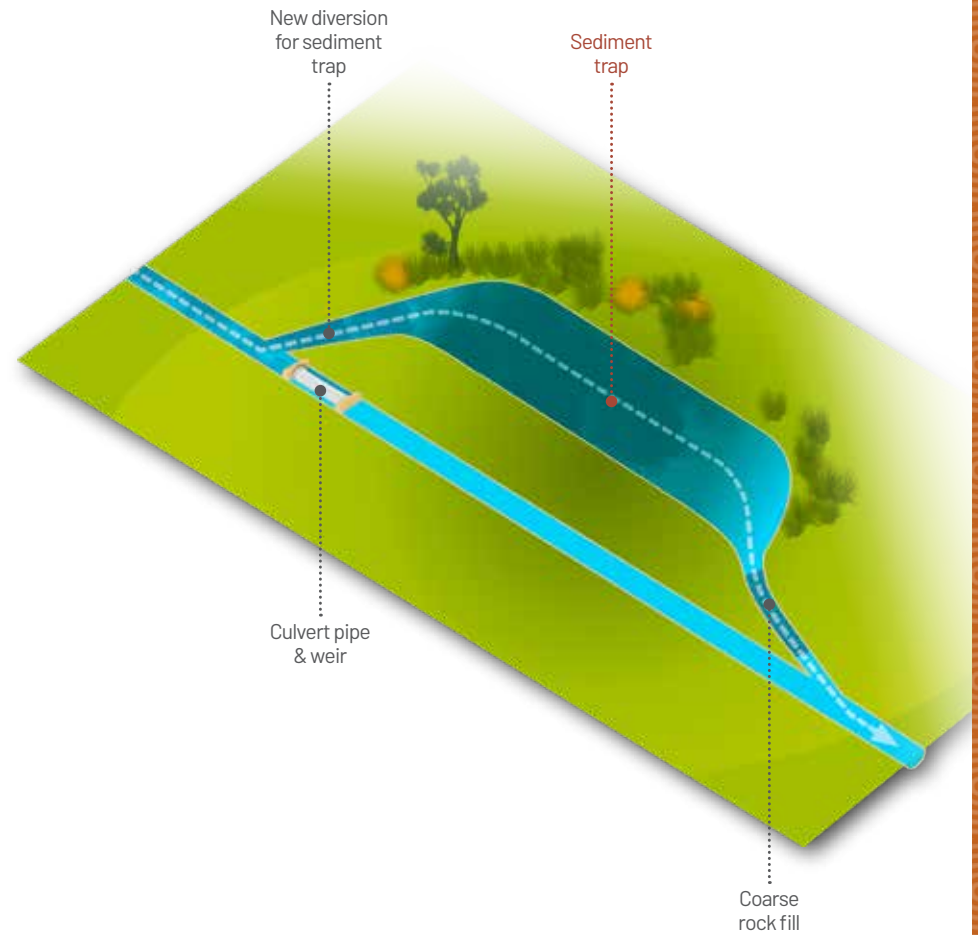


Diagram illustrating off-channel sediment trap.  
 (Modified from Living Water website [www.livingwater.net.nz/im:c379467d-fdcb-44bc-9a69-dc61b62460ca](http://www.livingwater.net.nz/im:c379467d-fdcb-44bc-9a69-dc61b62460ca).)  
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### 7.2.13 INTERVENTION 13: 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. It is important to note that sediment traps only trap larger/heavier sized particles – treatment wetlands will be needed to trap finer particulate matter. As such, a combination of sediment traps and treatment wetlands should be used to manage sediment in the catchment.

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.

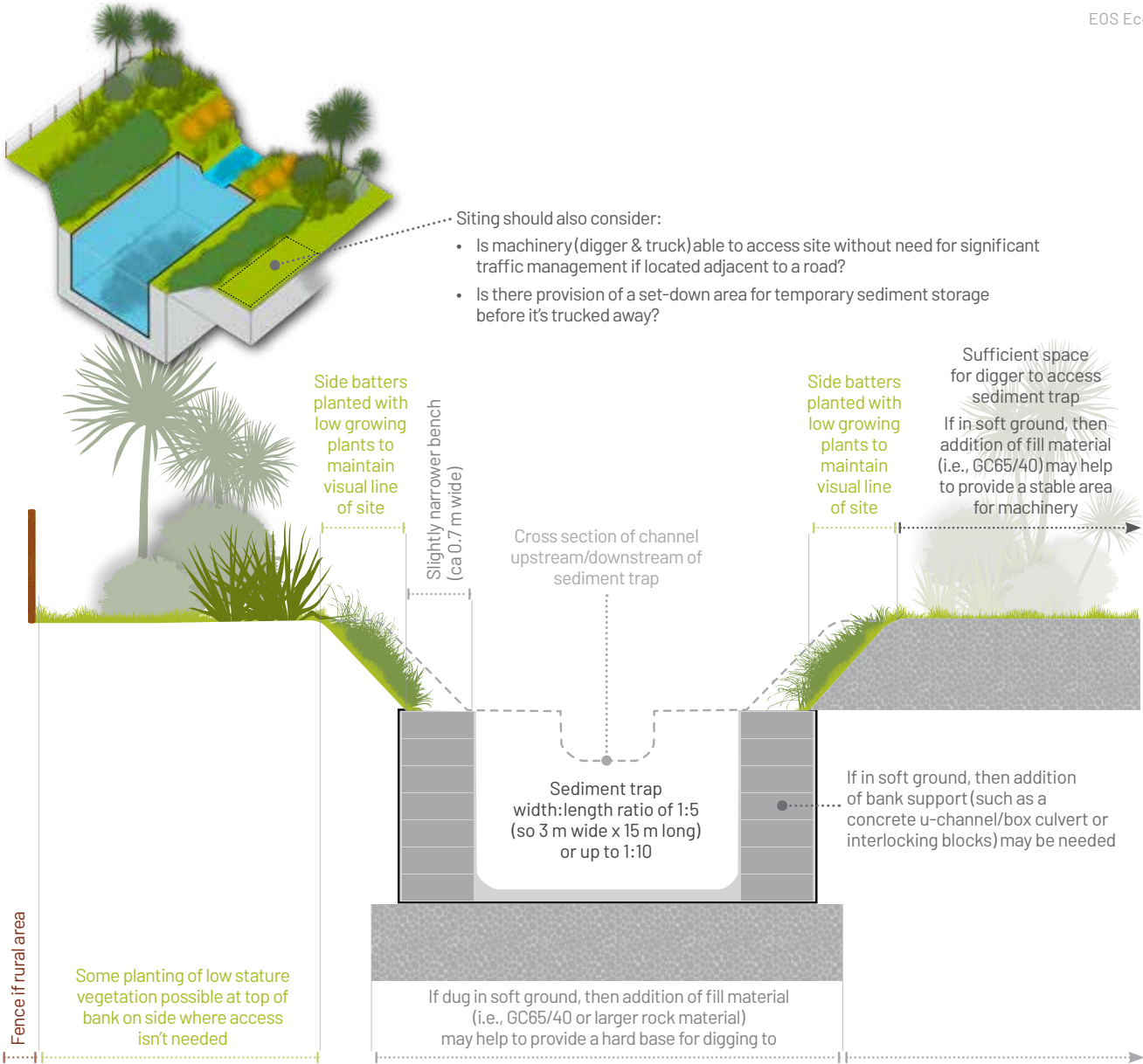
Compared to off-channel sediment traps, inline sediment traps are at greater risk of having accumulated sediment flushed out during a high flow event. However, because the Osbornes catchment is relatively flat and has a controlled outlet, flood flow velocities may not get high enough to scour out accumulated material from inline sediment traps. Removal of sediment may still require additional measures to limit resuspended sediment from being released, since they are inline with the main waterway. Inline sediment traps would involve enlarging and formalising existing sediment accumulation areas within the drainage scheme, providing for good machinery access for maintenance, and creating a 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, 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 inline sediment traps. The size of the machinery used to dig out the sediment trap will have an influence on where in the network inline sediment traps can be installed – areas where the channel is deeply incised may not be suitable due to limitations on the reach of an excavator. The recommended width-length ratio for inline sediment traps is a minimum ratio of 1:5 and maximum ratio of 1:10. Further information on inline sediment traps can be found on the Living Water website ([www.livingwater.net.nz/im:2115c587-9312-407d-a73e-6372ee3638cb](http://www.livingwater.net.nz/im:2115c587-9312-407d-a73e-6372ee3638cb)).

