

# MAHINGA KAI AND ECOLOGICAL RESTORATION PLAN FOR EALING SPRINGS, RANGITATA RIVER, SOUTH CANTERBURY

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*The view looking southeast over the Ealings Springs site. Edgars Pond is visible on the left-hand side of the image (Image: Environment Canterbury, August 2021).*

## **Contract Report No. 5920d**

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## 1. INTRODUCTION

The Rangitata River and its catchment have been identified as a priority under the Department of Conservation Nga Awa source to sea restoration programme<sup>1</sup>. The programme will provide a multi-agency approach to managing the Rangitata River. The agencies involved include the Department of Conservation, Te Rūnanga o Arowhenua, Fish and Game – Central South Island Lakes, Ashburton District Council, Timaru District Council and Environment Canterbury and they have formed a steering group (the Rangitata Steering Group) to oversee the restoration work. The Rangitata Steering Group has identified six sites within the lower Rangitata River catchment as initial priorities for restoration, and commissioned Wildland Consultants Ltd to develop high level ecological and mahinga kai restoration plans for these sites.

This report provides a restoration plan, to be implemented over a four-year timeframe, for the Ealing Springs site. Ealing Springs is a dryland river terrace and spring-fed stream system situated on the north side of the Rangitata River, approximately 18 kilometres from the river mouth. Fish and Game have previously prepared a draft restoration plan for the site (Fish and Game 2021). This document was used to guide our management recommendations. Wildlands has prepared similar plans for the five other Rangitata sites: Coldstream 1, Coldstream 2, Rangitata Hāpua, McKinnon's Creek, and the main stem of the Rangitata River.

## 2. SITE GOALS

Overarching project goals and objectives are needed to provide guidance for the ecological restoration of Ealing Springs. The goals below align with broader overarching goals identified by the Rangitata Steering Group.

### 2.1 Ecological restoration project goals

- To implement a robust ecological restoration plan that will increase the mauri and ecological integrity of the aquatic values and indigenous vegetation, as well as terrestrial and aquatic habitats at the Ealing Springs site.
- To increase the diversity and abundance of indigenous plant and animal species, prioritising mahinga kai resources, at Ealing Springs.
- The integral role that Te Rūnanga o Arowhenua play as kaitiakitanga over the Rangitata River is respected and incorporated in the restoration plan and project.
- The site continues to provide important recreational opportunities for the community including hunting, fishing and passive enjoyment of the natural environment.
- The site is recognised as a component of the wider braided river environment.

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<sup>1</sup> See: <https://www.doc.govt.nz/our-work/freshwater-restoration/nga-awa/>

## 2.2 Ecological restoration project objectives

By the end of the four-year timeframe of the project, the following will be achieved:

- Detailed ecological surveys have been completed and there is a high degree of understanding regarding the ecological values that are present at the site.
- The main threats at the site (e.g. pest plants and animals) have been identified and are being actively managed in restoration areas in cost effective ways.
- A braided plain restoration feasibility assessment has been completed and, if considered practical, is being implemented.
- Feasibility planning for additional wetland creation (e.g. the installation of weirs and/or earthworks to create additional wetland habitat and riparian planting) has been undertaken and, if feasible, is being implemented.
- Existing areas of indigenous vegetation and habitats are being enhanced through active management.
- Resilient restoration plantings of indigenous vegetation have been established. This will include vegetation types such as dryland forest that are rare on the lower Canterbury Plains, as well as those that provide mahinga kai resources for Te Rūnanga o Arowhenua.
- Habitats for indigenous lizards are protected and are being enhanced through active management.
- Natural and restored populations of mahinga kai species are increasing through active management and monitoring. Sustainable harvesting of these species is achieved within the medium term (within 10 years).
- Access tracks for recreational users of the reserve are constructed, maintained or upgraded, as necessary and in line with the goals of the steering group.
- The abundance of waterfowl and sport fish species is maintained or enhanced by the ecological restoration actions.
- Ongoing management decisions are informed by a robust monitoring programme that is implemented at appropriate timeframes.
- The ecological importance of the site is highlighted to the wider community through public engagement (e.g. volunteer planting days, website updates).

## 3. METHODS

Ecological and mahinga kai values, threats and restoration opportunities that are present at Ealing Springs were identified by the Rangitata Steering Group and provided as written summaries.



Additional information was gathered during a site visit and meeting on 1 July 2021. Participants included two Wildlands ecologists, representatives from the Department of Conservation, Te Rūnanga o Arowhenua, and Environment Canterbury. The purpose of the meeting was to discuss the key attributes and opportunities for restoration at Ealing Springs. Only the northern third of the site was visited and included Edgars Pond, the immediate downstream reach of Ealing Stream and adjacent dryland habitats through to the main stem of the Rangitata River. The site was not surveyed in detail during the field meeting but, where possible, vegetation and habitat types, and potential restoration areas were mapped on aerial photos. The vegetation and habitats within un-surveyed areas were assessed using Google Earth and imagery captured using a drone in August 2021 (provided by the Rangitata Steering Group).

## 4. SITE DESCRIPTION

The site consists of 211 hectares of river terrace situated on the flood plain of the Rangitata River, and is bordered by braid plain to the southwest and a terrace and grazing land on the northeast. The site contains an important spring-fed stream (Ealing Spring Creek) which flows through two main channels in a west to east direction. These channels contain riparian wetlands. The property also contains Edgars Pond, a popular waterfowl hunting site that provides important habitat for waterfowl species. The site is a designated Government Purpose Reserve (Wildlife Management Reserve) administered by Fish and Game, is a recognised salmon spawning site (Environment Canterbury 2019), and is a Class 1 Biodiversity Site. LINZ administers lands adjacent to the river and surrounding the spring upstream of the site.

## 5. ECOLOGICAL VALUES

### 5.1 Vegetation and habitat types

Nineteen vegetation and habitat types were identified during the site visit and from aerial imagery. Further field surveys are needed to identify additional vegetation and habitats, and the species they contain at the site. The vegetation and habitat types are listed below. Descriptions of these types, and their distribution, is provided in Appendix 1.

1. Radiata pine forest (shelterbelt) and treeland
2. Poplar forest
3. Mixed exotic treeland
4. Crack willow forest
5. Crack willow treeland and Scotch broom-gorse shrubland
6. *Muehlenbeckia* vineland and exotic treeland
7. Exotic scrub
8. Gorse shrubland
9. Scotch broom-gorse shrubland
10. Scotch broom shrubland
11. Scotch broom/exotic grassland and bare ground
12. Harakeke-toetoe flaxland
13. Harakeke-toetoe-rārahu-gorse flaxland, fernland and shrubland

14. Raupō reedland
15. Pūrei sedgeland
16. Exotic grassland
17. Pond
18. Gravelfield
19. Gravel road

## 5.2 Notable habitat

Spring-fed streams are important aquatic habitats in braided river systems. They seldom flood and therefore have greater algal and aquatic plant growth, which supports higher overall biodiversity (Instream 2019). This habitat type is relatively rare in the lower Rangitata River catchment. Wetlands, of unknown intactness and extent, are present along at the base of the river terrace. Wetlands are nationally significant ecosystems and, based on mapping from aerial photographs, potentially extend from Egars Pond to the road bridge at the downstream extent of the site. Wetland habitats in the lower Rangitata have been considerably reduced due to historic wetland draining for land development (Instream 2019). A major focus of ecological restoration actions at the site should be to protect and enhance these aquatic, riparian and wetland habitats.

## 5.3 Notable flora

Indigenous flora recorded during the site visit included tī kōuka (*Cordyline australis*), rārahu/bracken (*Pteridium esculentum*), harakeke (*Phormium tenax*), pūniu/prickly shield fern (*Polystichum vestitum*) and pūrei (*Carex secta*). Species observed within previous trial plantings of indigenous plants at the site included ribbonwood (*Plagianthus regius* subsp. *regius*) and tī kōuka. Fish and game (2021) also note the presence of kōwhai (*Sophora* spp.) and mānuka (*Leptospermum scoparium*). Fish and Game (2021) also note the presence of harakeke, raupō (*Typha orientalis*), rārahu/bracken and toetoe (*Austroderia richardii*) in wetlands east of Edgars Pond. Kōwhai (*Sophora* spp.) and a patch of manuka (*Leptospermum scoparium*) are present in dryer habitats. Meurk (2008) identify the manuka at Ealing springs as one of a few remaining populations of this once common species on the Canterbury Plains.

Further surveys are needed to map the distribution of these and other indigenous plant species.

## 5.4 Avifauna

Twenty-two indigenous and 13 exotic bird species were recorded on eBird within 10 kilometres of the project area (species listed in Appendix 2). Four species listed as Threatened or At Risk (as per Robertson et al. 2021) have been recorded by the State Highway bridge, Orari bridge, Te Araroa Bypass and towards Hinds: tara piroe/black-fronted tern (*Chlidonias albobristatus*; Threatened – Nationally Endangered), tūturiwhatu/banded dotterel (*Charadrius bicinctus bicinctus*; At Risk – Declining), taranui/Caspian tern (*Hydroprogne caspia*; Threatened – Nationally Vulnerable) and tarāpuka/black-billed gull (*Larus bulleri*; At Risk – Declining). Although not recorded on eBird, black-fronted dotterel (*Elseyornis melanops*; At Risk – Naturally Uncommon) may also be present on occasions. A further four species that are listed as At Risk have been recorded near the site: tōrea/South Island pied oystercatcher (*Haematopus finschi*;

At Risk – Declining), tara/white-fronted tern (*Sterna striata striata*; At Risk – Declining), tarāpunga/red-billed gull (*Larus novaehollandiae scopulinus*; At Risk – Declining), and kawau/black shag (*Phalacrocorax carbo novaehollandiae*; At Risk – Relict).

Waterfowl that include pūtangitangi/paradise shelduck (*Tadorna variegata*; Not Threatened), wāna/black swan (*Cygnus atratus*; Not Threatened), kuruwhengi/Australasian shoveler (*Anas rhynchos*; Not Threatened), pūkeko (*Porphyrio melanotus*; Not Threatened) and the exotic mallard (*Anas platyrhynchos*) inhabit the reserve (Fish and Game 2021). Exotic upland game birds such as quail (*Callipepla californica*) also occur at the site and provide recreational hunting opportunities (Fish and Game 2021).

Although highly cryptic and difficult to detect, species such as matuku/Australasian bittern (*Botaurus poiciloptilus*; Threatened – Nationally Critical), koitareke/marsh crake (*Porzana pusilla affinis*; At Risk – Declining), and pūweto/spotless crake (*Porzana tabuensis*; At Risk – Declining) may be present within the wetlands but have not been recorded on eBird at or near the site.

## 5.5 Freshwater fauna

Records from the New Zealand Freshwater Fish Database and Bonnett (1986) indicate the presence of upland bully (*Gobiomorphus breviceps*; Not Threatened as per Dunn *et al.* 2018), shortfin eel (*Anguilla australis*; Not Threatened) and longfin eel (*A. dieffenbachii*; At Risk – Declining) within streams at the site. There is an unverified sighting of Canterbury mudfish (*Neochanna burrowsius*; Threatened – Nationally Critical) shortly downstream of the site. Ealing Springs Creek contains brown trout (*Salmo trutta*) and was historically a chinook salmon (*Oncorhynchus tshawytscha*) spawning site (Fish and Game 2021).

Lamprey (*Geotria australis*, Threatened - Nationally Vulnerable) are not known to be present. However, spring-fed streams were historically important spawning sites on the Rangitata. There are no records of koura/freshwater crayfish (*Paranephrops zealandicus*; At Risk – Declining) from the Rangitata River catchment. Kākahi/freshwater mussels (*Echyridella menziesi*; At Risk - Declining) are only recorded in stockwater races just downstream of the RWL irrigation ponds near Arundel (InStream, 2019). Both species may be more widespread in the Rangitata Catchment, but not detected due to a lack of sampling effort.

## 5.6 Lizards and invertebrates

Southern grass skinks (*Oligosoma* aff. *polychroma* Clade 5; At Risk – Declining as per Hitchmough *et al.* 2015) have been recorded at the site (Frank 2021). Only a few remnant populations of this species remain on the south side of the Rangitata River, and therefore the presence of this skink species at the Ealing Springs site is significant.

