ECOLOGICAL RESTORATION PLAN
FOR ARTHURS POINT, QUEENSTOWN

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R6198

ECOLOGICAL RESTORATION PLAN FOR ARTHURS POINT, QUEENSTOWN

Contract Report No. 6198

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Project Team:
Erin Gallagher – Field survey, report author
Rose Stuart – Report author (freshwater fish and invertebrates)
Samantha King – Report author (lizards)
Della Bennet – Report author (avifauna)
Andrew Wells – Technical review
Tom Pyatt – GIS, figures
Des Smith – Peer reviewer

Prepared for:
Keeping Arthurs Point's Original Wildlife (KAPOW)
Arthur's Point Community Association (APCA)

DUNEDIN OFFICE: 764 CUMBERLAND STREET, DUNEDIN 9016
Ph 03-477-2096, 03-477-2095

HEAD OFFICE: 99 SALA STREET, P.O. BOX 7137, TE NGAE, ROTORUA
Ph 07-343-9017; Fax 07-343-9018, email ecology@wildlands.co.nz, www.wildlands.co.nz

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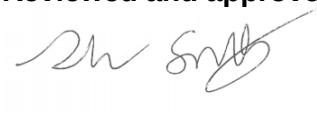
Reviewed and approved for release by:



Des Smith
South Island Regional Manager/Senior Principal Ecologist
Wildland Consultants Ltd

1. INTRODUCTION

Keeping Arthurs Point's Original Wildlife (KAPOW) have a vision to enhance local indigenous flora and fauna around Arthurs Point, Queenstown. The immediate surrounds of Arthurs Point are currently dominated by exotic vegetation. KAPOW have proposed they would like to see Arthurs Point restored to its original indigenous vegetation.

Arthurs Point is a suburb of Queenstown and is located between Mount Dewar, Queenstown Hill and Bowen Peak. The Kimiākau/Shotover River runs through the middle of Arthurs Point and consists of areas of gorge and braided river. Several Department of Conservation (DOC) areas around Arthurs Point are proposed for restoration including: McChesneys, Arthurs Point Gorge Scenic Reserve, Big Beach/Shotover River, Oxenbridge Tunnel Recreation Reserve, Morning Star Beach Recreation Reserve, and the Shotover River Marginal Strip. Other conservation areas nearby include: Shotover Creek, Devils Creek, Ben Lomond Scenic Reserve, Tuckers Beach Wildlife Management Reserve and the Lower Shotover.

KAPOW is an active community conservation group and is made up of several volunteer Arthurs Point residents. The KAPOW group have been actively undertaking pest animal control and indigenous planting around Arthurs Point since 2017.

The Arthur's Point Community Association (APCA) is a resident volunteer-run incorporated society that seeks to represent and support Arthur's Point community in matters of community interest.

KAPOW and APCA commissioned Wildland Consultants Ltd (Wildlands) to prepare an ecological restoration plan for the terrestrial margins of Arthurs Point. The plan outlines the objectives of the ecological restoration works, the ecological values and threats at the site, and the ways in which to manage these threats and values over time.

2. PROJECT OBJECTIVES

Ecological restoration objectives for Arthurs Point include:

- Re-establish indigenous biodiversity by restoring habitats for indigenous fauna.
- Enhance remnant indigenous vegetation areas and threatened habitats.
- Reduce/remove seed source of wilding conifers, and other exotic species that pose a threat to neighbouring conservation areas.
- Engage with local community, iwi, and businesses to support and contribute to the ecological restoration of Arthurs Point.

3. METHODS

3.1 Literature review

A review of relevant ecological information was undertaken for Arthurs Point including:

- Indigenous forest restoration guidelines and related references (McEwen 1987, Porteous 1993, Simpson and Teele 2017, and Dollery *et al*. 2018).
- The Otago Regional Pest Management Plan (ORC 2019).
- Records of birds within 10 kilometres of Arthurs Point on the eBird database maintained by Cornell University (accessed August 2022).
- New Zealand Freshwater Fish Database (NZFFD; NIWA 2019; accessed on-line[1] in August 2022), for records of freshwater fish (indigenous and introduced) and freshwater invertebrates within the Kimiākau/Shotover River.
- Records of lizards within 10 kilometres of Arthurs Point on the DOC Bioweb Herpetofauna database (accessed August 2022).
- Species records within the Shotover Ecological District on iNaturalist, a citizen science web application managed by the California Academy of Sciences and National Geographic (https://www.inaturalist.org/; accessed March 2022).
- A review of Google Earth to understand historic pathways and vegetation of the Kimiākau/Shotover River.

3.2 Field survey

The field survey was undertaken on 2, 8 and 9 March and 31 May 2022 to document flora and fauna values, threats, and to identify ecological management requirements at Arthurs Point. Indigenous and exotic plants within the site were recorded. The composition of existing areas of indigenous vegetation within the reserve were noted as a starting point for lists of indigenous plant species for restoration plantings at the site. Terrestrial vegetation types were classified and described following the structural classes outlined in Atkinson (1985). Wetlands were classified and described following the classification outlined in Johnson and Gerbeaux (2004). Vegetation and habitats present were mapped using hard copy digital aerial photographs, at a scale of 1:2000. Maps were subsequently digitised in ArcMap 10.8.

4. ECOLOGICAL CONTEXT

Arthurs Point is located within the Shotover Ecological District within the Lakes Ecological Region. Shotover Ecological District is large (*c*.92,200 hectares), and consists of the catchments of the Arrow and lower Kimiākau/Shotover Rivers. The ecological district consists of steep topography with deeply incised canyons. Altitudes range from 600 metres a.s.l. to the highest point at Mount Motatapu, 1991 metres a.s.l. (McEwen 1987).

The geology of the Shotover Ecological District mainly comprises steeply dipping Paleozoic Haast Schist with some Pleistocene outwash gravels and Holocene alluvium in the valley floors. On the upper slopes, extensive geological erosion occurs. The

[1] https://nzffdms.niwa.co.nz/search.

climate of the ecological district is characterised by hot summers and cold winters. The climate is affected by the rain shadow of the Main Divide; precipitation is moderately high and averages 650-1,600 millimetres per annum. The prevailing winds are from the northwest, with occasional strong gales. Snow above 1,000 metres a.s.l. persists for weeks during the winter season (McEwen 1987).