#### Key Features

- Not limited to rated drain network, suitable for all drain types with perennial or intermittent flow.
- An intervention for reducing sediment impact downstream but can also provide low flow habitat for fish.
- Hard edge lining may be necessary, with a focus on utility/maintenance requirements rather than biodiversity values.

**Core Benefits**

- Facilitating the deposition and mechanical removal of fine sediment from the waterway network.  
*Note: not as effective in trapping finer clay-sized material.*
- Reducing the amount of fine sediment transported down the drainage network.
- Reducing the quantity of other contaminants that may be associated with fine sediment (e.g., particulate nutrients).
- Reducing the ecological impacts of widespread drain maintenance.



- Siting should also consider:
- Is machinery (digger & truck) able to access site without need for significant traffic management if located adjacent to a road?
  - Is there provision of a set-down area for temporary sediment storage before it's trucked away?



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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### 7.2.14 INTERVENTION 14: SEDIMENT MANAGEMENT – Inline Event-Based Sediment Trap & Water Level Control

Inline event-based sediment traps are targeted areas for sediment removal in ephemeral sections of channel, where other inline sediment traps would be less effective. Based on the design principles of peak runoff control structures, these event-based sediment traps include a level of in-channel backup of water, which encourages the deposition of fine sediment. Similar in concept to peak runoff control structures, this type of sediment trap would require the installation of a control structure at the downstream end of the trap – for example, a culvert outlet, bund, spillway, or choked outlet could be used. The structures would be designed in such a way that the normal intermittent flow would pass through the control structure, but that water would be held back during higher flows, allowing sediment to settle out at those times.

This intervention could also be modified to be used as a form of water level control and treatment for parts of the catchment where there are tile drainage networks. Tile drainage is used to lower groundwater levels in waterlogged soils for improved pasture and crop growth but can cause reduced water availability in the ground during the drier (and main growing) season and can become a significant loss route for dissolved nutrients (Ballantine & Tanner, 2013). The use of water level controls in the catchment’s drainage channels can help to retain water within the soil profile during the drier summer months, increasing pasture and crop productivity during an otherwise moisture deficit period. The simplest form of water level control is to place a temporary control structure (i.e., a weir) in the channel at the end of the wet period to raise the water table, then to remove or lower them before the onset of the main wet season. Note that this approach requires active monitoring and maintenance. More automated forms of control are available that enable dynamic adjustment in response to soil water content. Such features could not only reduce the need for irrigation during the drier summer months, but also provide for sediment trapping and, should the water be retained for a sufficient time, allow for denitrification via microbial activity.