## 6. CULTURAL VALUES

### 6.1 Significant sites

A site of cultural significance for Te Rūnanga o Arowhenua lies upstream of Ealing Springs.

### 6.2 Mahinga Kai

Mahinga kai species recorded during the site visit included tī kōuka, rārahu, and harakeke. Raupō (*Typha orientalis*) also occurs at the site, based on aerial images and Fish and Game (2021). Mahinga kai waterfowl species occur at the site (see Section 5.4 above). Ealing Springs has been identified as a potential site for the reintroduction of other mahinga kai species including watercress (*Nasturtium officinale*), kanakana/lamprey, kākahi/freshwater mussel, and kōura/freshwater crayfish (Appendix 3). In addition, Te Rūnanga o Arowhenua have aspirations to introduce and sustainably harvest western weka (*Gallirallus australis australis*) along the Rangitata River. However, a detailed assessment of the feasibility for translocation should be undertaken before attempting any releases of this species. Testing of mahinga kai to ensure safety (e.g. heavy metal contamination of freshwater mussels or watercress) should be conducted before harvest.

## 7. ECOLOGICAL THREATS

### 7.1 Pest plants

Invasive plants (pest plants) are a primary threat to the habitats that are present at Ealing Springs. In addition, the pest plants will directly compete with existing areas of indigenous vegetation and restoration plantings, will inhibit the recruitment of indigenous seedlings and saplings, and act as a propagule source for nearby areas.

Nine environmental pest plants<sup>1</sup> present at Ealing Springs are listed in Appendix 4. All of these species should be controlled within the site as time and finances allow. Four of the environmental pest plant species recorded at the site are included in the Canterbury Regional Pest Management Plan 2018-2038 (Environment Canterbury 2018).

### 7.2 Pest animals

Feral pigs (*Sus scrofa*), rabbits (*Oryctolagus cuniculus cuniculus*), feral cats (*Felis catus*), and possums (*Trichosurus vulpecula*) have been previously recorded at the Ealing Springs site (Fish and Game 2021). Additional introduced mammal species are likely negatively impacting indigenous vegetation and the population density and persistence of terrestrial indigenous vertebrate and invertebrate species at the site. This is a cumulative pressure given indigenous fauna are restricted at this site by habitat availability. Specifically, pest animals may be having the following impacts:

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<sup>1</sup> Pest plant species that are known to have demonstrable negative impacts.

- Mice (*Mus musculus*), rats (*Rattus* spp.), mustelids (*Mustela* spp.), feral cats (*Felis catus*), brushtail possums and European hedgehogs (*Erinaceus europaeus*) are likely to be negatively impacting the population density and persistence of terrestrial indigenous fauna such as indigenous lizards and ground nesting birds.
- Rabbits, hares (*Lepus europaeus*), possums, rats, and mice may be impacting indigenous flora at the site.
- In addition to feral pigs, feral goats (*Capra hircus*), and deer (most likely red deer; *Cervus elaphus scoticus*) may periodically occur within the corridor of the Rangitata River, and therefore may access the Ealing Springs site. Pigs can cause considerable damage to the margins of wetlands and streams, while goats and deer are capable of causing the localised decline of palatable indigenous plant species.

### 7.3 Flooding and erosion by the river

Flooding and changes in the course of the braided river could potentially negatively impact existing indigenous habitats, and populations of indigenous plants and animals that occur within the site.

### 7.4 Changes in hydrology or channel modification

Protecting and maintaining the hydrodynamic integrity and connectivity are critical to maintaining the freshwater values of Ealing Springs. Primary threats to these include changes in water flow from water extraction or altered rainfall, direct modification of the channel (i.e. from drainage and infilling), pollution from adjacent agricultural land, and changes in hydrology and dynamics from pest plants.

Ealing Spring is protected from direct modification of the channel or reduction in flow under the Rangitata River Water Conservation Order (2006). However, it is possible that water extraction and changes in land use within the broader Rangitata River catchment may adversely affect water flow within Ealing Springs in the future. In particular, groundwater takes on the Mayfield-Hinds plain might adversely affect Rangitata River flows by reducing the groundwater pressure at Ealing Springs (Burbery, 2012).

In 2011 Fish and Game were granted resource consent (CRC110841) for works in the stream bed, including excavation of the bed material, battering of the banks, minor realignment of the streams and construct sediment retention ponds. Consideration of the potential adverse effects of these works on downstream hydrology and important habitats (i.e. wetlands) is required.

### 7.5 Water quality and sedimentation

Water quality in the Ealing Spring system will likely reflect the impact of effluent and fertiliser runoff from adjacent agricultural land, including paddocks surrounding the headwater spring. We are not aware of any water quality monitoring at the site.

Spring-fed streams are particularly susceptible to fine sediment deposition and land runoff, because they lack regular floods to flush out sediments (Instream 2019).

Excessive fine sediment can smother invertebrate communities and fish habitat and detract from natural character. Legacy sediment inputs are identified by Fish and Game as a barrier to salmonoid spawning at the site. Any earthworks or vegetation clearance in the streams have the potential to increase fine sediment inputs.

## 7.6 Low habitat diversity and barriers to indigenous fish migration

Ealing Spring contains good habitat for freshwater fish. However, the lack of mature riparian vegetation means that the habitat complexity (i.e. large stable woody debris, shading, refugia) is low. This is of particular importance for long- and shortfin eels, and for reducing the predation risk to all indigenous fish species. In addition, a culvert situated where the vehicle track crosses the main braid is a barrier to fish passage. Any other structures upstream would likely have similar impacts on fish movements. Changes in river location downstream where the Ealings creek joins the Rangitata may also, at times, be a barrier to fish passage.

Barriers that restrict salmonoid movement should be maintained if upstream populations of non-migratory indigenous fish are present.

## 7.7 Fire

The extensive areas of gorse (*Ulex europaeus*) and Scotch broom (*Cytisus scoparius*) shrubland at the site are a high fire risk, particularly during droughts. Fish and Game have also expressed concerns about the risk of fire at the site (Fish and Game 2021).

## 7.8 Climate change

NIWA climate change modelling predicts that the eastern South Island will have progressively hotter, dryer summers over the next 35 years due to global climate change (NIWA 2021). This could potentially increase the incidence and intensity of fires and reduce the diversity of indigenous plant and animal species at the site due to more severe and prolonged summer droughts. Climate change impacts could also potentially decrease the quality of riparian and wetland habitat by increasing frequency of drought stress, which may further reduce the diversity of indigenous plant and animal species at the site. Addressing climate change implications for Ealing Spring is beyond the scope of the restoration plan, although any actions to improve ecological resilience will likely confer improved capacity to accommodate climate change impacts, at least over short-medium time scales. For example, resilience to both higher and reduced water events resulting from climate change can be increased through water buffering. Buffering would be a likely result of wetland development and widening the main river stem.

The following reports provide a starting point for longer-term climate change resilience planning for Ealing Spring:

- Macara G. *et al.* 2020: Climate change projections for the Canterbury Region. *NIWA Client Report No. 2019339WN*. Prepared for Environment Canterbury. 156 pp.

- Awatere S. *et al.* 2021: He huringa ahuarangi, he huringa ao: A changing climate, a changing world. 2021. Manaaki Whenua Client Report. Prepared by for Nga Pae o te Maramatanga. 61 pp.

## 8. MANAGEMENT ACTIONS

The following sections outline management actions<sup>1</sup> required to achieve the goals and objectives listed in Section 2. They encompass the entire site which is split into management units, and are presented in order of priority. Therefore, if funding is limited and time is constrained, actions can be scaled back or selected habitats prioritised. Management actions safeguarding areas of higher ecological value such as the wetlands, streams and remnant dryland vegetation in the more accessible areas of the site is the priority at this site. A workplan summarising the priority management actions, and areas, is presented in Appendix 6.

### 8.1 Undertake vegetation and fauna surveys

Additional surveys are needed to map the vegetation and habitats, pest plant populations, and record indigenous and exotic plant species at the site. In addition, restoration sites for mahinga kai species should also be identified.

An indigenous fish and macroinvertebrate survey is needed to document their diversity within the streams and pond at the site. A detailed lizard survey is needed at the site prior to any clearance of vegetation within restoration areas. Likewise, bird and indigenous invertebrate surveys should be undertaken to determine the species that are present. Acoustic monitoring should be carried out to determine whether cryptic wetland bird species such as Australasian bittern are present within the wetlands at the site.

### 8.2 Explore options to further protect the riparian, wetland and remnant dryland shrubland habitat at the site

The site is managed as a Government Purpose (Wildlife Management) Reserve under Section 8 of the Conservation Act 1987. Consideration should be given to providing the site, and particularly the riparian areas, wetlands, and any remaining dryland vegetation (i.e. manuka forest) a higher level of protection to ensure continued active management of the area. Additional protections could be achieved if habitats within the site meet the criteria of a significant natural area in the Ashburton District Council's District Plan (ADC 2021).

### 8.3 Undertake restoration plantings of riparian forest, flaxland, and sedgeland on stream margins and in wetlands

Pest plants within riparian margins and in and around wetlands at the site should be controlled and restoration plantings of appropriate indigenous species undertaken in a staged manor (planting areas identified on Figure 1). In drier areas, a tractor mounted

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<sup>1</sup> Resource consent are required for some proposed actions within this site. Existing Fish and Game consents may cover some actions.

mulcher could be used to clear exotic vegetation prior to planting. Pest plants within the damper margins of streams and wetlands will need to be controlled on foot. The goal should be to restore a matrix of indigenous riparian forest, primarily containing kahikatea (*Dacrycarpus dacrydioides*), and indigenous flaxland, sedgeland, and reedland to complement existing indigenous vegetation. These restoration plantings will reduce aquatic weed growth, improve indigenous fish habitat and provide habitat for other indigenous fauna (e.g. raupō reedlands for the Threatened – Nationally Critical Australasian bittern). Restoration areas would require ongoing control of all environmental pest plants, and drier areas may require protection from rabbits and hares (e.g. plant guards).

#### 8.4 Improve instream habitat for freshwater fauna

The diversity of habitats for indigenous freshwater fish and invertebrates within streams could be increased by adding dead wood (large logs, piles of smaller logs) of non-invasive tree species or areas of boulders (as per Richardson and Taylor 2002). Depending on the overall structure of the in-stream materials, these sites may provide roosting areas for aquatic bird species.