Soils in the Ecological District are stony and strongly leached to weakly podzolised steepland soils from schist and related slope deposits. Some soils at lower altitudes are shallow to moderately deep droughty soils from loess over alluvium. Till and schist substrates predominate on terraces, fans, moraines and easier hills.

Remnants of red beech (*Fuscospora fusca*) forest cover occasional areas on the shores of Lake Wakatipu and Twelve Mile Creek Scenic Reserve. There are mountain beech (*Fuscospora cliffortioides*) forests up gullies to the treeline. Silver beech (*Lophozonia menziesii*) is also present within Twelve Mile Creek. Extensive bracken (*Pteridium esculentum*) fernland persists on the Wakatipu faces with naturalised Douglas fir (*Pseudotsuga menziesii*), larch (*Larix decidua*) and other exotic conifers. Above the lake shore is extensive kōhūhū (*Pittosporum tenuifolium*) scrub and occasional areas of mānuka (*Leptospermum scoparium*) scrub. Above the treeline is tussock-shrubland (*Chionochloa rigida-Dracophyllum* sp.) and some subalpine *Dracophyllum* sp.-*Veronica* sp.-*Senecio* sp. scrub. Above 1,400 to 1,500 metres, *Chionochloa macra* replaces *Chionochloa rigida*. Where forest and scrub are absent, snow tussockland is extensive to the lower altitudes, as well as blue tussock (*Poa colensoi*)-hard tussock (*Festuca novae-zelandiae*)-exotic grasses grasslands. The lower altitude areas that have been disturbed occasionally have shrublands of *Olearia odorata*, tūmatakura (*Discaria toumatou*) and *Coprosma* sp. The alpine areas are relatively barren, with schist screes and herbfields. *Chionochloa oreophila* grassland-herbfield is an important vegetation type in the alpine areas (McEwen 1987).

Several species of indigenous avifauna inhabit the Shotover Ecological District. The yellow-crowned parakeet/kakariki (*Cyanoramphus auriceps*, At Risk-Declining) is present in the beech forests. Eastern falcon/kārearea (*Falco novaeseelandiae novaeseelandiae*, Threatened-Nationally Vulnerable) are widespread over the Ecological District. New Zealand scaup/pāpango (*Aythya novaeseelandiae*, Not Threatened) occur on some of the smaller lakes and Lake Wakatipu. Marsh crake/kotoreke (*Porzana pusilla*, At Risk-Declining) has been reported near Queenstown and at Lake Hayes. The Australian coot (*Fulica atra*, At Risk-Naturally Uncommon) is also present on Lake Hayes. Lizards such as the green gecko (*Heteropholis* sp.) have also been reported within the Ecological District.

Today, much of the Shotover Ecological District is grazed (sheep and cattle) and pest animals such as goats are widespread across the district (McEwen 1987). Indigenous tall tussock grasslands (*c.*47.2%) are the dominant vegetation type, followed by exotic low producing grasslands (*c.*16.3%). Other indigenous vegetation types have been greatly reduced and those that are currently present include fernlands, mānuka and/or kānuka (*Kunzea* sp.) scrub/shrublands, broadleaved hardwood forest, subalpine shrubland, tūmatakura or grey scrub, and indigenous forest. These other indigenous vegetation types cover a total of *c.*10.8% of the ecological district (LCDBv5.0; Landcare Research 2020).

5. BACKGROUND INFORMATION

5.1 Project area

The project area consists of DOC-managed conservation land, marginal strips and recreation areas, and Land Information New Zealand (LINZ) managed Crown Land (Figure 1).

5.2 Cultural values

Arthurs Point sits on the banks of the Kimiākau/Shotover River. Kimiākau/Shotover River is place of cultural significance to Māori, forming part of the extensive network of kāika mahika kai and ara tawhito throughout this area (Hale 2019). Historically, the Kimiākau/Shotover River has been an important mahika kai source. Mahika kai values were in the form of weka (*Gallirallus australis*), koreke/New Zealand quail (*Coturnix novaezelandiae*; extinct), tuna (*Anguilla* sp.), aruhe/bracken (*Pteridium esculentum*), aāuru and kōura (*Paranephrops* sp.) (Hale 2019). The importance of the ara tawhito in this area is shown through the name of the river in meaning 'to look for the coast', suggesting that this river was a main route for Māori to the pounamu fields on te Tai Poutini/West Coast (Hale 2019).

5.3 Keeping Arthurs Point's Original Wildlife

KAPOW currently have 200 pest animal traps distributed around Arthurs Point. In 2018, KAPOW also undertook a community indigenous planting project. This planting project (2.5 hectares) is supported by the Wakatipu Reforestation Trust (WRT) and is located on a plateau of the Morning Star Reserve. KAPOW holds a DOC Community Agreement for conservation work within the Morning Star reserve (expires 2029).

Currently, this community conservation group is restoring the old DOC nursery. This old nursery is located on the Morning Star track and will be used for propagating local indigenous plant species suitable for restoration at Arthurs Point.

Recently, KAPOW initiated an 'Adopt-a-Plot' maintenance scheme. This scheme involves local residents, families,businesses (including Shotover Jet), Queenstown Primary School and the local rotary group adopting an area of new plantings in which they are responsible for weed maintenance.

5.4 Nearby restoration projects and groups

The Wakatipu Wilding Control Group (WCG) is a community, not-for-profit organisation created in April 2009. WCG is focused on protecting local biodiversity and controlling wilding trees that threaten these local ecosystems. In August 2020, WCG carried out an operation to remove 29 hectares of wildling conifers from the Morning Star Recreation Reserve. A logging crew is currently completing the clearance work within this Reserve. The WCG has a strategy to eventually remove all wilding pines on public land at Arthurs Point.