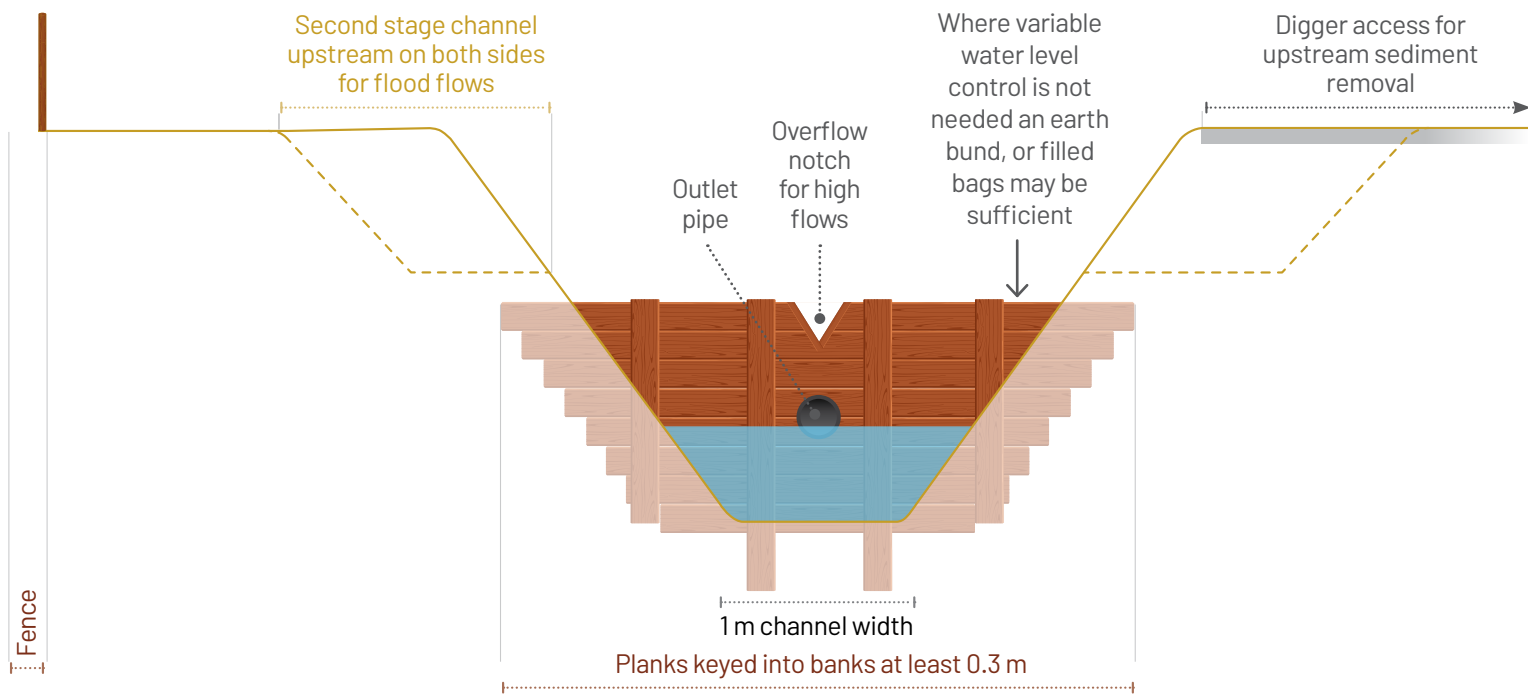
As this intervention would introduce a fish passage barrier to the system, it would only be suitable for ephemeral reaches within the catchment with low habitat values for fish upstream. The design of the structure would need to consider the existing ground levels to ensure that water does not overflow the available channel capacity – a design that incorporates a level of automation to the flow control would be ideal. 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 application for a catchment-wide resource consent for their initial construction and for the ongoing removal of sediment from these traps.

#### Key Features

- Not limited to rated drain network, suitable for ephemeral channels on farms.
- 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

- Facilitating the deposition and mechanical removal of fine sediment from the waterway network. *Note: not as effective in trapping finer clay-sized material.*
- Reducing the amount of fine sediment transported down the drainage network.
- Reducing the quantity of other contaminants that may be associated with fine sediment (e.g., particulate nutrients).
- Reducing the ecological impacts of widespread drain maintenance.



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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### 7.2.15 INTERVENTION 15: SEDIMENT MANAGEMENT – Detainment Bund

Paddock-based detainment bunds are an edge-of-field tool that may be used to settle sediment and nutrients out of overland flow/runoff that is generated during heavy rainfall events. Detainment bunds are typically built across informal flow paths or ephemeral waterways, where they hold back runoff and allow time for fine sediment to settle out of suspension and be deposited back on the paddock. Detainment bunds have been shown to be a cost-effective mitigation tool for retaining both fine sediment and particulate phosphorus within paddocks, although they are typically ineffective at reducing concentrations of dissolved nutrients (Clarke, 2013; Levine, 2020).

There is a vast length of informal flow paths in the Osbornes catchment relative to the length of waterways/formed channels (Table 6). In some cases, informal flow paths originate within critical source areas such as raceways, grazed forage crops, and pugged areas of paddocks. These critical source areas tend to have a disproportionately high contribution to the fine sediment and nutrient load that becomes entrained in runoff during rain events. Since runoff from paddocks and critical source areas feeds these ephemeral waterways, they may be a key source of contaminants to downstream waterways.

Paddock-based detainment bunds are typically constructed across a paddock to block off the flow path and hold back runoff for a period of up to several days to allow settling to occur. In sloped catchments, the natural landform is often used to provide the detainment area, while in flatter catchments a greater level of bunding will be needed to effectively hold back water. The optimal period for detaining water is around three days, to ensure that water retention does not kill the grass and to allow for the area to still be used for grazing. While inline sediment traps (Section 7.2.13) and event-based sediment traps (Section 7.2.14) are designed to be located within defined waterway channels, paddock-based detainment bunds are focused on informal flow paths where there is no defined channel. An advantage of paddock-based detainment bunds is that the large temporary ponding area provided by

detainment bunds allows for finer particles to settle out of suspension compared to inline or event-based sediment traps. While constructed wetlands also provide for the settling out of fine sediments, they may lack the capacity to achieve this during high flow events, and this is when paddock-based detainment bunds may be of most benefit. Paddock-based detainment bunds also provide treatment for runoff close to its source, reducing the loss of soil and nutrients from pastoral farmland and removing entrained contaminants before they can enter the catchment's waterways.

Detainment bunds rely on some infiltration of water into the ground, which allows them to trap finer sediment particles than what is possible with sediment traps. However, when used in poorly drained soils, infiltration is limited. In these conditions, detainment bunds primarily function by holding water back long enough for heavier or larger sediment particles to settle before the detained water is discharged to the receiving waterway or channel. Under such conditions, their ability to detain or trap finer particulates is reduced, and their function becomes more similar to that of a traditional sediment trap. In flat catchments with poor drainage, there may be insufficient fall to promote the drainage of water via gravity and the area required for detainment may be large. As the Osbornes catchment has predominantly poorly drained soils (90% poorly drained, 3% imperfectly drained, see Figure 10), paddock-based detainment bunds will primarily function to reduce peak runoff to the downstream catchment and trap heavier/larger sized particles. Their implementation should focus on areas with more overland flow paths (Figure 13) and land uses that generate higher sediment runoff. However, they must be carefully designed given the flat gradient, as water may be detained for prolonged periods and take up a large area.