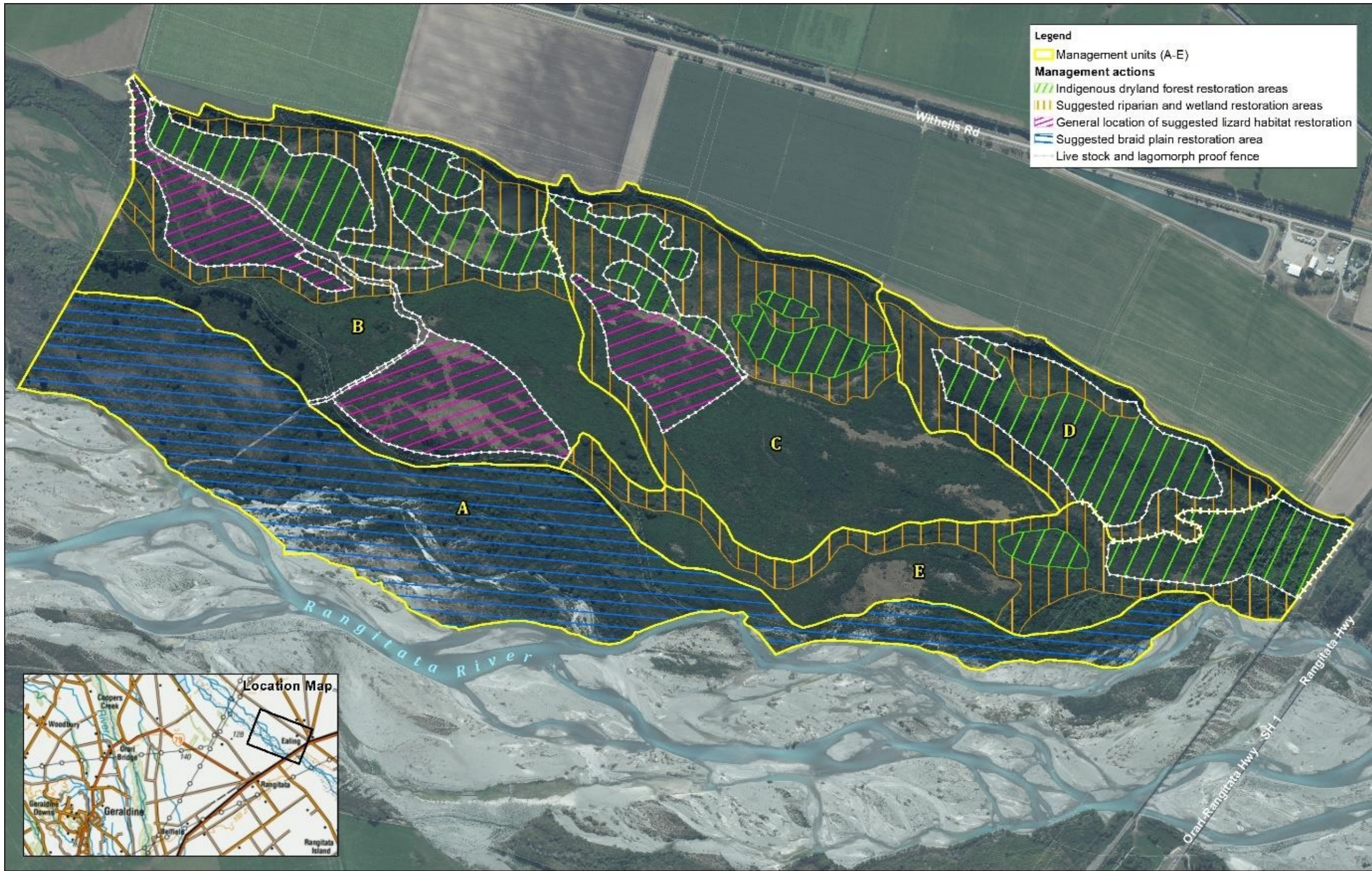
Fish and Game resource consents allow for creation of runs and riffles for the improvement of salmon spawning habitat. Opportunities for improved habitat creation for indigenous freshwater fauna, as well as potential adverse effects, should be considered if these works proceed.

Assess the value of removing or remediating the culvert on the Ealing Spring main braid, and any other fish passage barriers. The culvert limits the passage of both indigenous and exotic fish species. However, maintaining a barrier may be desirable if upstream reaches support, or are identified as a potential introduction site, for non-migratory indigenous species.

Potential conflict between ecological and mahinga kai values and the recreational and salmonoid values of the site need to be considered. Mitigation options include identifying spatially separated areas for indigenous versus exotic freshwater values (i.e. the main braid of Ealing Spring creek below the culvert for salmonid and recreational values, the side braid of Ealing Spring creek for indigenous freshwater fauna). Fish and Game have indicated that they would be supportive of such a proposal. Indigenous fish species present at Ealing Spring are migratory and so barriers to physically separate indigenous and exotic species are unlikely to be feasible. Restoration actions should instead seek to promote the resilience of indigenous species, through actions such as enhancement of habitat targeting key life stages, creation of diverse habitat, and the provision of refugia.

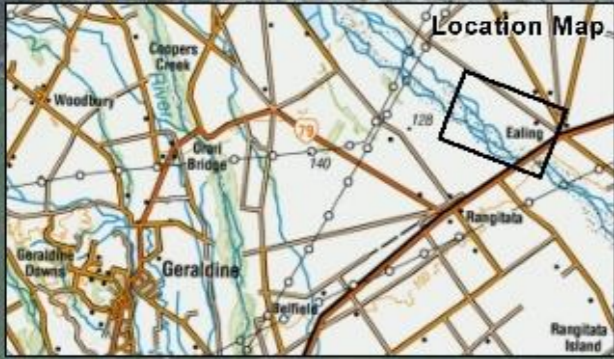
Monitoring should be conducted to determine the likely impacts of salmonid species on indigenous fish and biodiversity values. Doing so will identify opportunities for the design and implementation of management actions that provide for both indigenous values and the recreational values of the site.



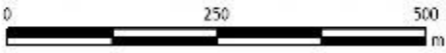


**Legend**

- Management units (A-E)
- Management actions**
- Indigenous dryland forest restoration areas
- Suggested riparian and wetland restoration areas
- General location of suggested lizard habitat restoration
- Suggested braid plain restoration area
- Live stock and lagomorph proof fence



**Figure 1. Management units and select management actions at Ealing Springs, Rangitata River, South Canterbury**



**Data Acknowledgment**  
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 2021 Imagery source: <https://aisimagery.ecan.govt.nz>  
 Project: 5920  
 Client: Department of Conservation  
 Ref: D1 0525  
 Path: Ealing\_Rangitata\_Restoration\_Plan\_Ch1.mxd  
 File: Figure\_EalingSprings\_NL.mxd

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 www.wildlands.co.nz, 0508 311212  
 Scale: 1:8,000  
 Date: 8/10/2021  
 Cartographer: FM  
 Format: A3R



## 8.5 Undertake targeted environmental pest plant control across the wider site on an ongoing basis

Radiata pine (*Pinus radiata*) and poplars (*Populus* spp.) should be controlled throughout the site on an ongoing basis. Due to the presence of shelterbelts of radiata pine on the margin of the northeastern terrace at the site, it is likely that wilding pines will periodically re-establish at the site. Crack willow (*Salix ×fragilis*) and grey willow (*Salix cinerea*), if present, should be systematically controlled to low levels as part of staged restoration actions. Control operations could be conducted either from the ground or by helicopter.

## 8.6 Undertake pest animal control

Monitoring should be conducted at the site to determine the fauna values and pest animal species that are present, and the likely impacts these pests are having on indigenous fauna (see Section 10). Rabbit and hare proof fences may need to be incorporated into fence designs to protect restoration plantings. Possums should be controlled if they impact plantings of palatable indigenous plant species as they mature and when fully established.

Low intensity predator control should be undertaken across the site to protect and enhance the skink population. This should target feral cats, mustelids, hedgehogs, rats and potentially mice. Feral cats would be targeted using modified Timms traps or Sentinels, and mustelids, hedgehogs and rats with DOC 200 series traps. Further rat and mouse control could be implemented in specific localities if monitoring indicates they are problematic. Lizard monitoring will guide predator control design, and measure any lizard population increases resulting from predator control.

## 8.7 Utilise exotic shrublands as a nursery for the restoration of dryland forest within sections of the site

Restoration plantings of dryland indigenous forest could be planted in a staged manner within the areas of gorse and Scotch broom at the site (initial planting areas are identified on Figure 1)<sup>1</sup>. A tractor mounted mulcher could be used to cut planting strips (15-20 metres between strips) within larger areas of shrubland. Smaller areas may require the use of scrub bars. The regrowth of all pest plants within the planting strips would then be sprayed, potentially using a tractor mounted sprayer, prior to planting (see Appendix 5 for species). The planting areas should particularly target microsites where plant survival is likely to be greatest (i.e. at the base of the northeastern terrace and other depressions at the site) (Figure 1). The surrounding shrublands would act to shelter the indigenous plants while they establish. Over the longer term, these restoration areas would be expanded to eventually encompass additional areas of suitable dryland habitat. Restoration areas would require ongoing control of all environmental pest plants, as well as protection from rabbits and hares through the construction of fences, plant guards, poisoning and night shooting.

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<sup>1</sup> Note that Landcare Research established enclosures at the site in 2010 to test methods for establishing indigenous vegetation within areas of Scotch broom.

## 8.8 Create habitat for indigenous lizards

Following a detailed lizard survey, areas of open grassland and stonefield should be maintained to provide habitat for southern grass skinks and other indigenous lizards. Other areas could be created (potential areas identified on Figure 1). Creating these areas will require the initial clearance of woody pest plants using earthmoving equipment. Maintaining open habitat will require ongoing pest plant control and the management of exotic grassland. Artificial refugia (e.g. piles of stones or logs) should be created throughout the lizard habitat areas, but could also be established in open areas across the wider site. Smaller portions of the lizard habitat restoration areas (e.g. ten 10 × 10 metre per restoration area) should be planted with the species in Appendix 5 to provide additional lizard habitat. The plantings would require the installation of livestock and lagomorph proof fencing to protect the planting area.

Lizards at the site should be monitored annually using artificial cover objects (ACOs) (Lettink 2012), or pitfall trapping. A qualified herpetologist should prepare a lizard monitoring plan.

## 8.9 Undertake a feasibility assessment to create additional riparian wetland habitat through earthworks and the installation of weirs

There is potential to create additional wetland habitat at the site through earthworks and the installation of weirs to control water levels within Ealing Springs Creek. Increasing the area of wetland would provide valuable additional habitat for indigenous wetland vegetation, indigenous fauna, game birds and fish. Additional advantages include sediment retention and water quality improvements. There is the potential to integrate wetland creation with consented sediment pond creation proposed by Fish and Game. The resource consents held by Fish and Game may assist in wetland creation. It is important that the creation of new wetland habitat does not occur at the expense of restoration of the existing wetland habitats.

If this suggested action is considered feasible/desirable, a hydrological assessment should be completed to identify suitable areas for construction and, critically, the potential for adverse impacts on downstream habitats. Sediment management during construction will be required.

## 8.10 Develop a fire plan and maintain firebreaks

A fire management plan should be developed to guide management decisions to prevent and contain wildfires at the site. Firebreaks, at least six metres wide, should be cut around the perimeter of each restoration area and along the northwestern boundary of the site.

## 8.11 Maintain existing tracks through the site

All existing vehicle tracks should be maintained at the site to provide access to the river and recreational hunting and fishing sites. Vehicle and walking tracks may also need to be cut through the dense exotic vegetation to provide access to restoration sites. Issues to be resolved include what level of public access is appropriate, managing fire risk, and breeding site sensitivities for indigenous species. Improved public access through farmland from the road will require a formal agreement with landowner.

## 8.12 Develop site- and species-specific restoration plans

The results of the fauna and vegetation surveys should be used to inform species- and site-specific restoration plans. The species-specific plans should target Threatened, At Risk and mahinga kai species (e.g. kanakana/lamprey; Threatened – Nationally Vulnerable, and kākahi/freshwater mussel; At Risk – Declining) and should be guided by Department of Conservation translocation protocols and the tikanga of Te Rūnanga o Arowhenua. Te Rūnanga o Arowhenua have identified eight mahinga kai species that could be restored at the site (provided in Appendix 3).

## 8.13 Remove exotic vegetation and restore braid plain habitat within part of the site

An assessment should be undertaken to determine if braid plain restoration is feasible on the southwest margin of the site (Figure 1). This will require hydrological and geomorphological assessments to determine the potential effects of creating the braid plain as well as an assessment of its impact on downstream infrastructure, including State Highway 1, rail and power corridors. The land is administered by LINZ and consent will be required. Ideally the land immediately northwest of the site should also be included within the restoration area.

Reestablishing braid plain within and near the site would have several ecological and land management benefits. First, it would remove a significant area of exotic vegetation from the margins of the river. Second, the creation of braid plain will provide additional habitat for indigenous fauna, which could potentially include Threatened and At Risk bird, fish, lizard and insect species. Third, braid plain restoration would reduce the erosion of the true right bank of the river by reestablishing a broader floodplain.

Potential negative effects of restoring the braid plain include the loss of stream habitat for certain indigenous freshwater fish, and terrestrial and aquatic bird species. The restoration would also likely lead to the short-term sedimentation of the river downstream of the site. Removing the buffering vegetation may increase erosion and flood risk to the main Ealing Springs site. Engineering advice will be required.

The restoration of braid plain at and near the site will potentially require modifications to the landscape and waterways within the project footprint, thereby triggering the need for a resource consent. Obtaining these consents should be incorporated into project timelines. Alternatively, redirection of river leads, mulching woody weed growths or the opening of river corridors to allow for natural river processes may be sufficient. Engineering advice will be required.

## 8.14 Undertake ongoing pest plant control within the braid plain restoration area

Once restored, the undisturbed margins of the braid plain will require ongoing pest plant control to prevent the reestablishment of exotic vegetation. This could be achieved through periodic (at least every five years) ground or aerial spraying operations.

