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BETTER ENVIRONMENTS, BETTER RETURNS

Willow Management Options for Managing Flood Risk

Prepared for Lowburn Community Catchment Group

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1. Introduction

The Lowburn Community Catchment Group obtained access to experts through the Freshwater Access to Experts programme which is a Ministry for Environment service delivered by Beca and NZ Landcare Trust. The scope of the project is to describe what the impacts of willows along the Lowburn Creek could be in relation to flooding risk and sediment control, and collate the perceived benefits and risks of willows by landowners. This report provides advice on some of the general benefits and risks posed by willow and the potential impacts of willow removal. This report is a starting point to enable discussions rather than the outcome. It does not provide a plan for willow management and instead summarises key information about willows and highlights opportunities to effectively and practically manage them going forward, based on a wide range of relevant sources further detailed in Appendix B, and identifies potential next steps.

1.1 Methodology

The following methodology was undertaken:

- Online survey of the catchment group and opportunities to submit knowledge and photos of willow and flooding experiences.
- Meeting between catchment group members and experts including site walkover from bottom to (road accessible) top of catchment.
- Develop this report and associated maps (the maps were not initially in scope but have been included based on catchment group feedback) with reference to existing literature and community feedback.
- Catchment group review of this report and subsequent discussion with experts

2. Technical Information Summary

The following provides key context in relation to willows, flood management and water quality and quantity. In each instance there is not a simple 'willows are good' or 'willows are bad', it comes back to the right plant in the right place.

Included in Appendix B is a bibliography that is numbered, and these are referred to below in text. The general themes from those references have contributed to the summary of information below along with our assessment and local knowledge of Willows in Central Otago and across New Zealand.

2.1 Willows

Willows aren't native to New Zealand, but we're all familiar with them as they have been in NZ since the 1830's^{4, 7}. Like any tree a key point is that you need to think about the right tree in the right place for the purposes you are looking to achieve. Crack willow (*Salix fragilis*) and grey willow (*Salix cinerea*) are very

invasive and can live for 100 years (pest willows)⁷. It is illegal to propagate or plant crack willow in NZ⁷. Matsudana willow and its hybrids are tree willows used for shelter belts and erosion control⁴ on land and along rivers, and there are a wide variety of popular clones^{5, 7}. In the wrong place, even non-invasive willows can block streams causing flooding, and scour stream banks⁷. Other factors to consider are that willows don't fruit and can shade out other plants.

2.2 Flooding

The erosive power of flowing water increases during periods of heavy rain. The more rain the greater the water volumes and velocity, and the greater the erosive forces. The natural habitat of many willows is the unstable streambank and riverbank environment. Their extensive root system gives them great stability in floods and the mass of fine roots will bind soil in all its forms and create an effective barrier between the flowing water and the soil, preventing gullyng and protecting stream and riverbank and slowing flows⁷. However, pest willows shed branches and during drier conditions spread across stream beds creating blockages and facilitating dam creation which can lead to diversion and scour during periods of high flow⁷. It can't be assumed that a native tree will do a better job. The right tree is context dependant and there is therefore a need to carefully consider what factors are contributing to the biggest risks, including flooding, and potential impacts.

2.3 Water Quality and Quantity

Willows can have both positive and negative impacts on water quality and quantity. They can provide shade and leaf matter to contribute to a healthy stream ecosystem. They can uptake a significant volume of water and due to their high transpiration rates, deplete streams and groundwater – especially in summer (case study data available from Waipara, North Canterbury⁸). Water savings could be made by planting shorter shallow-rooted species in riparian zones for which transpiration and growth are seasonally limited by water availability⁶.

Water quantity is an important value in the Lowburn Creek catchment,^{11,12} as to the habitat for brown and rainbow trout spawning, and juvenile rearing being an important source of recruitment for the Lake Dunstan trout fishery.¹² In particular, and in addition to the recreational trout fishery, longfin eel, koaro and upland bully are also present in the catchment.¹² Clutha flathead galaxias are present in the upper tributary known as Packspur Creek and are known to be the only population of Clutha flathead galaxias in the Low Burn catchment.¹³ In the fish survey report prepared by Water Ways Consulting Ltd in 2020, controlling the crack willow in Packspur Creek was an important management consideration, uncontrolled crack willow could rapidly colonise the stream courses and cause significant habitat alteration if not controlled.¹³

Water quality in the catchment is considered good and highly valued by local residents. The Otago Regional Council monitor water quality at Lowburn Creek at Swann Road. Water quality data for this site taken from the Otago Regional Council's Environmental Data Portal,¹⁴ is reproduced below. Table 1 includes a description of these water quality indicators.