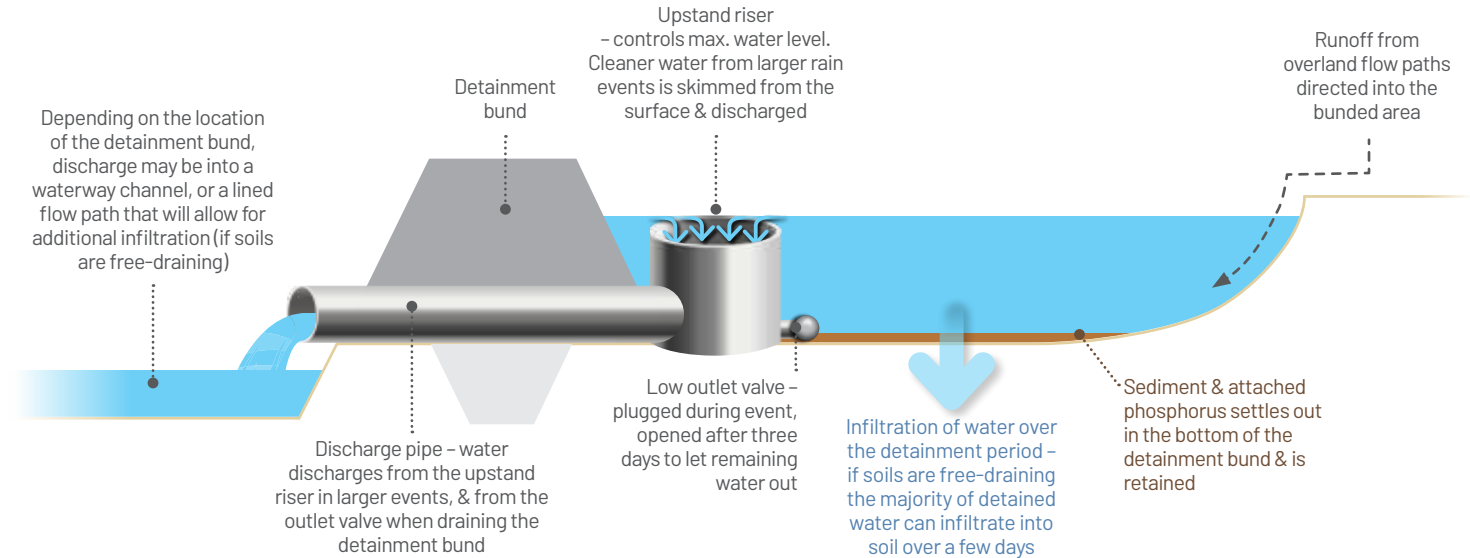
Further information on detainment bund design can be found in Patterson (2019) and Patterson *et al.*, (2019). Guidance from a specialist to design site-specific detainment bunds is recommended.

### Key Features

- Suitable for overland flow paths.
- Holds back flows during high rainfall events to provide for the attenuation of fine sediments and particulate nutrients.
- Reduces the loss of soil and nutrients from pastoral farmland by managing runoff close to source, but less effective in poorly drained soils where infiltration will not occur.
- An intervention for reducing sediment and nutrient impacts on the downstream environment.
- Careful design required for Osbornes catchment because of poor soil drainage and flat catchment.

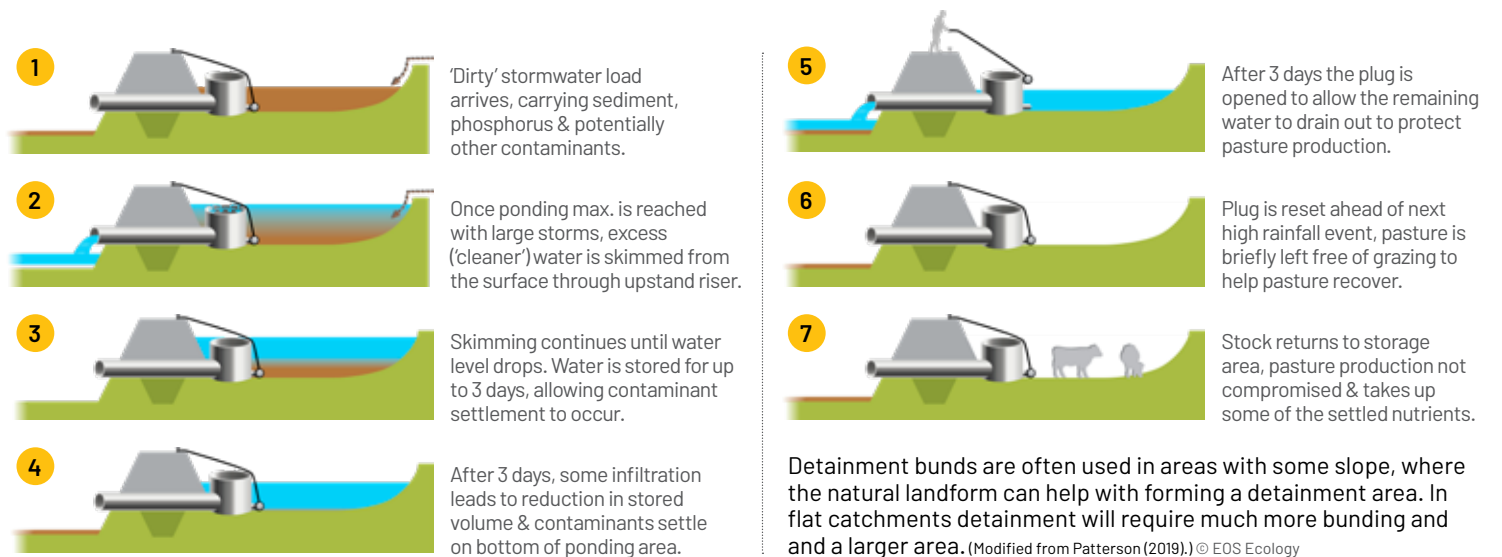
### Core Benefits

- Reducing the amount of fine sediment transported down the drainage network.
- Retaining soil and nutrients on pastoral farmland.
- Reducing peak runoff.