## 8.15 Identify management units

To facilitate the timely implementation of management actions we have broken the wider site into five management units (Figure 1). These management units could potentially be further subdivided in the future in line with available resources. Suggested subdivisions include areas of high indigenous values (i.e. wetlands, riparian margins), mahinga kai restoration areas, and priority planting habitats. Section 9 summarises the potential actions within these management units. Section 12 provides a suggested four-year workplan to achieve the actions.

## 9. SPECIFIC MANAGEMENT ACTIONS REQUIRED WITHIN THE MANAGEMENT UNITS

Table 1 outlines the specific management actions that are required for the implementation of ecological restoration at the site.

## 10. MONITORING

Monitoring should be regularly undertaken at the site to inform and improve the implementation of management actions, and measure restoration success. The monitoring should be carried out throughout the four year project and continued on an ongoing basis thereafter. Monitoring could be more frequent initially after implementation to track changes in response to restoration to the point where the site stabilises in a restored state, after which monitoring frequency could be reduced.

### Photopoints

Photos taken at specific points and at set timeframes, are an efficient way to monitor gross changes in vegetation composition and structure within a defined viewpoint. It is recommended that at least 10 photopoints are established at the site. The location of each photopoint should be recorded with a handheld global positioning system (GPS). A compass should be used to gauge a bearing to the center of the frame of the photopoint. The photographs should then be printed to provide a reference for future revisits. The photopoints should be resampled every year in sites where frequent management actions are occurring (e.g. ongoing pest plant control).

### Pest Plants and Restoration Plantings

Monitoring visits should be undertaken at least every three months during the growing season to track the proportions of pest plants killed via control work and the survival rates of restoration plantings. Walk through transects should be established through the larger restoration areas. The results of this monitoring should be used to improve management decisions regarding factors such as herbicide choice and the density and species selection of future restoration plantings.

Table 1: Ecological restoration management actions required at the Ealing Springs site.

Management Unit	Size (ha)	Current Vegetation and Habitat Type	Intended Vegetation and Habitat Type	Suggested Management Actions
A	59.0	<ul style="list-style-type: none"> <li>• Radiata pine forest (shelterbelt) and treeland</li> <li>• Crack willow forest</li> <li>• Crack willow treeland and Scotch broom-gorse shrubland</li> <li>• Gorse shrubland</li> <li>• Scotch broom-gorse shrubland</li> <li>• Scotch broom shrubland</li> <li>• Scotch broom/exotic grassland and bare ground</li> <li>• Exotic grassland</li> <li>• Pond</li> <li>• Gravelfield</li> <li>• Gravel road</li> </ul>	River and braid plain	<ul style="list-style-type: none"> <li>• Undertake detailed vegetation, lizard, aquatic fauna, bird and invertebrate surveys.</li> <li>• Complete hydrological and geomorphological assessments.</li> <li>• Obtain resource consent for the removal of exotic vegetation and earthworks at the site.</li> <li>• Aerially spray or manually remove entire management unit.</li> <li>• Remove exotic vegetation from the site and dispose of material.</li> <li>• Undertake earthworks to form river channels.</li> <li>• Control pest plants within the braid plan on an ongoing basis.</li> </ul>
B C D E	68.6 53.6 22.9 32.3	<ul style="list-style-type: none"> <li>• Radiata pine forest (shelterbelt) and treeland</li> <li>• Poplar forest</li> <li>• Mixed exotic treeland</li> <li>• Crack willow forest</li> <li>• Crack willow treeland and Scotch broom-gorse shrubland</li> <li>• <i>Muehlenbeckia</i> vineland and exotic treeland</li> <li>• Exotic scrub</li> <li>• Gorse shrubland</li> <li>• Scotch broom-gorse shrubland</li> <li>• Scotch broom shrubland</li> <li>• Scotch broom/exotic grassland and bare ground</li> <li>• Harakeke-toetoe flaxland</li> <li>• Harakeke-toetoe-rārahu-gorse flaxland, fernland and shrubland</li> </ul>	Indigenous dryland and riparian forest, flaxland, reedland and sedgeland. Low stature exotic grassland and stonefield (Management Unit B and C)	<ul style="list-style-type: none"> <li>• Undertake detailed vegetation, lizard, aquatic fauna, bird and invertebrate surveys.</li> <li>• Undertake assessment to elevate the legal protection status of riparian areas and wetlands within the management units.</li> <li>• Undertake a feasibility assessment for the creation of additional wetland habitat.</li> <li>• Install weirs and undertake earthworks if wetland restoration is considered feasible.</li> <li>• Establish additional vehicle and walking tracks through the site to facilitate management actions.</li> <li>• Clear woody pest plants from lizard habitat restoration areas and create artificial refugia (Management Unit B and C).</li> <li>• Install lagomorph proof fences within restoration areas if required.</li> </ul>

Management Unit	Size (ha)	Current Vegetation and Habitat Type	Intended Vegetation and Habitat Type	Suggested Management Actions
		<ul style="list-style-type: none"> <li>• Raupō reedland</li> <li>• Pūrei sedgeland</li> <li>• Exotic grassland</li> <li>• Pond</li> <li>• Gravel road</li> </ul>		<ul style="list-style-type: none"> <li>• Assess options to replace or realign the culvert to improve indigenous fish passage, or alternatively, improve barriers to exclude salmonioids.</li> <li>• Plant dryland trees and shrubs in enclosures within lizard restoration areas (Management Unit B and C) (see Appendix 5).</li> <li>• Control pest plants along the margins of riparian and wetland areas within each management unit and plant with the species listed in Appendix 5.</li> <li>• Mulch strips of woody pest plants prior to planting dryland indigenous forest and scrub species that are capable of surviving seasonal drought (see Appendix 5).</li> <li>• Plant riparian margins with indigenous riparian forest, harakeke and indigenous sedges and rushes (see Appendix 5).</li> <li>• Augment indigenous freshwater fish and invertebrate habitat by adding dead wood and boulders to streams and wetlands.</li> <li>• Undertake pest plant control around restoration plantings until canopy closure occurs.</li> <li>• Maintain firebreaks around restoration areas.</li> <li>• Control radiata pine, poplars, crack willow and grey willow (if present) across the wider site on an ongoing basis.</li> <li>• Incorporate mahinga kai species within plantings, where possible.</li> <li>• Undertake introductions of freshwater mahinga kai species (e.g. freshwater crayfish; <i>Paranephrops zealandicus</i>) if there is sufficient habitat.</li> <li>• Monitor for and undertake pest animal control to protect lizard populations (see Section 10).</li> <li>• Develop a fire management plan for the site.</li> </ul>
<b>Total at Site</b>	<b>236.4</b>			

## Natural and Reintroduced Populations of Threatened Species

All populations of naturally occurring and reintroduced threatened species should be regularly monitored to build a better understanding of their habitat requirements, determine the limitations to restoration success, and identify future management actions. The monitoring regime will vary by species and should be undertaken by biologists who have experience working with the target species.

### Pest Animals

Small mammal predators (rats, mustelids, cats, hedgehogs and possums) should be monitored as part of lizard conservation efforts at the site. Monitoring for rabbit and hare damage should be undertaken in any unfenced restoration plantings. As they mature, plantings of palatable dryland forest species should be monitored for damage by possums. All pest monitoring should follow the best practice guidelines provided on the Bionet website (<https://www.bionet.nz/library/>).

## 11. CONSTRAINTS

The successful ecological restoration of the Ealing Springs site is potentially constrained by a number of factors. These constraints, and their potential solutions, are outlined in Table 2.

Table 2: Potential constraints and solutions for the implementation management actions at the Ealing Springs site.

Potential Constraint	Potential Solutions
Scope of restoration is beyond timeframes and funding	<ul style="list-style-type: none"><li>• Prioritise to focus on significant habitats and remanent indigenous values in accessible areas of the site.</li></ul>
Proposed braided plain restoration considered unfeasible	<ul style="list-style-type: none"><li>• Control exotic vegetation by periodic aerial spraying operations.</li></ul>
Lack of ongoing funding beyond the four-year timeframe	<ul style="list-style-type: none"><li>• Begin applying for further funding within the first two years of the project.</li><li>• Hire a dedicated project manager to successfully implement the project.</li><li>• Widely publicise the work of the project to build a profile and community support.</li></ul>
Ongoing environmental pest plant invasion	<ul style="list-style-type: none"><li>• Undertake ongoing pest plant control.</li><li>• Ensure maintenance teams are experienced and follow best practice protocols.</li><li>• Where feasible, undertake restoration in the wider area to reduce pest plant propagule pressure.</li><li>• Undertake ongoing pest plant monitoring to improve the efficiency and effectiveness of control efforts (see Section 9 below).</li></ul>
Failure of restoration plantings	<ul style="list-style-type: none"><li>• Only contract reputable native plant nurseries who have a track record of growing high quality plants.</li><li>• Ensure planting teams are experienced and follow best practice protocols.</li><li>• Undertake regular maintenance of plantings in the three to four years after planting.</li><li>• Undertake regular monitoring to inform ongoing restoration actions (see Section 9 below).</li></ul>
Failure of species reintroductions	<ul style="list-style-type: none"><li>• Seek the advice of technical experts to ensure reintroductions follow best practice guidelines.</li></ul>



Potential Constraint	Potential Solutions
	<ul style="list-style-type: none"> <li>• Undertake regular monitoring to inform future reintroduction efforts.</li> <li>• Undertake regular monitoring following species reintroductions to determine ongoing management actions (see Section 9 below).</li> </ul>
Changes in course of river	<ul style="list-style-type: none"> <li>• Maintain a buffer of existing vegetation along the margins of the braid plain.</li> <li>• Where possible, ensure the upstream areas of the river are maintained free of large woody debris.</li> <li>• Adopt an adaptive management approach to landscape changes.</li> </ul>
Fire	<ul style="list-style-type: none"> <li>• Maintain firebreaks around restoration areas.</li> <li>• Develop a fire management plan for the site.</li> <li>• Where possible, control flammable exotic plant species (principally gorse and Scotch broom) throughout the site.</li> </ul>
Competing resource values (e.g. recreational fishing vs. species and habitat restoration)	<ul style="list-style-type: none"> <li>• Consult with recreational users (e.g. anglers) to inform them about the goals of the project.</li> <li>• Identify opportunities for complementary development of ecological restoration values and resource values. Consider the potential to set aside areas for competing resource values where restoration actions are conflicting (i.e. indigenous fish vs. salmonoids).</li> <li>• Prohibit resource collection at the site through take restrictions (implemented by Fish and Game, Environment Canterbury or the Department of Conservation) or a rāhui (implemented by Te Rūnanga o Arowhenua) until populations of key species have established.</li> </ul>
Climate change	<ul style="list-style-type: none"> <li>• Advocate that any future land development does not exceed unsustainable water extraction rates.</li> <li>• Implement the management actions outlined in this report.</li> <li>• Adopt an adaptive management approach to adjust to environmental changes.</li> </ul>

## 12. TIMELINE AND INDICATIVE COSTS FOR THE IMPLEMENTATION OF MANAGEMENT ACTIONS

The following workplans outline the timeline and indicative costs for the management actions within the management units. The timeline assumes that braid plain restoration is feasible within Management Unit A and that resource consent would be obtained within an 18 month period. The timeline also assumes that all actions are enacted, although prioritisation around key habitats and values is expected due to funding and resourcing constraints. The ecological management actions for Management Units B, C, D, and E are staggered by management unit over the four year life of the project (Table 3). The timeline is contingent upon the restoration actions continuing after the initial four years. The 12 month period for the implementation of management actions within the four years begins in November 2021.

Table 3: Timeline and indicative costs for the implementation of ecological restoration actions at the Ealing Springs site.