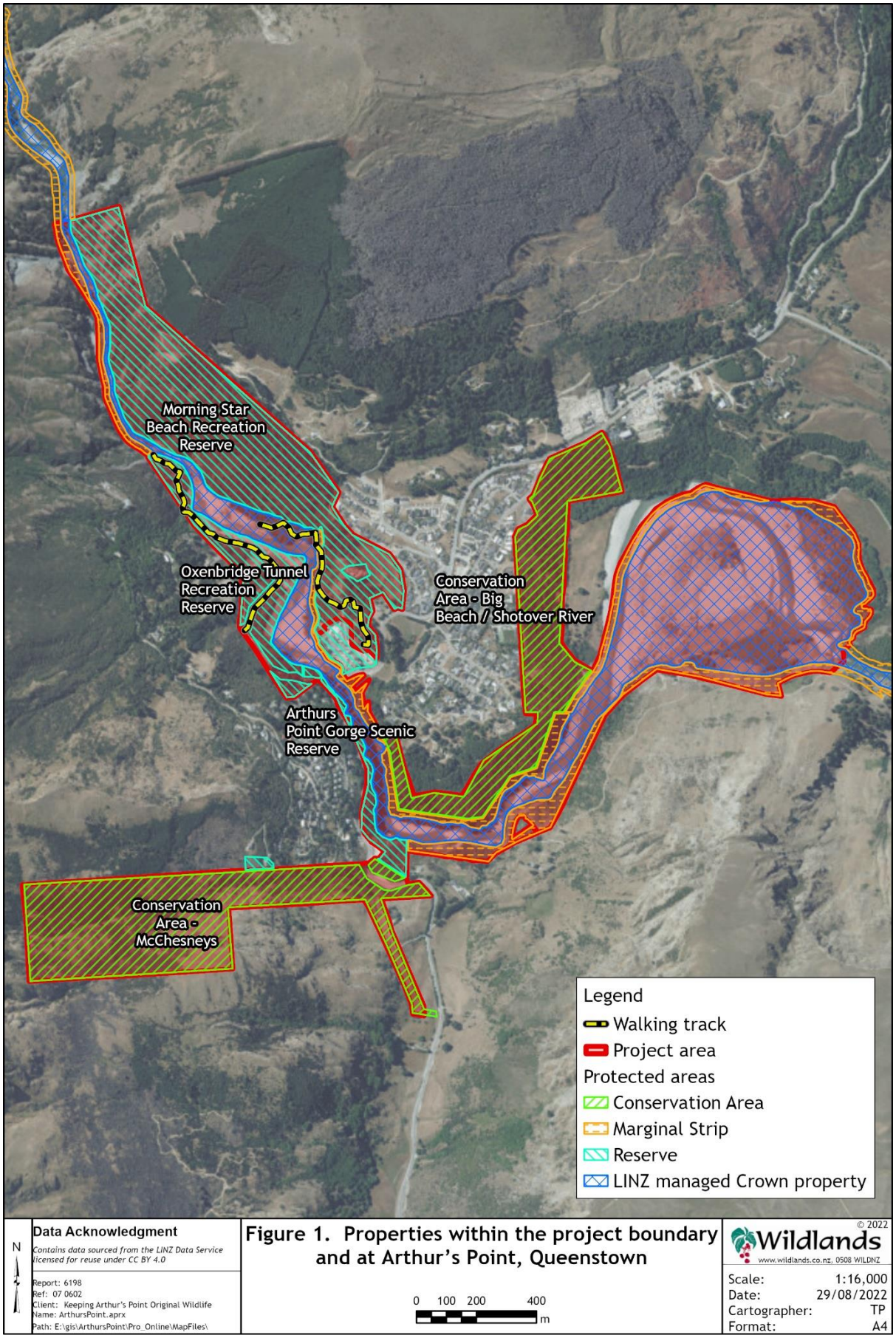


Figure 1. Properties within the project boundary and at Arthur's Point, Queenstown

The Friends of Tucker Beach Wildlife Reserve is another community group with a similar vision to restore biodiversity along the Kimiākau/Shotover River (in particular Tucker's Beach Wildlife Reserve). Formed in June 2017, this group has developed an Ecological Restoration Plan for Tuckers Beach Wildlife Reserve, and are now currently implementing this plan.

An environmental enterprise called Treespace has recently purchased Mount Dewar Station. Treespace is currently controlling the wilding pines on Mount Dewar and are also beginning large-scale indigenous planting.

6. FLORA

6.1 Overview

Eighty-eight vascular and non-vascular indigenous and 95 exotic vascular plant species were recorded during the site surveys. Three non-vascular indigenous plant species were also identified. Other non-vascular plant species present that were not identified.

6.2 Vegetation and habitat

Thirty-four vegetation and habitat types were identified during the field survey. The 34 vegetation types were then broadly classed into 21 vegetation types (Table 1; Figure 2a-2c), and these are described below.

Table 1: Vegetation and habitat types and their location at Arthurs Point, Kimiākau/Shotover River.

Broad Vegetation and Habitat Type	Vegetation and Habitat Type	Property	Area (Ha)
1. Indigenous forest	Mountain beech forest	Morning Star Beach Recreation Reserve	2.75
2. Exotic forest	Sycamore forest, crack willow forest, sycamore-Douglas fir forest, black poplar-radiata pine/sycamore-crack willow forest	McChesneys Conservation Area, Big Beach/Shotover River Conservation Area, Marginal Strip and Oxenbridge Tunnel Recreation Reserve	27.24
3. Exotic conifer forest	Larch-(Douglas fir) forest	Big Beach/Shotover River Conservation Area and Marginal Strip	13.25
4. Indigenous treeland	Mountain beech/kōhūhū-kāpuka treeland	Morning Star Beach Recreation Reserve	0.87
5. Exotic treeland	Black poplar/sycamore-crack willow treeland, sycamore-(hawthorn-crack willow) treeland, sycamore/hawthorn treeland, and hawthorn treeland	Morning Star Beach Recreation Reserve and McChesneys Conservation Area	8.55
6. Exotic conifer treeland	Radiata treeland and radiata-larch treeland	Oxenbridge Tunnel Recreation Reserve and Marginal Strip	0.86
7. Indigenous scrub	(Hawthorn)-tūmatakura-mikimiki-mānuka scrub	Morning Star Beach Recreation Reserve	3.28
8. Indigenous-exotic scrub	Buddleia/large-leaved pōhuehue scrub	Oxenbridge Tunnel Recreation Reserve	0.12
9. Exotic scrub	Sycamore/buddleia scrub, (sycamore)/Scotch broom scrub, and hawthorn/Scotch broom-blackberry scrub	Oxenbridge Tunnel Recreation Reserve and Morning Star Beach Recreation Reserve	7.58