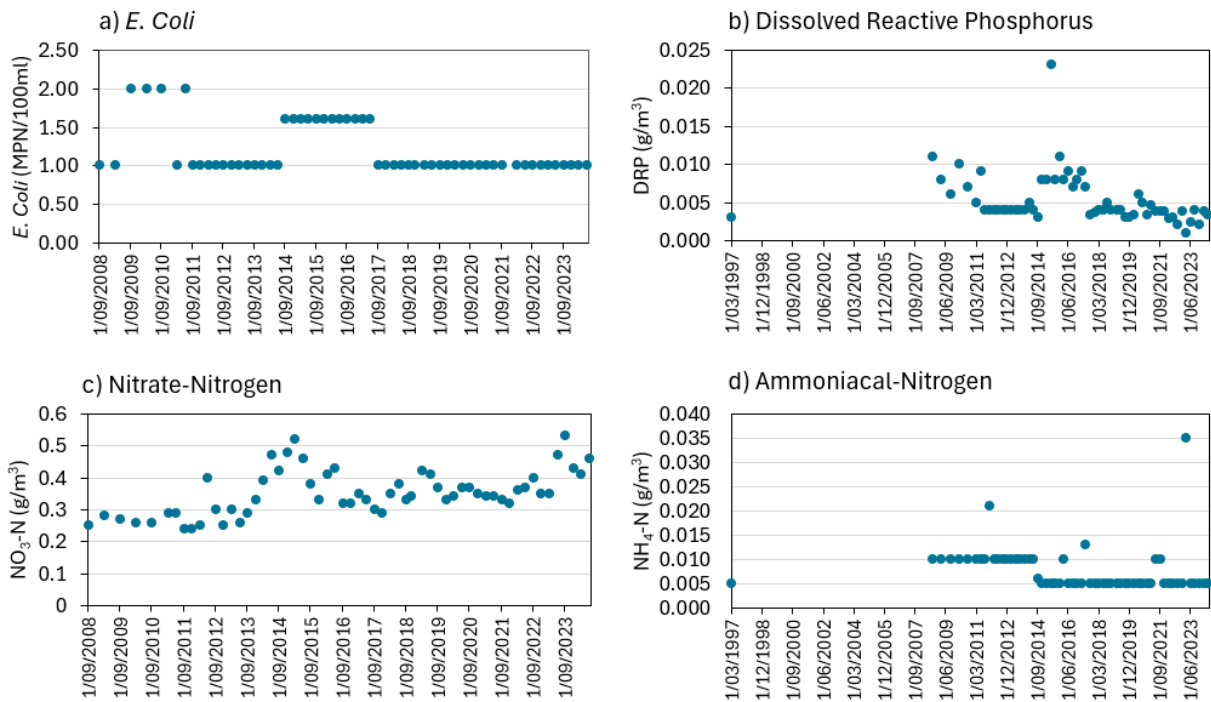


Figure 1: Data sourced from Otago Regional Council for a) *E. Coli*, b) dissolved reactive phosphorus (DRP), c) nitrate-nitrogen (NO₃-N), and d) ammoniacal nitrogen (NH₄-N).

Table 1: Summary of four key water quality indicators for water quality monitored by the Otago Regional Council.

Water Quality Indicator	National Objective Framework ¹ Limit	What is it? ¹⁵	Why is it a problem? ¹⁵
<i>E. coli</i>	130 (MPN/100ml) (median)	A type of bacteria from animal and human intestines.	High levels can cause illness.
DRP	Proposed metric only 0.018 g/m ³ (annual median)	Soluble phosphorus from rocks, minerals, soil, and fertilizers.	High levels can lead to excessive algae and weed growth, harming aquatic life.
NO ₃ -N	2.4 g/m ³ (annual median)	Nitrate from fertilizers, waste, and soil cultivation causing leaching.	High levels can be harmful to humans and animals in drinking water and promote excessive algae growth.
NH ₄ -N	0.24 g/m ³ (annual median)	A form of nitrogen found in fertilizers and sewages/effluents.	High levels can be toxic to aquatic life.

¹ The National Objectives Framework in the National Policy Statement for Freshwater Management 2020 sets out the process for regional councils, with communities and tangata whenua, to manage freshwater in their regions.

2.4 Willow Removal

Based on ORC comment²; Heli spraying or drill and inject in early autumn are recommended. This way the herbicide is drawn into the root system for an effective kill. Then leaving them to rot naturally or undertaking mechanical removal (generally not the root ball – this may trigger the need for consents) the following season. The slow rot approach generally means limbs crumble from the tips, not fall as large branches, but health and safety risks would need to be considered.