Detainment bunds pond water behind an earth bund, which may be around 1.5m 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



Detainment bunds are often used in areas with some slope, where the natural landform can help with forming a detainment area. In flat catchments detainment will require much more bunding and a larger area. (Modified from Patterson (2019).) © EOS Ecology

### 7.2.16 INTERVENTION 16: SEDIMENT MANAGEMENT – Bunded Sediment Stockpile

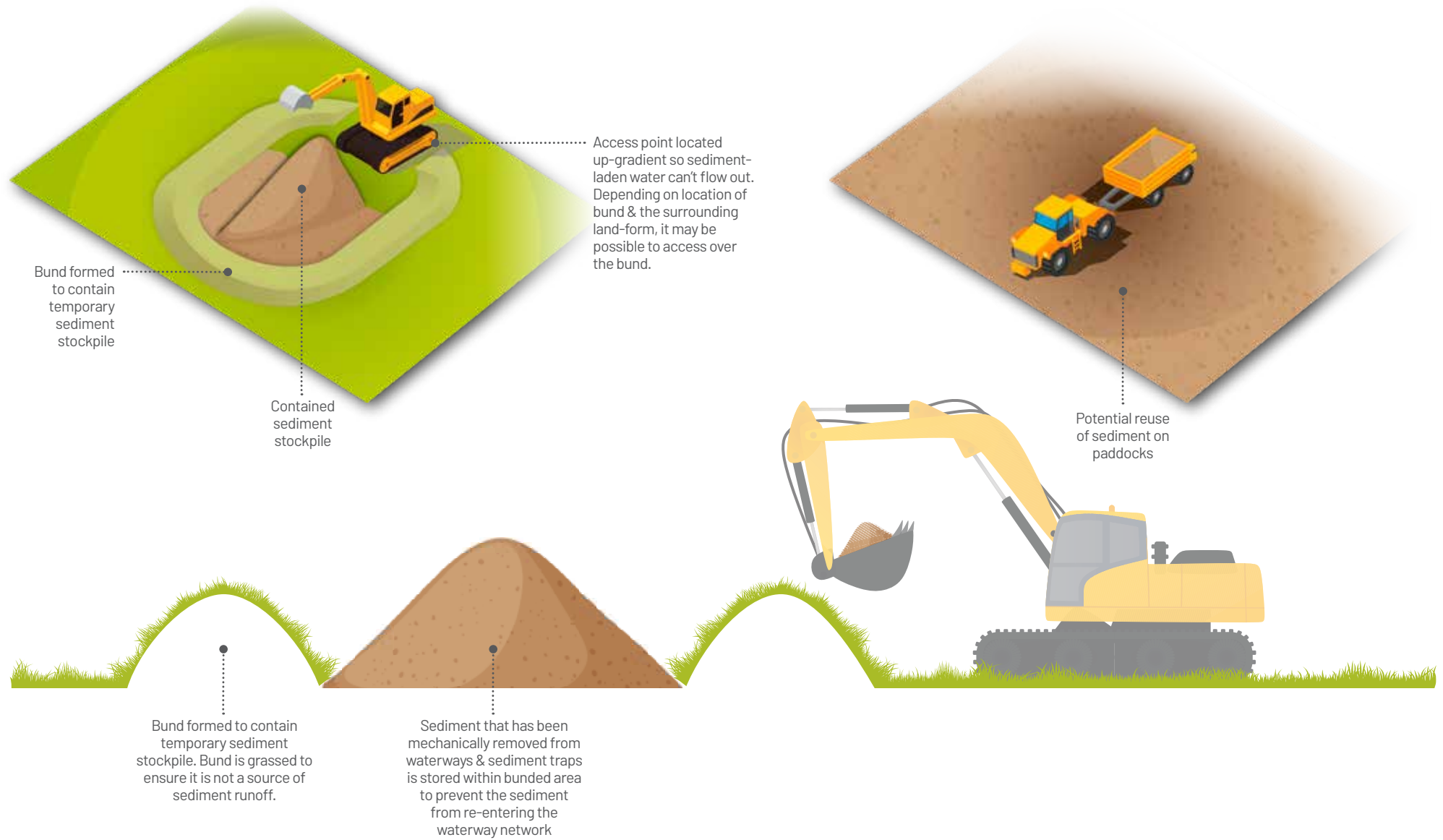
The Osbornes catchment has an existing and ongoing requirement for the mechanical removal of fine sediment to maintain the drainage function of the waterways within the scheme and to reduce the potential for accumulated fine sediment to contribute to water quality issues in the discharge from the catchment to Te Waihora/Lake Ellesmere. As the toolbox of interventions recommended in this CMP are implemented within the Osbornes catchment, there is expected to be a shift in the way that sediment is removed from the system. The existing widespread approach to sediment removal is expected to be replaced by a system that is focused on accumulating and removing sediment from well-defined sediment traps (Sections 7.2.12, 7.2.13, & 7.2.14). However, with both the existing and future approaches to sediment removal, there is a desire by the Osbornes Drain Catchment Management Working Party to retain sediment within the catchment if possible, which will require an area to stockpile the extracted sediment in a location that prevents it being transported back into waterways. The bunded stockpile provides a temporary storage location for the excavated material and enables the sediment to be tested for contamination and assessed for suitability to be reused on land within the catchment. In the instance that the sediment is suitable for reuse on land, the bunded stockpile facility will provide the flexibility to allow sediment to be spread on land when timing is most suitable in terms of stabilising the sediment with grass or other vegetation. The location of bunded stockpiles of sediment will need to be determined based on land availability and proximity to sediment traps.

#### Key Features

- Area for the temporary storage of sediment that has been mechanically removed.
- Prevents excavated sediment from washing back into waterways.
- 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.
- Providing for the re-use of sediment within or outside of the catchment.



Diagrams illustrate banded sediment scenario.

© EOS Ecology

### 7.2.17 INTERVENTION 17: OTHER – Aeration Pumps to Prevent Significant Reductions in Dissolved Oxygen

Low dissolved oxygen (DO) is a key water quality issue for the Osbornes catchment. Monitoring data from the pump station site indicates a declining annual trend between 2014 and 2021, with DO saturation typically below 50% during summer and autumn (December to May) (GHD, 2021). These DO values are based on daytime spot measurements, which influences results because photosynthesis increases DO levels during daylight hours, while respiration decreases DO at night. Therefore, although daytime measures of DO are low, DO levels are likely to get even lower at night.