Management Unit	Management Action	Timing	Price Estimate
<b>Year 1</b>			
All management units	Detailed vegetation and habitat survey	November 2021-April 2022	\$7,000
	Freshwater fauna survey	November 2021-April 2022	\$9,000
	Detailed lizard survey	November 2021-April 2022	\$9,000
	Indigenous invertebrate survey	November 2021-April 2022	\$6,000
	Establish photopoints where ecological restoration will occur	November 2021-April 2022	\$1,500
A	Undertake feasibility assessments for braid plain restoration (e.g. hydrological and geomorphological assessments)	Throughout the year	Exact costs to be determined. However, is likely be \$50,000 or more
	Initiate process for obtaining resource consent	Once feasibility assessment is complete	Exact costs to be determined
B	Order eco-sourced plants and planting materials for dryland forest, riparian and wetland areas (plant guards etc.)	November 2021	\$310,000
	Cut fence lines and install lagomorph proof fences if required.	November 2021-April 2022	\$52,000
	Mulch planting strips within gorse and scrub for indigenous dryland forest and riparian planting areas (section of unit only)	March 2022	\$20,000
	Prepare planting sites (dryland, riparian margins, wetlands and lizard enclosures)	April 2022	\$40,000
	Plant dryland and riparian margins	May and June 2022	\$90,000
	Plant wetlands	September 2022	\$40,000
	Order infill plants	October 2022	\$40,000
	B, C (lizard habitat restoration areas)	Clear exotic vegetation	November 2021-April 2022
Create artificial refugia		November 2021-April 2022	\$10,000
Install livestock and lagomorph proof fences if required.		November 2021-April 2022	\$16,000
Plant lizard enclosures		May and June 2022	\$3,000
Commence sheep grazing		September 2022 and ongoing thereafter	N/A
B, C, D, E	Undertake assessment to elevate the legal protection status of the site	Throughout the year	Cost to be determined by Department of Conservation
	Undertake a feasibility assessment for the creation of additional wetland habitat	November 2021-April 2022	Exact costs to be determined. However, is likely be \$30,000 or more

Management Unit	Management Action	Timing	Price Estimate
	Undertake earthworks and install a weir(s) if wetland augmentation is considered feasible	May-October 2022	\$60,000
	Undertake an assessment for the reintroduction of at least one freshwater mahinga kai species.	Throughout the year	\$15,000
	Install and undertake ongoing pest animal control for lizard protection	Throughout the year	\$23,000
	Clear vehicle tracks throughout site	November 2021-April 2022	\$5,000
<b>Year 2</b>			
A	Continue and complete process for obtaining resource consent	Once feasibility assessment is complete	Exact costs to be determined
	Aerially spray exotic vegetation over entire site	March-April 2023	\$30,000
	Clear exotic vegetation and create river and stream channels (including freshwater fauna restoration sites)	July-October 2023	Exact costs to be determined. However, is likely to be greater than \$150,000
A, B, C	Remeasure photopoints	November 2022-May 2023	\$1,000
B, C	Infill planting in dryland, riparian margins, wetlands (B only) and lizard enclosures (both B and C)	May and June 2023	\$40,000
	Pest plant control within all restoration sites (including within firebreaks)	Two times: November 2022, March 2023	\$80,000
C	Order eco-sourced plants and planting materials for dryland forest, riparian, and wetland areas (plant guards etc.)	November 2022	\$390,000
	Cut fence lines and install lagomorph proof fences if required.	November 2022-April 2023	\$40,000
	Mulch planting strips within gorse and scrub for indigenous dryland forest and riparian planting areas (section of unit only)	April 2023	\$20,000
	Prepare planting sites (dryland, riparian margins and wetlands)	April 2023	\$20,000
	Plant dryland and riparian margins	May and June 2023	\$30,000
	Plant wetlands	September 2023	\$50,000
	Order infill plants	October 2023	\$40,000
B, C, D, E	Undertake ongoing pest animal control for lizard protection	Throughout the year	\$30,000
	Reintroduce freshwater mahinga kai species	Timing to be determined by species specialist	\$3000
<b>Year 3</b>			
A, B, C	Pest plant control within restoration sites (including within firebreaks)	Two times: November 2023, March 2024	\$80,000

Management Unit	Management Action	Timing	Price Estimate
C	Infill planting in dryland, riparian margins and wetlands	May and June 2024	\$14,000
D	Order eco-sourced plants and planting materials for dryland forest, riparian and wetland areas (plant guards etc.)	November 2023	\$450,000
	Cut fence lines and install lagomorph proof fences if required.	November 2023-April 2024	\$54,000
	Mulch planting strips within gorse and scrub for indigenous dryland forest and riparian planting areas (section of unit only)	April 2024	\$20,000
	Prepare planting sites (dryland, riparian margins and wetlands)	April 2024	\$100,000
	Plant dryland and riparian margins	May and June 2024	\$80,000
	Plant wetlands	September 2024	\$60,000
	Order infill plants	October 2024	\$130,000
	A, B, C, D	Remeasure photopoints	November 2023-May 2024
B, C, D, E	Undertake ongoing pest animal control for lizard protection	Throughout the year	\$30,000
	Monitoring of reintroduced freshwater mahinga kai species	Timing to be determined by species specialist	\$1000
<b>Year 4</b>			
All management units	Remeasure photopoints	November 2024-May 2025	\$1000
A	Pest plant control within braid plain	November 2024-April 2025	\$15,000
A, B, C, D	Pest plant control within restoration sites (including within firebreaks)	Two times: November 2024, March 2025	\$75,000
D	Infill planting in dryland, riparian margins and wetlands	May and June 2025	\$40,000
E	Order eco-sourced plants and planting materials for dryland forest, riparian, and wetland areas (plant guards etc.)	November 2024	\$340,000
	Cut fence lines and install lagomorph proof fences if required.	November 2024-April 2025	\$22,000
	Mulch planting strips within gorse and scrub for indigenous dryland forest and riparian planting areas (section of unit only)	April 2025	\$20,000
	Prepare planting sites (dryland, riparian margins and wetlands)	April 2025	\$110,000
	Plant dryland and riparian margins	May and June 2025	\$110,000
	Plant wetlands	September 2025	\$30,000
	Order infill plants	October 2025	\$40,000

Management Unit	Management Action	Timing	Price Estimate
B, C, D, E	Undertake ongoing pest animal control for lizard protection	Throughout the year	\$30,000
	Augment indigenous freshwater fish and invertebrate habitat by adding dead wood and boulders to streams and wetlands	November 2024-April 2025	\$5,000
	Monitoring of reintroduced freshwater mahinga kai species	Timing to be determined by species specialist	\$1000
<b>Total</b>			<b>\$3,509,500</b>

### 13. CONCLUSIONS

The Ealing Springs site contains spring-fed riparian and wetland habitats that are of high ecological value due to their relative scarcity on the Canterbury Plains. In addition, the surrounding dryland habitats have high potential for the restoration of dryland indigenous forest and braid plain. Collectively, these habitats potentially provide excellent opportunities for the restoration of threatened and mahinga kai species, as well as the enhancement of existing populations of indigenous plants and animals (e.g. southern grass skink and raupō).

In order to meet the Rangitata Steering Groups overarching goals of improving species recovery, habitat enhancement, and identification of opportunities for restoring mahinga kai resources at the Ealing Springs site, ecological values, threats and management actions have been identified. The primary threats at the site are from pest plants, fire, pest animals, flooding and climate change. Management actions include using gorse and broom shrublands as a nursery for the establishment of dryland indigenous forest, controlling pest plants and undertaking restoration plantings on riparian margins and within wetlands, restoring braid plain habitat and undertaking predator control to enhance lizard populations. Implementing these management actions will greatly enhance the ecological integrity and mauri of Ealing Springs, and ensure that the site provides mahinga kai for Te Rūnanga o Arowhenua, and food gathering and recreational opportunities for the wider community for future generations.

### ACKNOWLEDGMENTS

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## VEGETATION AND HABITAT TYPES RECORDED AT EALING SPRINGS, RANGITATA RIVER

The vegetation and habitat types recorded at Ealing Springs during the July 2021 site visit and by analysis of aerial imagery are listed below. The distribution of these vegetation and habitat types is illustrated in Figure 2.

### 1. **Radiata pine forest (shelterbelt) and treeland**

Shelterbelts of radiata pine are planted on the northeastern margin of the site. Scattered individual trees are located on the southwestern half of the site in and adjacent to Management Unit A.

### 2. **Poplar forest**

Stands of poplar forest are located shortly northeast of Management Unit A.

### 3. **Mixed exotic treeland**

A stand of what appears to be eucalyptus (*Eucalyptus* sp.) is located on the northeast margin of the site in Management Unit D. Additional exotic tree species are likely also present.

### 4. **Crack willow forest**

Areas of crack willow forest occur throughout the site, but are particularly abundant in the southwestern half of the site.

### 5. **Crack willow treeland and Scotch broom-gorse shrubland**

Scattered areas of crack willow treeland are common in the southwestern half of the site. These areas of treeland appear to contain gorse and Scotch broom. Other exotic shrub species may also be present.

### 6. **Muehlenbeckia vineland and exotic treeland**

Areas of muehlenbeckia (*Muehlenbeckia australis*) vineland occur at the base of the terrace on the northeastern margin of the site. The vines are growing through and over exotic tree and shrub species.

### 7. **Exotic scrub**

Two areas of what is believed to be exotic scrub occur on the western margin of Edgars Pond. However, it is possible that these are indigenous species.



## **8. Gorse shrubland**

Gorse shrubland is the most abundant vegetation type at the site. It is likely that these areas of shrubland also contain Scotch broom and other pest plant species.

## **9. Scotch broom-gorse shrubland**

Areas of shrubland comprising Scotch broom and gorse primarily occur in disturbed sites along riparian margins and near the main stem of the river.

## **10. Scotch broom shrubland**

Small areas of what appears to be Scotch broom shrubland are located on the margins of the main stem of the river.

## **11. Scotch broom/exotic grassland and bare ground**

Small areas of scattered Scotch broom that occur over gravelfield and exotic grassland appear to primarily occur in the southwestern half of the site.

## **12. Harakeke-toetoe flaxland**

Areas of wetland that contain harakeke and toetoe (*Austroderia richardii*) are located on the northeastern side of Management Unit B and C. These areas of wetland likely contain a diversity of indigenous and exotic species, and warrant detailed surveys in the future.

## **13. Harakeke-toetoe-rārahu-gorse flaxland, fernland and shrubland**

Based on analysis of aerial imagery, areas of wetland that appear to contain harakeke, toetoe, rārahu and gorse occur on the northeastern side of Management Units C and D.

## **14. Raupō reedland**

What appears to be raupō reedland occurs in a branch of the main wetland in Management Unit C. Additional areas of reedland of this species may be present at the site.

## **15. Pūrei sedgeland**

Areas of wetland that contain pūrei are present in Management Units B, C and D. These wetlands likely contain a diversity of indigenous and exotic species, and warrant detailed surveys in the future.

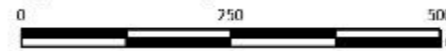
## **16. Exotic grassland**

Areas of exotic grassland are scattered through the site. It is likely they comprise species such as chewings fescue (*Festuca rubra* subsp. *commutata*), sweet vernal (*Anthoxanthum odoratum*) and Yorkshire fog (*Holcus lanatus*).





**Figure 2. Vegetation and habitats at Ealing Springs, Rangitata River, South Canterbury**



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 File: Figure\_EalingSprings\_Vegetation.mxd

**Wildlands**  
 www.wildlands.co.nz, 0933 901 067  
 Scale: 1:8,000  
 Date: 8/10/2021  
 Cartographer: FM  
 Format: A3R



**17. Pond**

Edgars Pond, located in Management Unit B.

**18. Gravelfield**

Small areas of gravelfield are located along the margin of the main stem of the river in Management Unit A.

**19. Gravel road**

Gravel tracks occur throughout the site. The most prominent track is located in Management Units A and B.