There are rules which may apply to the removal of willows from in and around rivers, lakes, and wetlands. These rules are in the local Regional Water Plan. What rules apply will depend on where the willow is located and the method you use to remove them.

If the activity is a permitted activity under the Regional Plan: Water, there are conditions relating to keeping floodways clear, controlling erosion and sediment release into water, retaining the natural shape of the waterway and avoiding other users downstream. In some cases, the Otago Regional Council must be notified before work commences.

3. What You Value About the Lowburn Creek

Based on the community members' input, below are the key identified values for the Lowburn Creek and catchment.

Environmental and Ecological Health	The community values the creek's role in supporting local wildlife, including trout spawning, natural galaxiids, bees, insects, and bird habitats. Clean, healthy water and a natural environment are also highly valued.
Recreational and Aesthetic Enjoyment	The creek is appreciated for recreational activities like swimming and kids playing, as well as its aesthetic beauty and the feeling of wildness it provides on some properties.
Historical and Cultural Significance	The history of the catchment and its cultural importance to the community are recognized and valued.
Practical Uses	The creek is important for practical purposes such as irrigation water, a source of firewood, and flood protection through stop banks and culverts.
Sustainability and Flow	Ensuring the continual flow of the creek and maintaining its cleanliness and ecological value are crucial for providing environmental and economic benefits to the community.



² In relation to specific consent requirements contact Otago Regional Council (contact details in appendix). The Otago regional plan for freshwater has some permitted activities including 12.B.1 which provides as a permitted activity for the discharge of herbicides if certain conditions are met. There is no permitted activity for mechanical removal.

4. Your Experience of Willows

We sought the community’s perspectives on a range of topics including what your perception is of the Willows along the Lowburn Creek, and about what your experiences of Willows has been.

Included in Appendix A is a map of the Lowburn Creek that summarises the types of willow present at key locations, highlighting where willows are more problematic or not, and includes photo examples.


4.1 Willow Perceived Benefits

<p>Erosion Control and Flood Protection</p>	<ul style="list-style-type: none"> • Help stabilize banks and protects land from erosion. Especially the sterile willow types. • Acts as natural flood barriers, especially when managed appropriately. <p>Photo: Sterile willow (on the right of photo), very upright and planted in rows stabilising the bank.</p>	
<p>Ecological, Aesthetic and Recreational</p>	<ul style="list-style-type: none"> • Provides shade for people using the river margins and helps regulate instream temperatures. • Supports habitat for bees, insects, and birds. • Contributes organic matter beneficial for stream health and fish habitat. • Adds to the aesthetics of the river and a wild and natural look and feel. • Supports activities like swimming, fishing (trout spawning), and children playing. 	 <p>Photo: stream shading and habitat diversity.</p>
<p>Economic and other</p>	<p>Source of firewood.</p> <p>Photo: Pile of tree including willow debris collected after September 2023 flooding.</p>	



4.2 Willow Perceived Impacts

<p>Flood exacerbation and infrastructure damage</p>	<ul style="list-style-type: none"> • Willow debris can block culverts and increase flood risks, especially during major weather events. • Inlet blockages and sedimentation issues. • ORC intervention has been required for infrastructure protection and flood mitigation. • Significant flooding events, particularly in 1999 and 2023 have caused property damage and are necessitating changes in river management. 	<p>Photo: Willow debris at Swan Road culvert after September 2023 flooding. Provided by Jean Gibson.</p>
<p>Uncontrolled spread</p>	<ul style="list-style-type: none"> • Many locations face difficulties in managing willows due to their rapid re-seeding after clearing efforts, requiring continuous manual intervention. <p>Photo: Lowburn Creek near Swann Road, with small regenerating willow trees.</p>	
<p>Water Quality and Quantity Stream Health Issues</p>	<ul style="list-style-type: none"> • Willows can suck large volumes of water that then evaporates from their leaves. • Willows growing in the streambed and 	

	<p>their potential to exacerbate erosion.</p> <p>Photo: Recent bank scour from September 2023 flooding near Swan Road.</p>	
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4.3 Other Matters Impacting the Stream

Mechanical Willow Removal	<ul style="list-style-type: none"> Concerns about impacts on water quality changes as a result of willow removal, or not, despite high stream health in general.
Unstable Land	<ul style="list-style-type: none"> Sedimentation from hillside slips is identified as a contributor to water quality issues downstream, despite overall high stream health.