Broad Vegetation and Habitat Type	Vegetation and Habitat Type	Property	Area (Ha)
10. Indigenous shrubland	Tūmatakura shrubland	Morning Star Beach Recreation Reserve	2.13
11. Indigenous-exotic shrubland	Hawthorn/tūmatakura-mikimiki-Scotch broom shrubland and (sycamore)/tūmatakura-Scotch broom-buddleia shrubland	Oxenbridge Tunnel Recreation Reserve and Morning Star Beach Recreation Reserve	12.97
12. Exotic shrubland	(Crack willow)/buddleia-tree lupin-gorse shrubland, Scotch broom/buddleia shrubland, gorse-Scotch broom shrubland, Scotch broom shrubland, and Scotch broom-blackberry shrubland	LINZ managed Crown land and McChesneys Conservation Area	6.51
13. Exotic grassland	Exotic grassland	McChesneys Conservation Area, Big Beach/Shotover River Conservation Area, Marginal Strip and Oxenbridge Tunnel Recreation Reserve	9.73
14. Rautahi marsh	Rautahi marsh	McChesneys Conservation Area	0.05
15. Braided river	Gravelfields, wet and dry silt mudflats, lichen-mossfields, shrublands and fast-flowing open water	LINZ managed Crown land and Marginal Strips	44.65
16. Gorge	Gorge, boulderfields, exotic and indigenous shrublands, exotic conifer forest, exotic forest	Marginal Strip, Arthurs Point Gorge Scenic Reserve, Morning Star Beach Recreation Reserve and LINZ managed Crown property	3.86
17. Stream	Streams, bare soils, fernlands, crack willow forest	McChesneys Conservation Area, Marginal Strip, LINZ managed Crown property	Not mapped
18. Rock outcrops	Rock outcrop and herbfields	LINZ managed Crown land and Marginal Strips	Not mapped
19. Sand slip	Sand slip	Oxenbridge Tunnel Recreation Reserve	0.43
20. Conifer slash open area	Slash, bare soils, exotic grassland and exotic herbfields	Morning Star Beach Recreation Reserve	3.09
21. Unsurveyed area	Mountain beech forest/treeland, low-producing grassland and grey scrub/shrubland	Morning Star Beach Recreation Reserve and McChesneys Conservation Area	30.88

1. Indigenous forest (2.75 hectares)

Indigenous forest comprises just one type at Arthurs Point: Mountain beech forest (Plate 1). This forest is restricted to several very small clusters on the valley slopes up the Kimiākau/Shotover River. The understorey is relatively sparse and includes a few scattered indigenous species such as hareball (*Wahlenbergia albomarginata*) and Richard's spleenwort (*Asplenium richardii*). Seedling and juvenile Hall's tōtara (*Podocarpus laetus*) are scattered throughout the forest. Hawthorn (*Crataegus monogyna*) seedlings and juvenile sycamore (*Acer pseudoplanatus*) are scattered near the edges of the forest. Tussock hawkweed (*Hieracium lepidulum*) covers the ground floor in areas of forest near the edge or near canopy gaps. Clusters of indigenous lichens and mosses also occur near the forest edge.