Low DO strongly influences water chemistry. In the Osbornes catchment, the low DO conditions are expected to cause accumulated fine sediments to release phosphorus and organic matter, through the role of oxygen in carbon, nitrogen, and phosphorus cycling (Figure 19). Low DO also places significant stress on aquatic organisms, meaning that this issue must be addressed before improving fish passage through the pump station and providing a way for fish to enter the catchment waterways.

Aeration pumps are a potential intervention to mechanically increase DO levels within the Osbornes catchment waterways. Aeration is widely used in highly organic wastewater treatment systems and dairy effluent ponds to prevent anoxic conditions that can cause odour issues and poor treatment performance. It has also been used in park settings across Aotearoa New Zealand. For example, aeration has been installed in the Auckland Domain duckpond to improve water quality and at Virginia Lake in Whanganui to control toxic cyanobacteria blooms and odour. Similarly, in the Osbornes catchment, aeration could help maintain DO levels and reduce associated water quality problems. Various aeration solutions are available, including surface and subsurface options (e.g., <https://parklink.nz/lakes-and-ponds/aeration>; [www.apexwater.co.nz/products/apex-surface-aerators](http://www.apexwater.co.nz/products/apex-surface-aerators)). Costs (including the cost of establishing a power supply to the aerators) and benefits of these options would need to be assessed in the context of Osbornes catchment.

Aeration is included as an intervention in this CMP as a future backup option, if the recommended suite of tools and solutions does not achieve sufficient improvement in DO levels in these drainage waterways. The purpose of the intervention would be to prevent significant reductions in DO throughout the perennial reaches of the catchment (not just the forebay), thereby preventing the deterioration of the water quality at the pump station and ultimately improving the discharge to Te Waihora/Lake Ellesmere.

#### Key Features

- Future backup option to prevent significant reductions in dissolved oxygen levels.
- Mechanical aeration could be focused in the perennial sections.
- Purpose to prevent significant reductions in DO in the catchment, thereby improving dissolved oxygen in the discharge to Te Waihora/Lake Ellesmere.
- Costs and benefits of aeration options would need to be considered.

#### Core Benefits

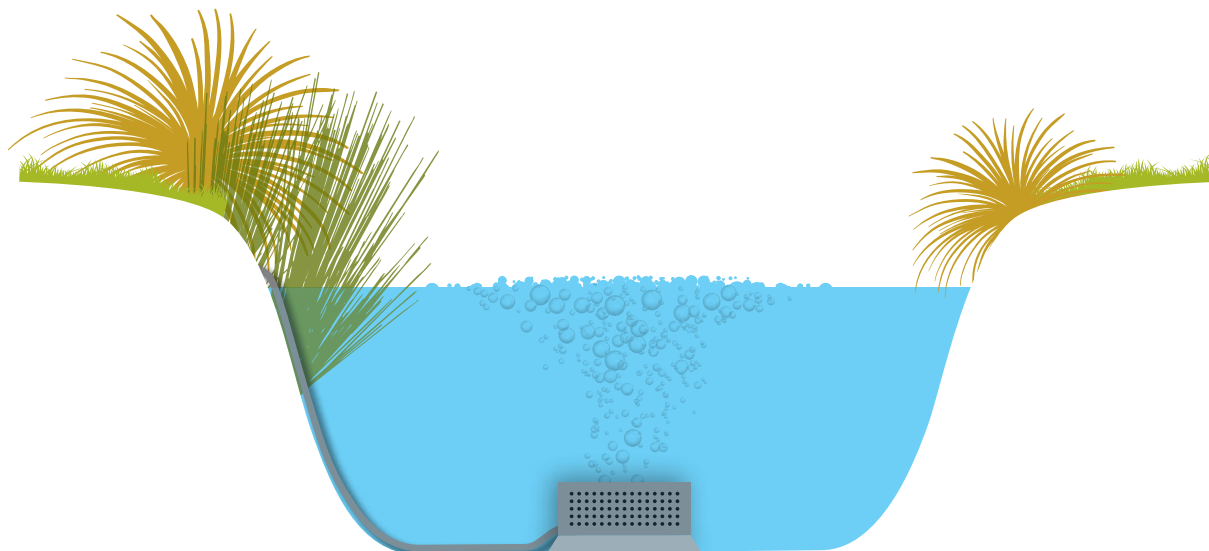
- Preventing significant reductions in dissolved oxygen helps to reduce impacts on instream life.
- Avoid persistently low DO conditions that contributes to the generation of elevated contaminant (i.e., phosphorus) levels in the discharge to Te Waihora/Lake Ellesmere.



Example of a surface fountain-type aeration system.  
© EOS Ecology



AI generated image



Example of a sub-surface aeration pump system.  
© EOS Ecology

### 7.2.18 INTERVENTION 18: OTHER – Low Flow Use for Irrigation/Land Discharge

A potential short-term measure to reduce the effects of poor water quality in the Osbornes catchment could be discharging drainage water to land and thus removing fine organic surficial sediments during summer, when water quality is typically at its poorest. The current discharge consent (CRC172231) sets water quality limits for total ammoniacal nitrogen and targets for nitrate-N, DRP, *E. coli*, DO, and total suspended solids. If these standards are not met, the consent holder must investigate, conduct further monitoring, and implement all practicable measures to achieve compliance.

Previous monitoring has shown that some water quality standards, particularly for DO, DRP, and *E. coli*, are not consistently met. Discharging water and organic surficial sediments to land during low-flow periods offers an alternative treatment and avoids discharging poor quality water into Te Waihora/Lake Ellesmere. This option serves as a contingency when interventions are still being implemented and modified, and discharge via the pump station is unsuitable due to water quality concerns. While the frequency of its use is uncertain, the existing consent already allows for this approach, enabling its implementation as needed under suitable conditions.

#### Key Features

- Potential discharge to land when poor water quality limits the ability to discharge to Te Waihora/Lake Ellesmere.
- Provides opportunity for land treatment of drainage water and surficial sediments.
- Would need to be tied in with farming operations to be beneficial.
- The current resource consent conditions allow this.

#### Core Benefits

- Irrigation to land reduces the need to discharge poor quality water to Te Waihora/Lake Ellesmere.