4.4 Key Themes and Summary

Environmental Management	Landowners adjacent to the Lowburn Creek wish for a balance between retaining willows for perceived benefits, and generally accept a long-term goal of replacing pest/problem willows with native or other appropriate species to enhance biodiversity (including using sterile willow).
Community Involvement and Action	Landowners recognise the importance of community involvement in managing willows and implementing long-term solutions, supported by adequate funding and strategic planning.
Flood and Sediment Control	A desire to work with key stakeholders on the role of willows in flood and sediment management, and the need for effective culvert and inlet maintenance to prevent blockages.
Sustainability and Biodiversity	Whatever is done, it is clear landowners want to ensure sustainable practices are employed, including rules of thumb about the 'right tree in the right place', to improve the overall health and function of the Lowburn Creek ecosystem.

Overall, while willows along the Lowburn Creek can provide various ecological and recreational benefits, they can also have ecological and recreational costs (smothering, exclusion, water use^{1,2,3}) and pose challenges related to flood risk, debris build-up, and land management complexities.

Community perspectives highlight the importance of balanced and informed approaches to their management long-term to maintain both environmental health and community safety.

5. Next Steps

The purpose of this report was not to establish a management strategy or offer a way forward, rather we have identified some key further steps below, and the map attached has highlighted focus areas that would be beneficial for further review based on the feedback from landowners.

There is a consensus on the need for strategic management to balance ecological considerations with flood risk mitigation and infrastructure protection.

Stratford Creek will continue to provide a risk of invasion from pest willows. Exploring options for Stratford Creek would benefit the whole catchment. This would involve engaging with DOC due to the presence of marginal strips.

A Catchment Plan would be of significant benefit to the effective and efficient ongoing management of the catchment (including willow management). A catchment plan would also be of significant benefit for the catchment group to secure future catchment management funding. Extensive examination of costs and benefits and options is provided in Appendix B these resources are great source of information for more detailed consideration. Experience will be a key factor and reaching out to those that have delivered work in comparable places improve the outcomes achieved.

5.1 Potential Approach and Conclusion

The below summarises some possible approaches, based on feedback received from landowners, and offers a recommendation or options for further collaboration.

Manage	Decrease number of pest willow and control foliage; succession planting right plant, right place. Where willow is managed or removed, a regeneration plan is needed. There is a wide range of guidance on willow management ^{5,8}
Eradicate	As a group identify areas for where pest willow could be removed overtime. If eradication is selected, this is best done during autumn, and should target appropriate areas for eradication to minimize future spread. Willows should not be eradicated until a replanting plan is prepared/considered, and eradication can be staged in a way to ensure in-stream values are protected during and immediately after removal. The eradication plan should focus on the pest willow that pose a direct threat to the catchment – specifically those in or adjacent to the waterbody. Efforts into eradication in the inlet area will be of benefit for managing flood risk, however, while sources for reinvasion exist this will not be a permanent solution and active management over time is recommended. This should be considered as part of a future Willow Management Strategy. There is guidance on willow removal ⁸
Retain	(Sterile) willow planted for a specific purpose which are in the right place and adequately managed. There is a wide range of guidance on what types of willow are suitable in which contexts ⁵
Collaboration & Funding	<ul style="list-style-type: none"> Further catchment field days discussing options and exploring examples of what others have/are doing. Te Oma Station have welcomed the Lowburn group to come and see how the valley could look in the future with/without willows.

	<ul style="list-style-type: none">• Prepare a Catchment Plan that sets the scene for the catchment group's establishment, and how the group wish to work together and on what projects.• Continue working with your local Catchment Advisor for Central Otago and engage with key stakeholders.• Prepare a Willow Management Strategy.• A future funding opportunity includes the ORCs Eco Fund.• Engage with the River Engineering team at the Otago Regional Council on access for where there is no marginal strip and on ways to improve and manage flood carrying capacity. A great contact is Scott Liddell +64272788521 Scott.Liddell@orc.govt.nz.
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Appendix A: Maps