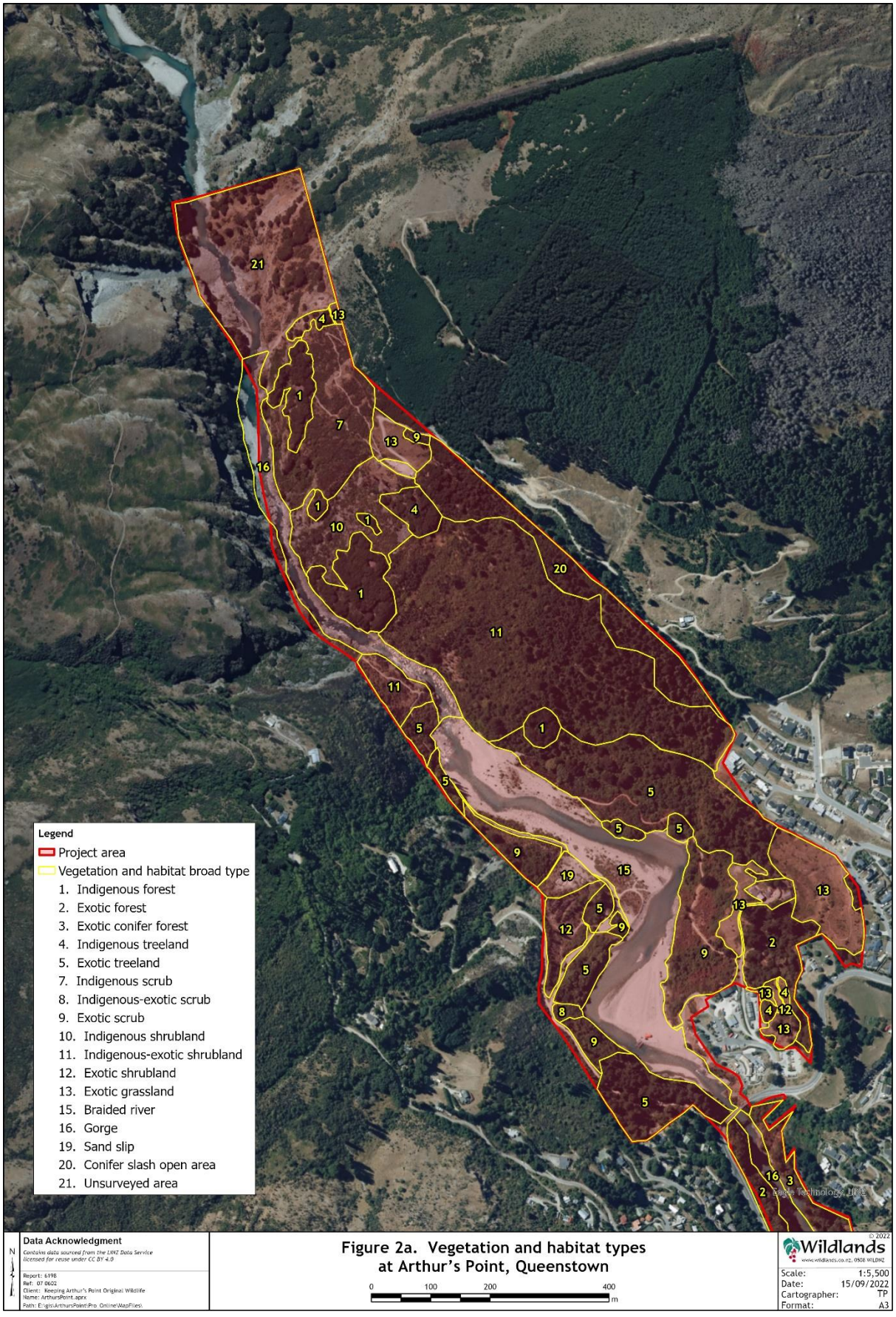
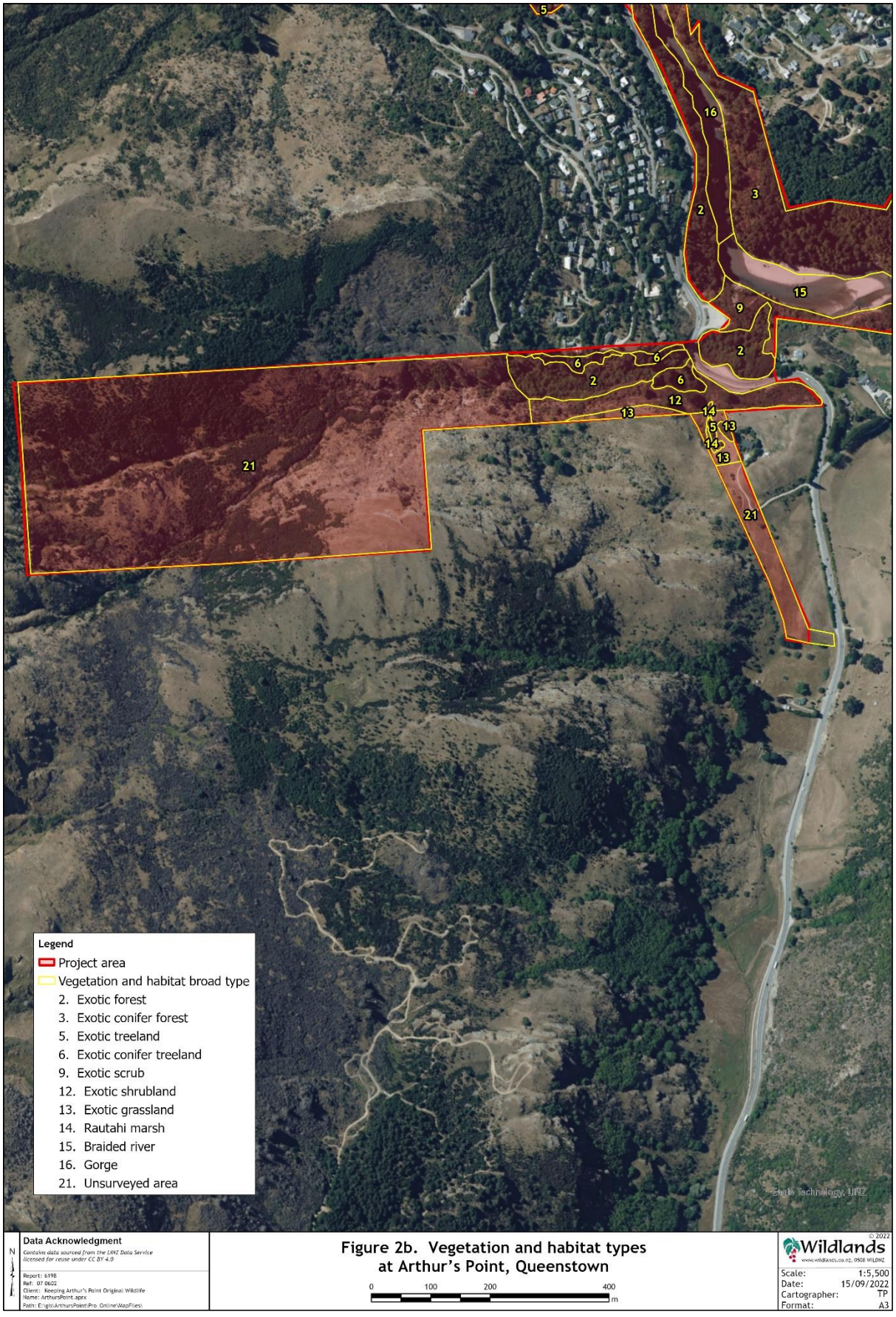