Image source: Shutterstock

Potential discharge of water from the lower reaches of Osbornes Drain (including at the pump house) to land – an alternative to discharging poor quality water to Te Waihora/Lake Ellesmere during low flow periods.

## 7.2.19 INTERVENTION 19: PUMP STATION MODIFICATIONS – Fish-Friendly Pumps

For over a century, fish have not had unimpeded access to the waterways within the Osbornes catchment; however, they have still managed to make their way into the catchment in significant numbers. There has been a pump station at the outlet of Osbornes catchment since the 1960s, although the drainage scheme has been discharging to Te Waihora/Lake Ellesmere through flapped floodgates since the early 1900s (Section 3.1). The existing pump station does not explicitly provide for fish passage into or out of the catchment. As a requirement of the resource consent to discharge water from the Osbornes catchment into Te Waihora/Lake Ellesmere (CRC172231), SDC installed a fish exclusion device to prevent fish from entering the pump station and to improve the pump station flap valves to prevent recirculation of water from the lake back into the drainage network. SDC was also required to prepare an eel and fish impediment and relocation plan, and this was completed during 2017 (Jacobs, 2017). The plan confirms that the pump station is maintained to impede the migration of fish and eels between Te Waihora/Lake Ellesmere and the Osbornes catchment, although the related fish relocations have shown that there are several species of fish in the catchment, including shortfin tuna/eel, longfin tuna/eel, inanga, and upland bully. Despite annual fish salvage and relocation over five years, tuna/eel numbers have remained stable, suggesting that there may be ongoing recruitment pathways to the catchment. While it is uncertain how these fish are making their way into the catchment, there is some connection between the Osbornes catchment and the neighbouring Huritini/Halswell River during floods that overtop the embankment between these systems.

While it is possible to improve the pump station to allow for safe upstream and downstream fish passage, this should only be considered once water quality and habitat conditions upstream of the pump station have improved. At present, encouraging fish passage into the catchment would be inappropriate, as the habitat and water quality conditions in the drainage waterways are known to be stressful for aquatic life. However, there is potential to explore options for downstream movement of fish out of the catchment. Given the significant numbers of fish, particularly important mahinga kai species such as tuna/eels, captured and relocated out of Osbornes Drain over a five-year period, steps to facilitate downstream movement are necessary. This includes investigating fish-friendly pump options.

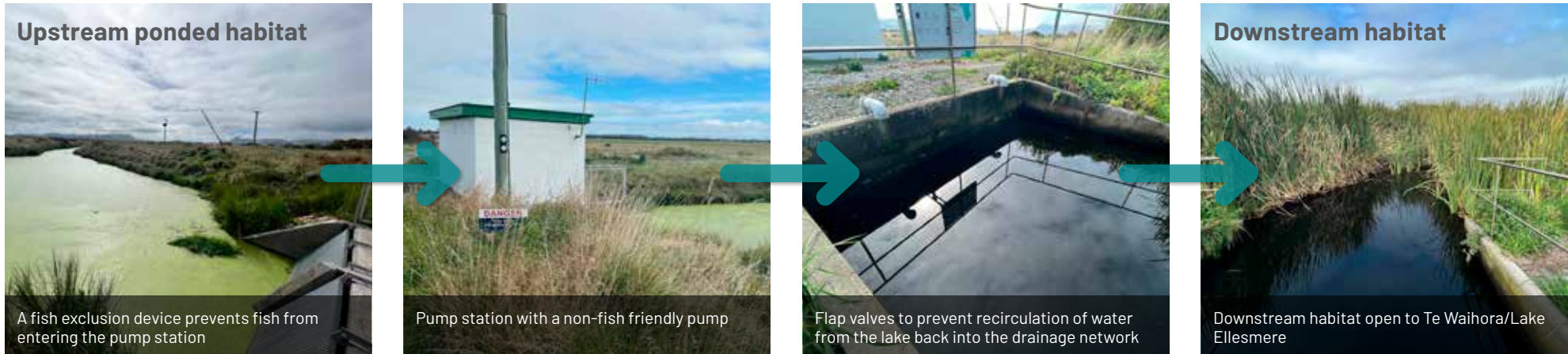
Fish passage improvement through pump stations has been undertaken in drainage and stormwater schemes in other parts of Aotearoa New Zealand, including Waikato ([www.waikatoregion.govt.nz/services/publications/ps2318/#:~:text=To%20help%20combat%20these%20effects%2C%20the%20Pathways%20to,fish%20at%20Waikato%20Regional%20Council%20%28WRC%29%20pump%20stations](http://www.waikatoregion.govt.nz/services/publications/ps2318/#:~:text=To%20help%20combat%20these%20effects%2C%20the%20Pathways%20to,fish%20at%20Waikato%20Regional%20Council%20%28WRC%29%20pump%20stations)) and the Kāpiti Coast ([www.stantec.com/en/projects/new-zealand-projects/t/te-ati-awa-stream-pump-station](http://www.stantec.com/en/projects/new-zealand-projects/t/te-ati-awa-stream-pump-station)) – and the learnings from these will be valuable to consider in the context of the Osbornes catchment. Further information on improving fish passage at pump stations can be found here: [www.doc.govt.nz/globalassets/documents/conservation/native-animals/fish/fish-passage/pump-station-fish-passage.pdf](http://www.doc.govt.nz/globalassets/documents/conservation/native-animals/fish/fish-passage/pump-station-fish-passage.pdf).

### Key Features

- Modification of the pump station to provide for fish passage between Osbornes catchment and Te Waihora/Lake Ellesmere.
- Shorter term goal to allow fish passage out of the catchment.
- Future potential to provide for two-way fish passage – only recommended once water quality and instream habitat have been improved by implementing other tools and solutions.
- Existing resource consent would need to be amended to allow for this.

### Core Benefits

- Providing for fish passage between Osbornes catchment and Te Waihora/Lake Ellesmere (into or out of the catchment).



**Upstream ponded habitat**  
A fish exclusion device prevents fish from entering the pump station

Pump station with a non-fish friendly pump

Flap valves to prevent recirculation of water from the lake back into the drainage network

**Downstream habitat**  
Downstream habitat open to Te Waihora/Lake Ellesmere

The current pump house limits fish passage and disconnects Te Waihora/Lake Ellesmere from the Osbornes catchment. Water quality and habitat conditions in the catchment need to be improved before upstream fish passage is improved, as current conditions are unsuitable for fish.