## AVIFAUNA SPECIES RECORDED ON EBIRD NEAR THE EALING SPRINGS SITE, RANGITATA RIVER

Scientific Name	Common Name	Threat Classification <sup>1</sup>
<b>Indigenous</b>		
<i>Anas gracilis</i>	Grey teal	Not Threatened
<i>Anas rhynchotis</i>	Australasian shoveler	Not Threatened
<i>Aythya novaeseelandiae</i>	New Zealand scaup	Not Threatened
<i>Charadrius bicinctus bicinctus</i>	Banded dotterel	At Risk-Declining
<i>Chlidonias albostratus</i>	Black-fronted tern	Threatened-Nationally Endangered
<i>Circus approximans</i>	Swamp harrier	Not Threatened
<i>Cygnus atratus</i>	Black swan	Not Threatened
<i>Egretta novaehollandiae</i>	White-faced heron	Not Threatened
<i>Haematopus finschi</i>	South Island pied oystercatcher	At Risk – Declining
<i>Himantopus himantopus leucocephalus</i>	Pied stilt	Not Threatened
<i>Hirundo neoxena neoxena</i>	Welcome swallow	Not Threatened
<i>Hydroprogne caspia</i>	Caspian tern	Threatened-Nationally Vulnerable
<i>Larus bulleri</i>	Black-billed gull	At Risk-Declining
<i>Larus dominicanus dominicanus</i>	Southern black-backed gull	Not Threatened
<i>Larus novaehollandiae scopulinus</i>	Red-billed gull	At Risk-Declining
<i>Phalacrocorax carbo novaehollandiae</i>	Black shag	At Risk-Relict
<i>Phalacrocorax melanoleucos melanoleucos</i>	Little pied shag	Non-resident Native – Vagrant
<i>Porphyrio melanotus</i>	Pūkeko	Not Threatened
<i>Sterna striata striata</i>	White-fronted tern	At Risk-Declining
<i>Tadorna variegata</i>	Paradise shelduck	Not Threatened
<i>Todiramphus sanctus vagans</i>	New Zealand kingfisher	Not Threatened
<i>Vanellus miles novaehollandiae</i>	Spur-winged plover	Not Threatened
<b>Exotic</b>		
<i>Anas platyrhynchos</i>	Mallard	Introduced and Naturalised
<i>Branta canadensis</i>	Canada goose	Introduced and naturalised
<i>Callipepla californica</i>	California quail	Introduced and naturalised
<i>Cereopsis novaehollandiae</i>	Cape Barren goose	Introduced and naturalised
<i>Columba livia</i>	Rock pigeon	Introduced and naturalised
<i>Corvus frugilegus</i>	Rook	Introduced and naturalised
<i>Emberiza citronella</i>	Yellowhammer	Introduced and naturalised
<i>Gymnorhina tibicen</i>	Australian magpie	Introduced and naturalised
<i>Passer domesticus</i>	House sparrow	Introduced and naturalised
<i>Prunella modularis</i>	Dunnock	Introduced and naturalised
<i>Sturnus vulgaris</i>	Starling	Introduced and naturalised
<i>Turdus merula</i>	Blackbird	Introduced and naturalised
<i>Turdus philomelos</i>	Song thrush	Introduced and naturalised

<sup>1</sup> Robertson *et al.* 2021.

## POTENTIAL MAHINGA KAI RESOURCES THAT COULD BE ESTABLISHED AT EALING SPRINGS, RANGITATA RIVER

Species	Common Name	Threat Status	Mahinga Kai Resource
<b>Plant</b>			
<i>Cordyline australis</i>	Tī kōuka, cabbage tree	Not Threatened	Numerous medicinal, food, fibre uses <sup>1</sup> .
<i>Nasturtium officinale</i>	Kōwhitiwhiti, watercress	Introduced and Naturalised	Edible leaves, used medicinally for headaches <sup>1</sup> .
<i>Phormium tenax</i>	Harakeke, flax	Not Threatened	Numerous medicinal, food, fibre, dyes, and construction uses <sup>1</sup> .
<i>Typha orientalis</i>	Raupō, bullrush	Not Threatened	Numerous medicinal, food, hunting, and construction uses <sup>1</sup> .
<b>Birds</b>			
<i>Anas superciliosa</i>	Pārerā/grey duck	Threatened – Nationally Critical	Food and feathers (historically), <sup>2</sup>
<i>Botaurus poiciloptilus</i>	Matuku, matuku-hūrepo	Threatened – Nationally Critical	Food and feathers (historically). Included within oral histories <sup>3</sup>
<b>Freshwater Fish</b>			
<i>Geotria australis</i>	Kanakana, piharau, lamprey	Threatened – Nationally Vulnerable	Food <sup>4</sup>
<b>Freshwater Invertebrate</b>			
<i>Echyridella menziesii</i>	Kākahi, freshwater mussel	At Risk – Declining	Mussel flesh used as food and medicine. Shells used as tools <sup>5</sup> .

- Further information at (requires a search of individual plant species): <https://maoriplantuse.landcareresearch.co.nz/WebForms/default.aspx>
- Source: Phillips (1947).
- <https://www.doc.govt.nz/nature/native-animals/birds/birds-a-z/australasian-bittern-matuku/>
- [https://niwa.co.nz/our-science/freshwater/tools/kaitiaki\\_tools/species/piharau](https://niwa.co.nz/our-science/freshwater/tools/kaitiaki_tools/species/piharau)
- [https://niwa.co.nz/our-science/freshwater/tools/kaitiaki\\_tools/species/kakahi#:~:text=Traditionally%2C%20they%20were%20collected%20throughout,as%20a%20rongo%C4%81%20or%20medicine\).](https://niwa.co.nz/our-science/freshwater/tools/kaitiaki_tools/species/kakahi#:~:text=Traditionally%2C%20they%20were%20collected%20throughout,as%20a%20rongo%C4%81%20or%20medicine).)

**ENVIRONMENTAL PEST PLANTS OBSERVED  
AT EALING SPRINGS, RANGITATA RIVER**

<b>Scientific Name</b>	<b>Common Name(s)</b>	<b>Status in the RPMP</b>
<i>Clematis vitalba</i>	Old man's beard	Sustained Control
<i>Cytisus scoparius</i>	Scotch broom	Sustained Control
<i>Leycesteria formosa</i>	Himalayan honeysuckle	Not listed
<i>Lupinus arboreus</i>	Tree lupin	Not listed
<i>Pinus radiata</i>	Radiata pine	Not listed
<i>Populus spp.</i>	Poplar	Not listed
<i>Rubus fruticosus</i>	Blackberry	Organism of Interest
<i>Salix xfragilis</i>	Crack willow	Not listed
<i>Ulex europaeus</i>	Gorse	Sustained Control

## GUIDELINES FOR PLANTING AND MAINTAINING INDIGENOUS PLANT SPECIES AT EALING SPRINGS, RANGITATA RIVER

### OVERVIEW

The following section provides an overview of the management actions required for the successful planting and establishment of indigenous species at Ealing Springs.

### SPECIES SOURCES AND SELECTION

- All indigenous plant species should occur naturally in similar sites within the Low Plains Ecological District.
- All plants should be sourced from Low Plains Ecological District genetic stock or from nearby ecological districts and should generally have been grown from seed to maximise potential genetic diversity.
- A range of indigenous species with different attributes were identified for the plantings (listed in Tables 4, 5, and 6). These include:
  - Trees that will form a mature canopy
  - Fast growing early successional species
  - Shrubs that will provide diversity in the understorey
  - Raupō, harakake and a range of sedges and rushes for planting on riparian margins and in wetlands
  - Mahinga kai species
  - Nationally Threatened/At Risk (as per de Lange *et al.* 2018) and locally uncommon species to enhance conservation values. Suggested species include hook grass (*Carex strictissima*), coral broom (*Carmichaelia crassicaulis*) and shrubby tororaro (*Muehlenbeckia astonii*). The historical distribution of these species is not known with certainty, but it is very likely they were more widely distributed in the ecological district prior to European colonisation.
  - Vigorous indigenous species that will quickly colonise the planting areas (e.g. toatoa, *Haloragis erecta*; karamū; and koromiko, *Veronica salicifolia*).
  - Fleshy-fruited species, to provide food for indigenous fauna and to facilitate their dispersal by birds.

## **PLANT GRADES**

- Planter bag (PB) plant grades (ideally 2/3) should preferably be used for most of the plantings as their stature and robustness reduces their vulnerability to light or incidental browsing by herbivorous animal pests (e.g. rabbits, possums), and they are more resilient to frosts and other environmental extremes.
- PB grade plants should also be used for enrichment plantings.
- Where pre-planting site preparation and post-planting monitoring and maintenance are carried out to a high standard, plants in root trainers (RTs) can be used instead of larger (more costly) plants in individual PBs.

## **PLANT SPACINGS**

- Plant trees at 1.5 - 2 metre spacings (depending on species).
- Plant shrubs at 1 to 2 metre spacings (depending on species).
- Sedges, rushes and grasses should generally be planted at 0.5 metre spacings with the exception of species such as pūrei, swamp sedge and toetoe which should be planted at 1 metre spacings.
- Plants should be set back from fences by 1.5 metres to prevent livestock browse if stock is present.

## **SITE PREPARATION PRIOR TO PLANTING**

- Planting areas should be prepared in mid to late autumn, ideally four to six weeks prior to planting. Individual planting sites should have vegetation cover reduced by spraying 0.4 metre round areas with 10% glyphosate in water.
- Herbicide should be applied by a qualified applicator (Growsafe and Approved Handler certified).
- It is important that existing naturally-occurring indigenous vegetation (especially containing Nationally Threatened/At Risk or locally uncommon species) is not adversely affected by the planting programme. Plantings should be integrated with and enhance existing indigenous vegetation as much as possible, therefore no indigenous vegetation should be removed to facilitate planting.



## **TIMING OF PLANTING**

- In dryland areas, timing of planting will be dictated by the rainfall patterns in the intended planting season but, in general, should be planted from late autumn, once soil moisture levels reach field capacity, through to mid-winter.
- In wetland areas, planting should be undertaken in early-mid spring (September or October, depending on winter rainfall) once standing water in flooded areas has begun to recede. Site visits should be conducted at the wetland restoration areas to determine the timing of planting during the spring when it is planned.

## **PLANT GUARDS**

- In dryland areas, newly-planted trees and shrubs can be decimated by rabbit and hare browse, so protection against browse is critical.
- In unfenced areas, individual plant guards should be used to protect each plant if browsing is an issue. They also provide shelter, increased humidity, reduction of moisture loss, and help to prevent unintended herbicide damage.
- Guards should be removed and reused once the foliage of the plants grows out of the top of the guard.

## **MAINTENANCE OF PLANTS**

- In the first 12 months following planting operations, assess plant condition and weed competition every three months.
- For the first two years following planting, plants should be released from environmental weeds a minimum of three times a year by hand weeding or spraying with selective herbicides.
- For up to five years following the planting, further releases from environmental weeds may be required once or twice a year during the growing season by hand weeding or spraying with selective herbicides. When plants are emergent above the surrounding vegetation (typically a grass sward), little further management is required. However, ongoing control of pest plants will be required, particularly before canopy closure is achieved.
- Infill planting to replace plants that have died may be required and should be undertaken during the second or third year after the original planting.

Table 4: Indigenous plant species to be planted in dryland areas of the Ealing Springs site, Rangitata River.

Scientific Name	Common Name	Conservation Status <sup>1</sup>	Spacing (m)	Percentage (%)	Quantity per Hectare
<i>Coprosma crassifolia</i>	Thick-leaved coprosma, mikimiki	Not Threatened	1	2	200
<i>Coprosma propinqua</i>	Mingimingi, mikimiki	Not Threatened	1	5	500
<i>Coprosma robusta</i> <sup>3</sup>	Karamū	Not Threatened	1	1	100
<i>Cordyline australis</i> <sup>2, 3</sup>	Cabbage tree, tī kōuka	Not Threatened	1.5	2	50
<i>Elaeocarpus dentatus</i> <sup>3</sup>	Hīnau	Not Threatened	1.5	2	89
<i>Griselinia littoralis</i> <sup>3</sup>	Broadleaf, kāpuka	Not Threatened	1.5	2	89
<i>Hoheria angustifolia</i>	Narrow-leaved lacebark, houhere	Not Threatened	1.5	10	445
<i>Kunzea robusta</i>	Kānuka, rawirinui, kopuka	Threatened – Nationally Vulnerable	1.5	15	667
<i>Leptospermum scoparium</i>	Mānuka, tea tree	Not Threatened	1.5	15	667
<i>Olearia paniculata</i>	Akiraho	Not Threatened	1.5	4	178
<i>Pittosporum eugeniooides</i> <sup>3</sup>	Tarātā	Not Threatened	1.5	1	45
<i>Pittosporum tenuifolium</i> <sup>3</sup>	Kōhūhū, black matipo	Not Threatened	1.5	2	89
<i>Plagianthus regius</i> <sup>3</sup>	Lowland ribbonwood, mānatu	Not Threatened	1.5	5	222
<i>Podocarpus totara</i>	Lowland tōtara	Not Threatened	1.5	15	667
<i>Prumnopitys taxifolia</i>	Mataī, black pine	Not Threatened	1.5	10	445
<i>Pseudopanax crassifolius</i>	Lancewood, horoeka	Not Threatened	1.5	5	222
<i>Sophora microphylla</i>	Small-leaved kōwhai	Not Threatened	1.5	2	89
<i>Veronica salicifolia</i>	Koromiko	Not Threatened	1	2	200
				<b>100</b>	<b>4,964</b>

2 Mahinga kai species.

3 Plant in landscape depressions and sheltered sites where summer soil moisture levels are likely to increase plant survival rates.