Figure 2a. Vegetation and habitat types at Arthur's Point, Queenstown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2. Exotic forest
3. Exotic conifer forest
5. Exotic treeland
6. Exotic conifer treeland
9. Exotic scrub
12. Exotic shrubland
13. Exotic grassland
14. Rautahi marsh
15. Braided river
16. Gorge
21. Unsurveyed area
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Figure 2b. Vegetation and habitat types at Arthur's Point, Queenstown
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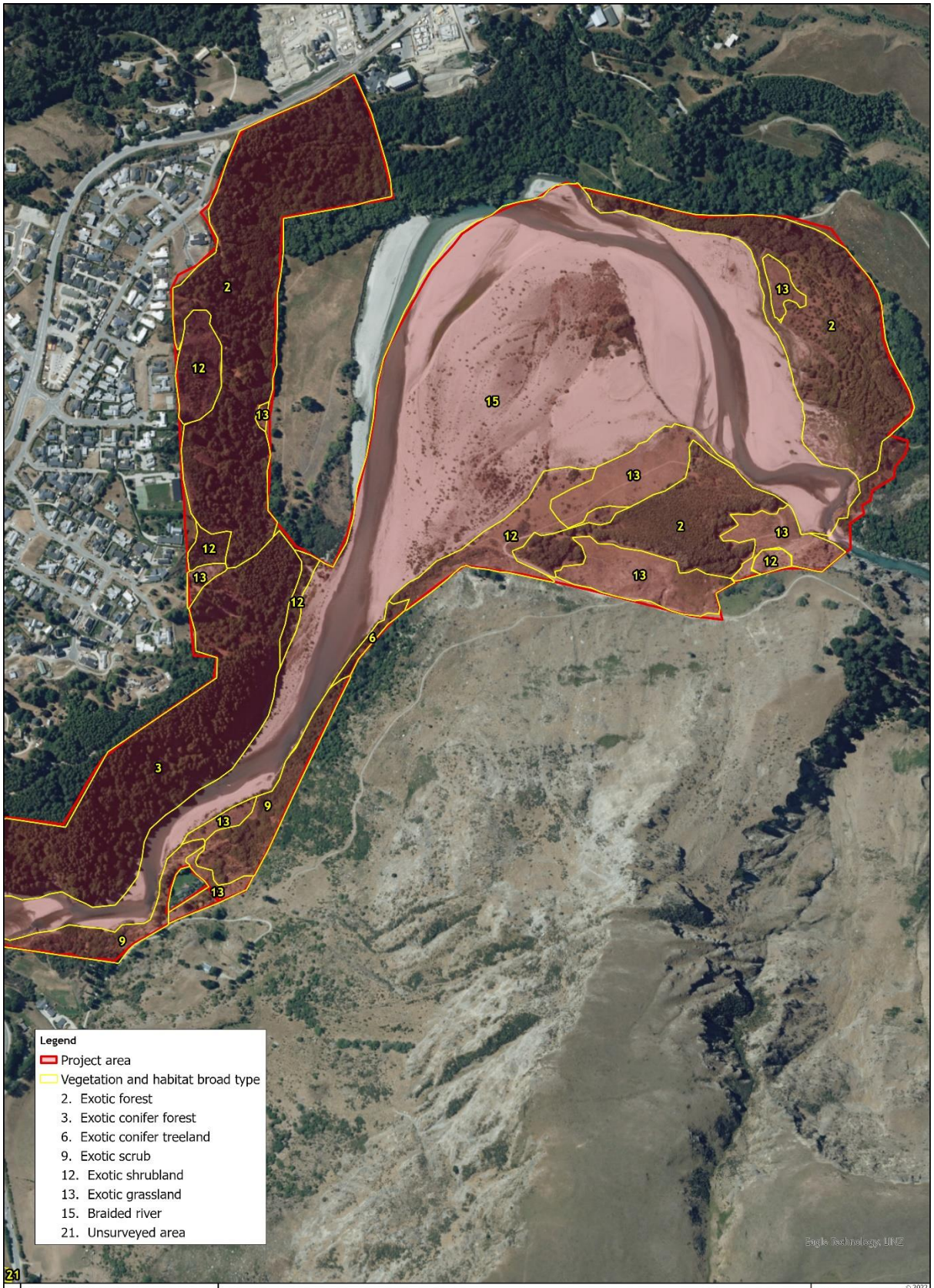

Figure 2c. Vegetation and habitat types at Arthur's Point, Queenstown

Plate 1: Mountain beech forest. 9 March 2022.

2. Exotic forest (27.24 hectares)

Four types of exotic forest were identified around Arthurs Point: sycamore forest, crack willow (*Salix ×fragilis*) forest, sycamore-Douglas fir forest, and black poplar (*Populus nigra*)-radiata pine (*Pinus radiata*)/sycamore-crack willow forest.

Sycamore forest covers the lower section of McChesney's Creek. Ground cover in areas with steep wet banks and stream margins comprises thick indigenous ferns and mosses including prickly shield fern (*Polystichum vestitum*) and rereti (*Austroblechnum lanceolatum*). The exotic herb, wall lettuce (*Mycelis muralis*), is also scattered across these wet areas. The exotic liane/shrub blackberry (*Rubus fruticosus*) occurs sporadically throughout, and also as occasional large dense clusters. A few juveniles of the exotic Scotch broom (*Cytisus scoparius*) and hawthorn are scattered throughout the understorey of the sycamore forest.

Crack willow forest is restricted in occurrence to the braided river margin. Below the crack willow canopy, a few exotic herbs and grasses are present on the forest floor and these become more abundant near the forest margin. Occasional clusters of indigenous and exotic ferns, including prickly shield fern and male fern (*Dryopteris filix-max*), are also present. There are patches of sycamore seedlings in the understorey in some areas with light gaps. The crack willow forest on the true left of the Kimiākau/Shotover River is more variable, with areas of crack willow treeland (where the canopy is discontinuous) and areas of crack willow scrub characterised by dense juvenile crack willow regeneration.

The sycamore-Douglas fir forest is located on the banks of the west and southwest facing slope above Big Beach. Sycamore and Douglas fir dominate the canopy in intermingled monospecific stands. Exotic vegetation, including sycamore

seedlings and blackberry, dominates the understorey. Damp ledges near the track are sparsely covered by indigenous species including mosses, hairy pennywort (*Hydrocotyle moschata*), *Carex* sp., *Poa pusilla*, and creeping willowherb (*Epilobium nummularifolium*). Prickly shield fern dominates some areas of the forest floor (Plate 2). Exotic herbs, including wall letrtuce, also occupy the damp ledges. Male fern is scattered on the edges of the prickly shield fern clusters. The indigenous liane, tātarāmoa/bush lawyer (*Rubus schmidelioides*), is distributed sparsely through all layers of the forest. Crack willow fringes the sycamore-Douglas fir forest near the bottom flat section.

Plate 2: Prickly shield fern and sycamore seedlings covering the ground floor of the sycamore dominant section of the sycamore-Douglas fir forest. 8 March 2022.

The black poplar/sycamore-crack willow forest occupies a small area on the northwest edge of the Oxenbridge Tunnel Recreation Reserve. A walking track runs through the forest.

Black poplar-radiata pine/sycamore-crack willow forest is restricted to a small area within the middle gorge area.