**Enclosed screw:**  
**FishFlow Enclosed Archimedes Screw Pump (EASP)**  
99% safe passage (1% injured, 0% mortality)  
- findings based on tests with tuna/eels.

**Direct-drive Axial-flow:**  
**Modified MacEwans FF 24/30**

- 97% safe passage (2% injured, 1% mortality) - findings based on tests with tuna/eels.
- Can retrofit existing pump without civil rebuild.
- Other MacEwans axial pump options are not fish-friendly (31-100% fish mortality).

**Submersible:**  
**Bedford Submersible SAF45**

- 45% safe passage (49% injured, 6% mortality).
- Lower mortality rate than traditional pumps but still inflicts considerable injury. The SAF70 is unlikely to be better.

**Direct-drive mixed-flow:**  
**Bosman MC Vision**

- Not yet tested in Aotearoa NZ.
- Can be made to a range of sizes (small-to-large head and flow volumes) so if successful would be a good alternative for budget- or size-constrained sites.

Pumps considered to be fish-friendly based on guidance from Department of Conservation. Above are the findings from Waikato Regional Council field testing of fish passage (Williams, 2025; White *et al.*, 2024).

### 7.2.20 INTERVENTION 20: PUMP STATION MODIFICATIONS – Pump Station Removal

Removing the Osbornes Drain pump station would allow a direct connection to Te Waihora/Lake Ellesmere, which may help reinstate elements of the natural lake mixing processes, improving water quality. Currently, the pump station creates an artificial impoundment that leads to stagnant water and contributes to poor water quality in Osbornes Drain. Since fish have not had unimpeded access to the waterways within the Osbornes catchment for over a century (Section 7.2.19), pump station removal would also reconnect the catchment with the lake and increase fish habitat availability. Although improving water quality in the catchment and meeting the existing water quality consent limits is the current priority for the Osbornes Drain Catchment Management Working Party, pump station removal is identified as a potential future option.

Complete removal of the pump station would require a substantial re-think of the function of the drainage scheme and land use in the catchment, which is currently protected/isolated from the wider Te Waihora/Lake Ellesmere system. In particular, with the removal of the pump station, water levels in Te Waihora/Lake Ellesmere would become the key influence on waterways in the lower part of the catchment, along with land drainage. The effects of climate change and sea level rise would also have a comparatively greater influence on the low-lying catchment.

#### Key Features

- Long term solution.
- Enable unimpeded access for fish into and out of the catchment.
- Significant impacts on current land use.

#### Core Benefits

- Providing for fish passage between Osbornes catchment and Te Waihora/Lake Ellesmere (into and out of the catchment).

**Upstream environment**



**Downstream environment**



**Remove pump house to connect upstream & downstream environments**





Reserve area downstream of  
pump station where wetland  
restoration will occur

Image source: Stu Farrant

## 8 Long-Term Vision & Aspirations

Intensively modified lowland catchments are among the most degraded aquatic systems in Aotearoa New Zealand. To halt further degradation and improve these waterways and their downstream receiving environments, substantial changes in management practices are essential. The Osbornes catchment is a highly modified system of drainage waterways with a unique pumped outfall. Its water quality and habitat are in a severely degraded state. The initial focus for this catchment is improving water quality by reducing contaminant inputs from the land area, preventing deterioration in the perennial storage reaches, and maintaining good water quality at the point of discharge. This differs from other drainage catchments where immediate habitat restoration or ecological enhancement are the priority. Over time, as water quality improves, the goal will shift toward enhancing ecological and cultural values within the catchment.

Given Osbornes Drain's contribution of flow and contaminant loads to Te Waihora/Lake Ellesmere, improving discharge quality is critical. This CMP provides a roadmap for transformative waterway management in the Osbornes catchment. It outlines catchment-scale approaches and a toolbox of interventions that address drainage functions while managing water stored in perennial reaches prior to intermittent pumped discharge. These actions lay the foundation for improving ecological, cultural, and landscape values over time.

The CMP includes tools that have proven successful on a trial basis in conventional drainage catchments but have not yet been applied at this scale in Aotearoa New Zealand. The Implementation Guide (IG) for the Ararira/LII (Aqualinc *et al.*, 2023) demonstrated how such tools can be integrated into the existing management framework through a staged, coordinated approach to achieve the catchment vision. This guidance is equally relevant to the Osbornes catchment but must also address the unique challenge of water degradation during storage in the perennial reaches before pumping. While some solutions proposed in this CMP may incur higher costs than current practices, their multiple benefits will help steer the catchment toward a more sustainable and resilient future. The greatest challenge is ensuring proactive management of water quality prior to pumped discharge, which is unique to this catchment in a Canterbury context.

Effective implementation of this CMP and others in the Selwyn District will rely on adaptive management. This involves setting appropriate measures and targets across multiple values, monitoring progress, and adjusting as needed. Initially, efforts must focus on reducing contaminant inputs and actively managing perennial reaches to prevent anoxia and additional contaminant generation. Over time, monitoring should expand to include cultural indicators alongside ecological assessments. Early indicators of success will include reductions in

fine sediment loads, improved dissolved oxygen levels in the perennial reaches, and ultimately decreases in contaminant concentrations. The CMP also recognises the need to maintain adequate drainage for productive land, requiring ongoing monitoring of water quality and quantity discharged from the pump station, as formalised in the resource consent conditions.

The Osbornes CMP provides a transformative approach to addressing the pressing challenges of degraded water quality while balancing the needs of productive land use. By prioritising water quality improvements, maintaining water quality in perennial reaches, and gradually transitioning towards ecological and cultural enhancement, the CMP provides a clear pathway for sustainable catchment management. Through adaptive implementation underpinned by robust monitoring and evaluation, this plan sets the foundation for transforming Osbornes catchment into a healthier, more resilient system that contributes positively to the wider Te Waihora/Lake Ellesmere catchment and aligns with the aspirations of its community. 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. Interventions identified through the CMPs and master plans will be progressed through design, consenting and construction stages in the 2026/27 Annual Plan and across the 10-year period of the 2027–2037 Long Term Plan.



A managed grassed ephemeral flow path

Image source: EOS Ecology

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