<sup>1</sup> As per de Lange *et al.* (2018).

Table 5: Indigenous plant species to be planted on riparian and wetland margins within the Ealing Springs site, Rangitata River.

Scientific Name	Common Name	Conservation Status <sup>1</sup>	Spacing (m)	Percentage (%)	Quantity per Hectare
<b>Drier riparian areas</b>					
<i>Coprosma propinqua</i>	Mingimingi, mikimiki	Not Threatened	1.5	2	89
<i>Coprosma virescens</i>	Mikimiki	Not Threatened	1.5	1	45
<i>Cordyline australis</i> <sup>2</sup>	Cabbage tree, tī kōuka	Not Threatened	1.5	5	500
<i>Coriaria sarmentosa</i> <sup>2</sup>	Tutu	Not Threatened	1	2	200
<i>Dacrycarpus dacrydioides</i>	Kahikatea, white pine	Not Threatened	2	15	667
<i>Eleocharis acuta</i>	Sharp spike sedge	Not Threatened	0.5	1	400
<i>Griselinia littoralis</i>	Broadleaf, kāpuka	Not Threatened	2	2	50
<i>Haloragis erecta</i>	Toatoa	Not Threatened	2	1	25
<i>Leptospermum scoparium</i>	Mānuka, tea tree	Threatened –Nationally Vulnerable	1.5	10	445
<i>Sophora microphylla</i>	Small-leaved kōwhai	Not Threatened	2	5	125
<i>Teucrium parvifolium</i>	NZ verbena, teucrium	Not Threatened	1.5	1	45
<i>Veronica salicifolia</i>	Koromiko	Not Threatened	2	2	89
<b>Wetland riparian areas</b>					
<i>Austroderia richardii</i>	Toetoe	Not Threatened	1	10	1,000
<i>Carex buechananii</i>	Cutty grass, matirewa	At Risk – Declining	0.5	1	400
<i>Carex coriacea</i>	Cutty grass, rautahi	Not Threatened	0.5	1	400
<i>Carex geminata</i>	Cutty grass, rautahi	Not Threatened	0.5	1	400
<i>Carex maorica</i>	Cutty grass, rautahi	Not Threatened	0.5	1	400
<i>Carex secta</i>	Pūrei, pūkio	Not Threatened	1	10	1,000
<i>Carex strictissima</i>	Hook grass	Threatened –Nationally Endangered	0.5	1	400
<i>Carex virgata</i>	Swamp sedge	Not Threatened	0.5	1	400
<i>Coriaria sarmentosa</i> <sup>2</sup>	Tutu	Not Threatened	1	1	100
<i>Eleocharis acuta</i>	Sharp spike sedge	Not Threatened	0.5	1	400
<i>Juncus edgariae</i>	Leafless rush, wī	Not Threatened	0.5	1	400
<i>Juncus pallidus</i>	Giant rush, leafless rush, wī	Not Threatened	0.5	1	400
<i>Juncus sarophorus</i>	Leafless rush, wī	Not Threatened	0.5	1	400
<i>Phormium tenax</i> <sup>2</sup>	Lowland flax, harakeke	Not Threatened	1	20	2,000
<i>Typha orientalis</i> <sup>2</sup>	Raupō, bull rush	Not Threatened	0.5	2	1,000
<b>Total</b>				<b>100</b>	<b>11,780</b>

2 Mahinga kai species.

Table 6: Indigenous plant species to be planted within lizard habitat restoration areas at Ealing Springs, Rangitata River.

Scientific Name	Common Name	Conservation Status	Spacing (m)	Percentage (%)	Quantity per Hectare
<i>Carmichaelia australis</i>	Native broom, common broom	Not Threatened	1	10	1,000
<i>Carmichaelia crassicaulis</i>	Coral broom	Threatened – Nationally Vulnerable	1	2	200
<i>Coprosma intertexta</i>		At Risk – Declining	1.5	5	222
<i>Coprosma propinqua</i>	Mingimingi, mikimiki	Not Threatened	1.5	10	445
<i>Corokia cotoneaster</i>	Korokio	Not Threatened	1.5	10	445
<i>Discaria toumatou</i>	Matagouri, tūmatakuru	At Risk – Declining	1.5	10	445
<i>Festuca novae-zelandiae</i>	Fescue tussock, hard tussock	Not Threatened	1	5	500
<i>Helichrysum lanceolatum</i>	Niniao	Not Threatened	1.5	10	445
<i>Melicytus alpinus</i>	Porcupine shrub	Not Threatened	2	8	200
<i>Muehlenbeckia astonii</i>	Shrubby tororaro, wiggwig	Threatened – Nationally Endangered	2	2	50
<i>Muehlenbeckia complexa</i>	Scrub pōhuehue, wire vine	Not Threatened	1	5	222
<i>Myrsine divaricata</i>	Weeping matipo, weeping māpou	Not Threatened	1.5	2	89
<i>Olearia adenocarpa</i>	Plains olearia	Threatened – Nationally Critical	1.5	2	89
<i>Olearia fimbriata</i>		Threatened – Nationally Vulnerable	1.5	2	89
<i>Olearia lineata</i>		At Risk – Declining	1.5	10	445
<i>Poa cita</i>	Silver tussock, wī	Not Threatened	1	5	500
<i>Sophora microphylla</i>	Small-leaved kōwhai	Not Threatened	1.5	2	89
<b>Total</b>				<b>100</b>	<b>5,475</b>

## SUMMARY OF MANAGEMENT ACTIONS AND PRIORITIES FOR EALING SPRINGS RESTORATION WORK PLAN

### Key Objectives and Actions for Management Zones identified in Figure 3

1. Culvert: assess ecological effects of culvert. Replace or reposition to improve indigenous fish passage, or retain as barrier to salmonoids.
2. Stream – main stem, upper reach: manage for indigenous aquatic values, downstream predation during migratory stages will limit opportunities.
3. Stream – main stem, lower reach: actions to align with Fish and Game interests, could include kākahi beds, harakeke or tī kōuka planting, balance investment here against ecological gains from investment elsewhere in site.
4. Stream - second stem: manage for indigenous aquatic values, consider options to exclude salmonoids, assess suitability to restore kākahi and kanakana, riparian planting and wetland restoration.
5. Pupuatuke Spring: outside the scope of the restoration plan, identify threats to headwater spring and stream, implement actions to protect and enhance riparian and instream habitats and water quality (i.e. riparian planting). Current LINZ lease, approval required before implementation.
6. Egars Pond: waterfowl hunting site, opportunities to improve indigenous fish habitat, especially for tuna.
7. Wetland restoration areas: reintroduce wetland species, promote natural regeneration, control woody weeds and plant, survey for other threats and manage as required, ongoing pest plant control.
8. Stream margin restoration areas: establish filtering vegetation cover to reduce nutrient and containment inputs and improve instream and riparian habitat, maintain flows.
9. Dryland restoration areas: Reintroduce dryland forest species, section of area only, control woody weeds and plant, ongoing pest plant control, promote passive vegetation establishment following regeneration from plantings.
10. Potential river braid restoration area: recognise and promote dynamism, potential area for woody weed control to promote bird habitat and braidplain restoration.
11. Whole area: predator control, survey for unknown habitats and values, control pest plants identified as conservation priorities, monitor, survey for additional threats and unknown habitats and values, ensure works are sympathetic to ecological values, establish tracks and formalise access, work with Te Rūnanga o Arowhenua to identify and implement other actions to enhance the ecological integrity, mauri and provision of mahinga kai, implement other actions as identified in the Main Stem restoration plan.

Activity/Task	Area/Zone (Refer Figure 3)	Activity Required	Timing	Objective/Reason
Undertake vegetation and fauna surveys	Whole site	This survey will identify and prioritise restoration areas	ASAP	Identify/confirm priority areas
Undertake pest plant survey at the site	Whole site	This survey will identify all pest plants present and control priorities needed	ASAP	Develop pest plant management plan
Develop pest plant management plan	Priority sites identified in surveys	Identify all problematic pest plants and priority areas and species for control	After pest plant survey	Pest plants have the potential to modify the functionality of stream system system, iimpact mahinga kai resources, reducing nesting habitat for indigenous birds and inhibit the regeneration of indigenous vegetation.
Mahinga kai feasibility study	All areas	Undertake an initial feasibility study for the reintroduction of a mahinga kai species (or multiple species).	ASAP - ongoing	Identify opportunities for mahinga kai reintroduction or enhancement with Te Rūnanga o Arowhenua. i.e. flow suitability for kanakana, weka introduction.  Develop and implement a management plan for mahinga kai.
Salmonid barrier feasibility study	Culvert/Zone 1 Stream – second stem/Zone 4	Undertake an initial feasibility study for the establishment of barriers to salmonoids.	ASAP - ongoing	Salmonoids predate indigenous fish species. May limit restoration opportunities. Options that allow for passage of indigenous species but not salmonoids may not be feasible. Note: water conservation order currently presents salmonoid exclusion.
Refine restoration plan after survey and feasibility assessments	Culvert/Zone 1 Streams/Zone 2, 3, 4, & 8 Spring/Zone 5 Wetland areas/Zone 7 Dryland forest/Zone 8	Define restoration areas, priorities, plant numbers, and appropriate species list	After habitat survey	Better defining areas will allow for more accurate plant number calculations – need for ordering eco-sourced plants  Plan may need to be adjusted depending on values, threats and new priorities identified during surveys.
Fire management	Whole site	Develop fire management plan	After surveys	Area of gorse and Scotch broom shrubland at the site are a high fire risk, particularly during droughts.
Order eco-sourced plants and planting materials	Stream margin/Zone 8 Spring/Zone 5 Wetland areas/Zone 7 Dryland forest/Zone 8	Order eco-sourced plants and planting materials (plant guards etc.) Refer to Appendix 5 table 4, 5 & 6 for suitable planting species.	ASAP after refining restoration plan	Eco-sourcing is important for the local ecological integrity. Eco-sourcing plants can be a long process. Plants need to be ordered as soon as possible. Not all species will need to be guarded.
Install tracks	Stream margin/Zone 8 Spring/Zone 5 Wetland areas/Zone 7 Dryland forest/Zone 8	Create tracks to improve access to key restoration sites.	After refining restoration plan	Access to the site is required to implement restoration actions.
Establish photopoints and monitor	All areas	Establish photopoints where ecological restoration will occur	Prior to restoration	Good monitoring tool to observe progress and help with future restoration projects. Undertake regular monitoring as outlined in Section 10.
Pest animal control	Whole site	Establish and install DOC 200 pest animal traps around site perimeter and within areas of	Autumn/Winter (March-July 2022)	Vital to sustain indigenous bird, lizard and some invertebrate species reliant on dryland river habitat. Possums pose threat to restoration plantings.