3. Exotic conifer forest (13.25 hectares)

Larch-(Douglas fir) forest covers a large area of steeply-sloping land at the southern end of the Big Beach/Shotover River conservation area (Plate 3). The understorey is mostly bare except for a few light gaps that are dominated by exotic herbs and juvenile sycamore trees. Other species of exotic conifers are also present in low numbers, including macrocarpa (*Cupressus macrocarpa*) and radiata pine. There are sections within this forest containing rock slabs and cliff edges. Some areas of forest floor are dominated by small clusters of prickly shield fern and male fern. Richard's spleenwort and kōwaowao/hounds tongue;

Zealandia pustulata subsp. *pustulata*) are also present in very low abundances in the forest floor.

Plate 3: Steep slope within the larch-(Douglas fir) forest. 2 March 2022.

4. Indigenous treeland (0.87 hectares)

Three indigenous treelands are present around Arthurs Point. The mountain beech/kōhūhū-kāpuka (*Griselinia littoralis*) treeland occupies a small area near the beginning of the Morning Star walking track. This treeland is part of a restoration planting. The indigenous trees are surrounded by exotic grassland and Scotch broom shrubland. Mountain beech treeland is present in the northern end of Morning Star Reserve, and red beech treeland is found in a small at the start of the Morning Star walkway. The red beech treeland has been planted and contains Scotch broom in the shrub layer.

5. Exotic treeland (8.55 hectares)

Four exotic treelands were identified around Arthurs Point: black poplar/ sycamore-crack willow treeland, sycamore-(hawthorn-crack willow) treeland, sycamore/hawthorn treeland, and hawthorn treeland.

The sycamore-(hawthorn-crack willow) treeland covers a large area in the middle of the Morning Star Recreation Reserve. In areas of more dense sycamore trees, an understorey of indigenous and exotic species is present. Clusters of prickly shield fern are a feature of the ground cover, and the exotic shrub gooseberry (*Ribes uva-crispa*) is widespread and sometimes dense in the shrub layer under the canopy. Cotoneaster (*Cotoneaster* sp.), hawthorn and crack willow are present in more open areas. Some areas not under the canopy contain a dense shrub vegetation of mostly exotic species including Scotch broom, blackberry and

buddleia (*Buddleja davidii*), along with less abundant indigenous shrubs of tūmatakura and mikimiki (*Coprosma propinqua*).

The hawthorn treeland runs parallel to the rautahi marsh near McChesneys. Exotic grassland dominates between the hawthorn trees.

6. Exotic conifer treeland (0.86 hectares)

The radiata treeland is located on the southern end of the Oxenbridge Tunnel Recreation Reserve and near the road at McChesneys conservation area (Plate 4). Understorey composition below the radiata canopy varies from barren areas to areas dominated by exotic species in light gaps. In more open areas outside of the radiata canopy, exotic trees and shrubs of cotoneaster, sycamore, buddleia and blackberry are present amongst exotic grasses. A road runs through the treeland, providing access to the Kimiākau/Shotover River.

Plate 4: Sycamore seedlings in the foreground of the radiata pine treeland. 8 March 2022.

Radiata pine-larch treeland also contains frequent indigenous trees and shrubs where the treeline meets the braided river. These indigenous plant species include mikimiki, tūmatakura, mānuka, koromiko (*Veronica salicifolia*) and *Coriaria sarmentosa.*

7. Indigenous scrub (3.28 hectares)

(Hawthorn)/tūmatakura-mikimiki-mānuka scrub is located at the northwest end of Morning Star Reserve, and is the only indigenous scrub vegetation type present. Hawthorn emerges over the grey scrub and is easily identified in summer and autumn by the presence of its red berries (Plate 5). Further into the valley, there are emergent indigenous trees including kāpuka and kōhūhū. Other

indigenous species dispersed through the scrub include aruhe/bracken and scented tree daisy (*Olearia odorata*). Exotic shrubs are also scattered throughout and include sweet briar (*Rosa rubiginosa*) and Scotch broom. Three indigenous lianes are common within the scrub, tātarāmoa/bush lawyer, akakaikiore/native jasmine (*Parsonsia capsularis* var. *tenuis*) and large-leaved pōhuehue (*Muehlenbeckia australis*).

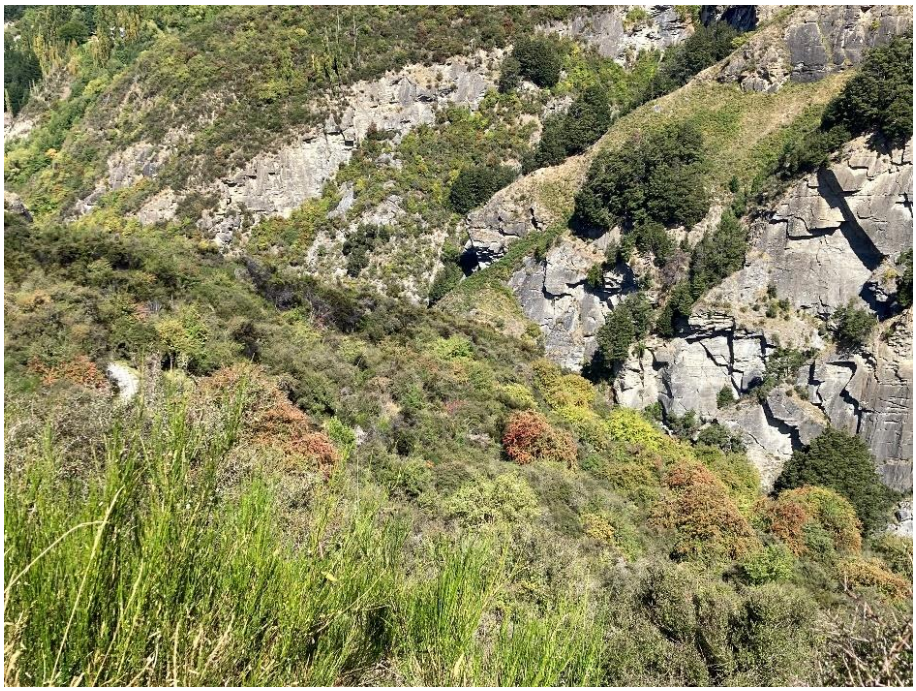

Plate 5: (Hawthorn)/tūmatakura-mikimiki-mānuka scrub in the Kimiākau/Shotover River valley. 8 March 2022.