Appendix B: Bibliography and Contacts

1. Amaravathi, K K (2010) The role of crack willow in the wetland water balance, Moutere region, New Zealand (<https://ir.canterbury.ac.nz/items/da530602-4d0d-4fc9-8eab-0e6d9567af7a>; Accessed 24/07/2024)
2. Budny, ML (2015) Impact of Willow Encroachment on Water and Carbon Exchange in the Vegetation of a Subtropical Wetland (https://fau.digital.flvc.org/islandora/object/fau%3A31267/datastream/OBJ/view/The_impact_of_willow_encroachment_on_water_and_carbon_exchange_in_the_vegetation_of_a_subtropical_wetland.pdf; accessed 24/07/2024)
3. CSIRO (2007) Removing willows can generate big water savings (<https://gwydirshire.com/wp-content/uploads/2014/05/benefits%20of%20willow%20removal.pdf>; accessed 24/07/2024)
4. Landcare Research (2008) Use of willows and natives for stream bank control in New Zealand: a survey of regional councils (https://icm.landcareresearch.co.nz/knowledgebase/publications/public/willows_survey_report_2008.pdf; accessed 24/07/2024)
5. National Poplar and Willow Users Group (2007) Guidelines for Establishing and Managing Poplar and Willow Trees on Farms (<https://www.poplarandwillow.org.nz/documents/growing-poplar-and-willow-trees-on-farms.pdf>; accessed 24/07/2024)
6. NIWA (2019) Accounting for water use by willows, wetlands and native riparian plantings (<https://www.envirolink.govt.nz/assets/Envirolink/1933-HBRC241-Accounting-for-water-use-by-willows-wetlands-and-native-riparian-plantings.pdf>; accessed 24/07/2024)
7. NZ Landcare Trust (2015) Best Practice Guidelines for Willow and Alder Control for Riparian Restoration for the Waikato River (<https://landcare.org.nz/wp-content/uploads/2022/09/Willow-Alder-Guidelines-2015.pdf>; accessed 24/07/2024)
8. Marttila et al (2017) Does transpiration from invasive stream side willows dominate low-flow conditions? An investigation using hydrometric and isotopic methods in a headwater catchment (<https://onlinelibrary.wiley.com/doi/abs/10.1002/eco.1930>; accessed 26/07/2024)
9. ORC (2024) Guidance on willow control (<https://www.orc.govt.nz/environment/land-care/land-use-in-otago/willow-management-in-otago/guidance-on-willow-control/> accessed 24/07/2024)
10. Tasman District Council (2011) Crack Willow Removal/Management Programme (<https://tasman.govt.nz/document/serve/RESC11-08-06%20Crack%20Willow%20Removal-Management%20Programme.pdf?DocID=23826>; accessed 24/07/2024)
11. Stewart, D (2020) Low Burn Water Resources Assessment. Prepared for Otago Regional Council.
12. Dale, M (2012) Management flows for aquatic ecosystems in the Low Burn. Report prepared for the Otago Regional Council.
13. Water Ways Consulting Ltd (2020) Low Burn fish survey. REPORT NUMBER: 75-2019.
14. Otago Regional Council Environmental Data Portal. (<https://envdata.orc.govt.nz/AQWebPortal/>; accessed 9/08/2024).
15. Land Air Water Aotearoa (LAWA). (<https://www.lawa.org.nz/>; accessed 9/08/2024)

Central Otago Willow Projects:

- Lake Hayes catchment rehabilitation project - Project Manager Sarah Mukai - willow treatment options
- Lindis Catchment Group – contact (potentially Tim Davis) – undertook willow removal
- ORC – successful willow removal along Maniototo end of the Pigroot
- Manuherikia Willow Management Strategy for the Manuherikia Catchment, current project being led by Sally Dicey from Whirika.

Some of your key stakeholders:

ORC - including the ORC River Engineering Team. Scott Liddel (+64272788521 | Scott.Liddell@orc.govt.nz)

Local Iwi – Aukaha ((03) 477 0071)

DOC – Nicole Sutton nsutton@doc.govt.nz Delivery Manager Jobs for Nature, Queenstown. DOC are a landowner (e.g., Stratford Creek Marginal Strip), and will have an interest in local water quality and native flora and fauna.

Fish and Game - David Priest dpriest@fishandgame.org.nz (021702594). Fish and Game will have an interest in the Lowburn Stream as a trout spawning stream for the Lake Dunstan fishery. Willows also provide habitat for water fowl.

Checking if ORC consent is required:

High-level consent guidance can be found at <https://www.orc.govt.nz/consents-and-compliance/consenting-information/willow-removal>. But the variable site specific circumstances means it is important for people to contact consent.enquiries@orc.govt.nz to check consent requirements and/or permitted activity conditions.

Willow id: (if species is uncertain):

<https://www.poplarandwillow.org.nz/key/version-1-0-5/start>

<https://keys.landcareresearch.co.nz/nzsalix/>

<https://www.poplarandwillow.org.nz/>

Funding:

ORC Eco Fund - www.orc.govt.nz/our-council-our-region/eco-fund

Other projects:

'Jobs for Nature' has funded a range of projects which have involved willow removal. The agency funding the project can put you in touch with relevant contacts and projects can be seen on <https://www.jobsfornature.govt.nz/funded-projects/>.