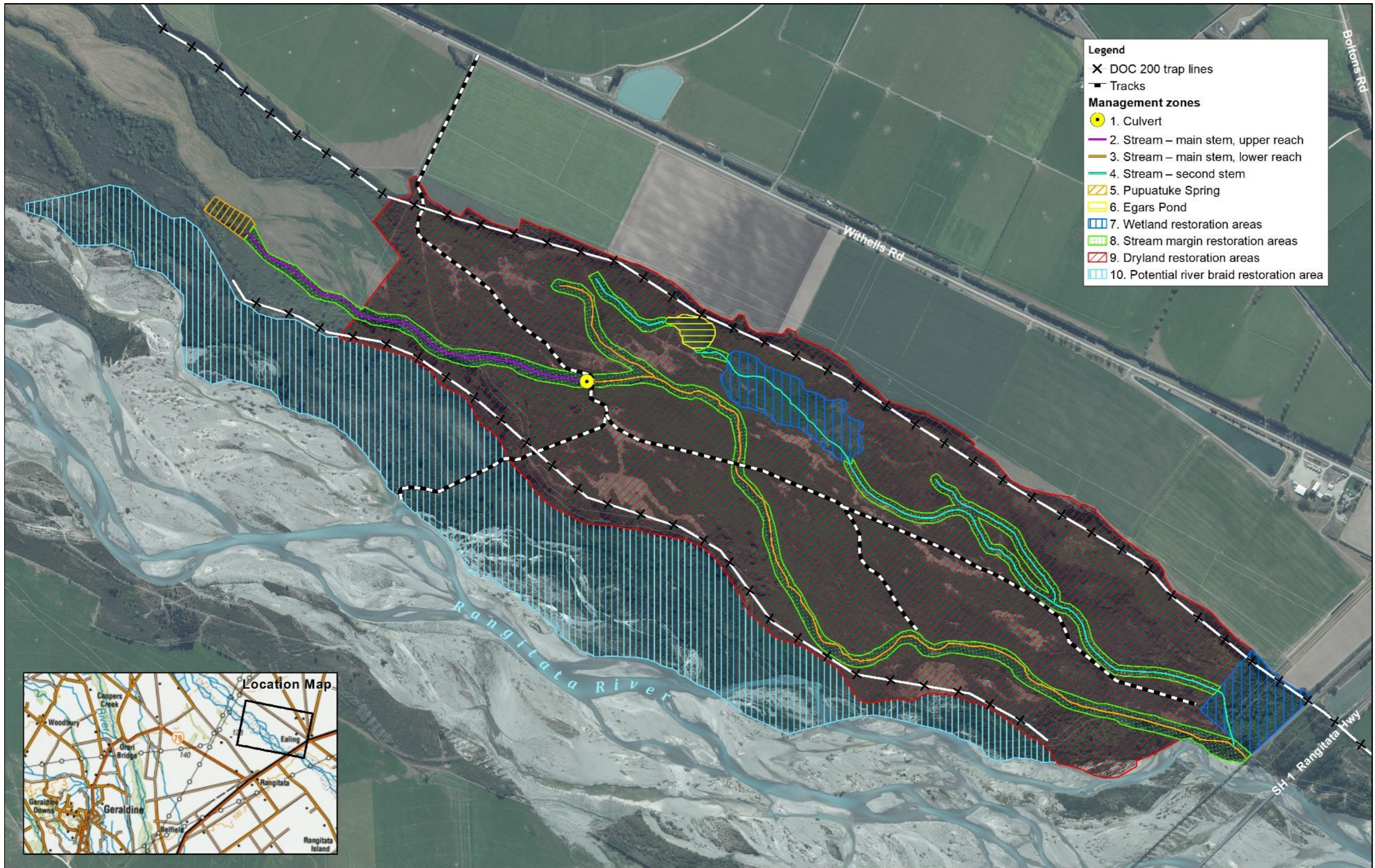
Activity/Task	Area/Zone (Refer Figure 3)	Activity Required	Timing	Objective/Reason
		dryland habitat to protect ground-nesting indigenous birds, lizards and invertebrates.  Establish supplementary Timms traps for possums.	On-going - check monthly	
Culvert remediation (if assessed as ecologically beneficial) or install fish barriers.	Culvert/Zone 1  Stream – second stem/Zone 4	Replace or remediate culvert to improve fish passage or install barriers to limit salmonoid passage.	Winter (May-October) 2022 or Summer (November-January) 2023	Barriers to fish passage can create refugia from predation in upstream reaches, but can also limit indigenous fish migration. Net benefit vs. cost of retaining or creating barriers to be considered.  Important to avoid critical indigenous fish migration periods.
Pest plant control	Priority sites identified in the surveys.	Target pest plant species. Spot spray, cut and paste or mulch & digger vegetation removal. Depending on extent of exotic species present and their proximity to waterways.	After pest plant management plan has been developed-June 2022 – ongoing.  Timing depends on target species and method of control.	Pest plants have the potential to modify the functionality of streams & wetlands, impacting mahinga kai resources, reducing nesting habitat for indigenous birds and inhibit the regeneration of indigenous vegetation.  Priority target areas for gorse control are within planting and natural regeneration zones.  Any existing naturally-occurring indigenous vegetation should be identified and flagged (using suitable flagging tape), so as not to be removed, or damaged during pest plant control.  <b>Critical that control occurs on an annual ongoing basis.</b>
Note: Planting and site preparation efforts have been split to make it more manageable timewise, with a second site preparation and planting phase to be undertaken in either the follow spring or Autumn to ensure maximum plant survival. Initial planting areas are sections of areas only and extended as resourcing allows beyond the four-year time period.				
Mark out planting zones	Planting areas	Suitable areas for planting within to be identified and marked out	Winter/early spring 2022	Planting clumps or strips of indigenous vegetation within dryland zones will provide seed source to promoted natural regeneration into the surrounding pest plant control zones. Areas with greatest soil depth and leaf mulch should be selected for planting to ensure maximum survival. Wetland planting to enhance existing values. Riparian planting to improve habitat and provide seed source to promote natural regeneration.  Existing naturally-occurring indigenous vegetation should be re-identified and flagged (if flagging no longer present) Where possible planting should be integrated with existing indigenous vegetation.
Fence installation (if required)	Selected areas of Zone 9	Install fencing around planting areas. To encompass entire zone or smaller units depending on planting strategy and cost.	Winter/early spring 2022	Exclude livestock and ideally rabbits and hares. May not be required.

Activity/Task	Area/Zone (Refer Figure 3)	Activity Required	Timing	Objective/Reason
Planting site preparation	Spring/Zone 5 Wetlands/Zone 7 Phase 1 Riparian planting areas/Zone 8	Follow up control of any pest plants that have survived or regenerated following initial control – within planting zones. Spot spray planting sites (0.4 metre round areas with 1% glyphosate or other suitable herbicide depending on target species and time of year).	At least one month prior to planting	This is important for successful establishment of planted species and makes it easier and/or more efficient for planting.  <b>All pest plant control should be undertaken by experienced Growsafe certified operators.</b>
Planting	Spring/Zone 5 Wetlands/Zone 7 Phase 1 Riparian planting areas (wet areas only/Zone 8	Plant and guard species were necessary. Plant at 1 – 1.5 m spacing for shrub/tree species. Refer: Appendix 5 table 4, 5 & 6 for planting list and specifications.	At least one month after site preparation  Spring 2022 – wetland areas, damp riparian and spring areas  Autumn 2023 – dryland areas.	Create a seed source for future natural regeneration, and enhance current habitats.  In dryland areas planting should be undertaken from late autumn through to mid-winter. Once soil moisture levels reach full capacity.  In wetland areas, planting should be undertaken in early-mid spring (September or October, depending on winter rainfall) once standing water in flooded areas has begun to recede. Planting to follow staged willow control, and could be staggered along a gradient from drier to wetter, early in the season to later as conditions dictate.
Planting site maintenance	Spring/Zone 5 Wetlands/Zone 7 Phase 1 Riparian planting areas (wet areas only/Zone 8	Spray (Glyphosate) or hand release plants from weeds and pest plants as required.	At least 3-4 visits over Spring-Summer for the first 3 years - after planting. Then ongoing as required until plantings have established.	This is vital for the successful establishment of the planting areas. Invading weeds can quickly establish and complete/outgrown planted species.
Planting site preparation	Phase 2 Riparian planting areas/Zone 8  Dryland forest/Zone 9	Follow up control of any pest plants that have survived or regenerated following initial control – within planting zones. Spot spray planting sites (0.4 metre round areas with 1% glyphosate or other suitable herbicide depending on target species and time of year).	At least one month prior to planting	This is important for successful establishment of planted species and makes it easier and/or more efficient for planting.  <b>All pest plant control should be undertaken by experienced Growsafe certified operators.</b>
Planting	Phase 2 Riparian planting areas/Zone 8  Dryland forest/Zone 9	Plant and guard species were necessary. Plant at 1 – 1.5 m spacing for shrub/tree species. Refer: Appendix 5 table 4, 5 & 6 for planting list and specifications.	Autumn 2024 – dryland areas.	Create a seed source for future natural regeneration, and enhance current habitats.  In dryland areas planting should be undertaken from late autumn through to mid-winter. Once soil moisture levels reach full capacity.



Activity/Task	Area/Zone (Refer Figure 3)	Activity Required	Timing	Objective/Reason
Planting site maintenance	Phase 2 Riparian planting areas/Zone 8  Dryland forest/Zone 9	Spray (Glyphosate) or hand release plants from weeds and pest plants as required.	At least 3-4 visits over Spring-Summer for the first 3 years - after planting. Then ongoing as required until plantings have established.	This is vital for the successful establishment of the planting areas. Invading weeds can quickly establish and complete/outgrown planted species.
Infill planting	All planting areas	Infill planting to replace plants that have died	Second or third year after the original planting.	Required to establish canopy closure.
Promote natural regeneration	Dryland forest/Zone 9	Promote natural regeneration in existing areas of indigenous vegetation.	Spring 2022 – ongoing.	Facilitating natural regeneration from planted areas or existing areas of indigenous vegetation is an effective method of indigenous vegetation establishment.
Extend planting areas	Whole site	Staged extension of planting areas as resourcing allows	Ongoing	Create a seed source for future natural regeneration, and enhance current habitats.
Braidplain restoration (If assessed as feasible)	Potential braidplain restoration/Zone 9	Assess opportunities to undertake woody weed control to create braidplain habitat.  Apply for resource consent if required.	Spring/Summer 2022 - ongoing	Control pest plants in areas where braid plain restoration will take place and undertake works to remove the vegetation.  The appropriate option should be determined by available budget and resource consent requirements but could include burying, mechanically mulch or transport the material off sites.  Carry out a land status check with LINZ prior to braid plain restoration.  Critical to assess potential increase in flood/erosion risk of main site if this action is implemented.
Improve lizard habitat	Dryland forest/Zone 9	Maintain open grasslands, create additional areas, add artificial refugia.	After surveys – ongoing	The site supports Southern grass skinks
Protect hydrological and water quality	All areas	Actions as required to protect integrity of Ealing Springs	After surveys – ongoing	Protecting and maintaining the hydrodynamic integrity and connectivity are critical to maintaining the freshwater values of Ealing Springs
Site access	All areas	Work with adjacent landowners to negotiate access to site.	ASAP – ongoing	Reliable site access critical for achievement of long-term restoration goals.



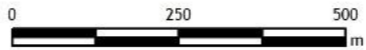


- Legend**
- ✕ DOC 200 trap lines
  - ▬ Tracks
  - Management zones**
  - 1. Culvert
  - 2. Stream – main stem, upper reach
  - 3. Stream – main stem, lower reach
  - 4. Stream – second stem
  - ▨ 5. Pupuatuke Spring
  - ▨ 6. Egars Pond
  - ▨ 7. Wetland restoration areas
  - ▨ 8. Stream margin restoration areas
  - ▨ 9. Dryland restoration areas
  - ▨ 10. Potential river braid restoration area



Figure 3. Priority areas at Ealing Springs, Rangitata River, South Canterbury

**Data Acknowledgment**  
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 Client: Department of Conservation  
 Ref: 07 0515  
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 File: Figure\_EalingSprings\_MU\_v2.mxd



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 Format: A3R



SITE PHOTOGRAPHS



Plate 1: The view along the northeastern side of the site. Edgars Pond is visible on the lower righthand side of the image, and wetlands are present in the centre left. August 2021 (image credit: Environment Canterbury).



Plate 2: The view, looking northwest, over the southwestern side of the Ealing Springs site. Braid plain could potentially be restored within sections of this part of the site. August 2021 (image credit: Environment Canterbury).





Plate 3: The view over Edgars Pond looking northeast towards the terrace scarp. 1 July 2021.



Plate 4: A wetland arm on the western margin of Edgars Pond. Tussocks of pūrei are visible in the fore- and mid-ground. A large tī kōuka is visible in the background (centre right of image). 1 July 2021.





Plate 5: An area of exotic grassland at Ealing Springs. Areas such as this one offer opportunities for the restoration of indigenous lizard habitat at the site. 1 July 2021.



Plate 6: A restoration planting trial established by Landcare Research at the site in 2010. The outcomes of this trial should be used to inform the restoration plantings of dryland indigenous forest at the site. 1 July 2021.



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