8. Mixed indigenous-exotic scrub (0.12 hectares)

The buddleia/large-leaved pōhuehue scrub is located within the Oxenbridge Tunnel Recreation Reserve. This dense scrub is dominated by buddleia, with occasional sycamore, and is often densely covered by the indigenous liane, large-leaved pōhuehue.

9. Exotic scrub (7.58 hectares)

Three vegetation types have been categorised under exotic scrub: sycamore/buddleia scrub, (sycamore)/Scotch broom scrub, and hawthorn/Scotch broom-blackberry scrub.

The sycamore/buddleia and (sycamore)/Scotch broom scrub are present within the Oxenbridge Tunnel Recreation Reserve. Occasional radiata pine and crack willow are present in the scrub.

The hawthorn/Scotch broom-blackberry scrub is located near the start of the Morning Star Reserve. Other exotic trees are also present and usually emergent within this scrub, and include crack willow, black poplar and *Eucalyptus* species.

10. Indigenous shrubland (2.13 hectares)

Tūmatakura shrubland is present in between the mountain beech forest patches in the Morning Star Reserve. The groundcover is dominated by exotic herbs and grasses including sweet vernal (*Anthoxanthum odoratum*), tussock hawkweed and wild marjoram (*Origanum vulgare*). Exotic conifers have recently been felled and left within this shrubland. Occasional mikimiki and prickly shield fern are present, as well as Scotch broom.

11. Mixed indigenous-exotic shrubland (12.97 hectares)

The hawthorn/tūmatakura-mikimiki-Scotch broom shrubland is located near the end of the Oxenbridge Tunnel Track. Hawthorn forms dense clusters in places, and is also scattered throughout this shrubland. Akakaikiore/native jasmine is present and found climbing over mikimiki. There are also occasional rock outcrops, exotic grassland and bare soil areas (Plate 6).

Plate 6: Hawthorn/tūmatakura-mikimiki-Scotch broom shrubland under a rock outcrop. 8 March 2022.

The other indigenous-exotic shrubland present is (sycamore)/tūmatakura-Scotch broom-buddleia shrubland. This covers a large area of the Morning Star Reserve, and is dominated by exotic plant species. Occasional indigenous trees and shrubs are scattered throughout and include tūmatakura, mikimiki, kōhūhū, scented tree daisy, Hall's tōtara and mountain beech. A few exotic trees are also present throughout, mainly crack willow and hawthorn. Several large radiata pine have been recently felled and left within this shrubland.

12. Exotic shrubland (6.5 hectares)

Five vegetation types have been categorised as exotic shrubland: (crack willow)/buddleia-tree lupin-gorse shrubland, Scotch broom/buddleia shrubland, gorse-Scotch broom shrubland, Scotch broom shrubland, and Scotch broom-blackberry shrubland. Most of these are present adjacent to or within the braided river areas of the Kimiākau/Shotover River. The exotic shrublands present on the edges of the braided river contain areas of bare soil, sand and rock, and exotic grasslands.

The Scotch broom shrubland within the McChesneys conservation area contains a few large emergent radiata pine.

13. Exotic grassland (9.73 hectares)

High and low producing exotic grasslands are present at various locations around Arthurs Point. The three dominant exotic grasses within these grasslands are cocksfoot (*Dactylis glomerata*), browntop (*Agrostis capillaris*) and sweet vernal (*Anthoxanthum odoratum*). Wetter areas include a range of other species including Yorkshire fog (*Holcus lanatus*), buttercup (*Ranunculus repens*), rautahu (*Carex* sp.) and soft rush (*Juncus effusus*). A few exotic and indigenous shrubs are scattered throughout the grasslands, including Scotch broom, sweet briar, tūmatakura and mikimiki. Indigenous grasses such as silver tussock (*Poa cita*), *Rytidosperma* sp. and blue tussock (*Poa colensoi*) are rare within these grasslands. Some of the exotic grassland areas have restoration plantings within them; planted species include harakeke (*Phormium tenax*), toetoe (*Austroderia richardii*), mānuka, kāpuka, makomako/wineberry (*Aristotelia serrata*), *Coprosma rugosa* and mountain beech.

14. Rautahi marsh (0.05 hectares)

The rautahi marsh is located above McChesney's Creek. Exotic grassland and treeland surround the wetland. The marsh is dominated by rautahi, and the exotic grasses/rushes Yorkshire fog (*Holcus lanatus*), browntop and jointed rush (*Juncus articulatus*). Indigenous herbs scattered throughout the marsh include a buttercup (*Ranunculus* sp.) and *Hydrocotyle novae-zeelandiae*.

15. Braided river (44.65 hectares)

The braided river habitat occupies the course of the Kimiākau/Shotover River and contains several vegetation and habitat types within it: gravelfields, wet and dry silt mudflats, lichen-mossfields, shrublands and fast-flowing open water (Plate 7). The most characteristic feature of the gravelfields and lichen-mossfields is the several patches of *Raoulia* sp. (*R. australis* and *R. haastii*) (Plate 8). Exotic shrubs and trees are invading all dryland areas of the braided river; the primary species are buddleia, Scotch broom, crack willow, tree lupin, white sweetclover and gorse (Plate 9). Other indigenous plant species scattered throughout the gravelfields and silt mudflats include *Coriaria sarmentosa*, creeping willowherb (*Epilobium komarovianum*), *Epilobium melanocaulon*, *Colobanthus* sp. and native gunnera (*Gunnera dentata*). Several exotic herbs are present on many of the dryland areas,

including haresfoot trefoil (*Trifolium arvense*), stonecrop (*Sedum acre*), selfheal (*Prunella vulgaris*) and thyme (*Thymus vulgaris*).

Plate 7: Braided river with the exotic trees of Arthurs Point in the background.12 August 2021.

Plate 8: Common mat daisy amongst the lichen-mossfield with encroaching tree lupin, buddleia and Scotch broom. 9 March 2022.

Plate 9: KAPOW volunteer Jeannie Galavazi amongst the (crack willow)/buddleia-tree lupin-gorse shrubland. 9 March 2022.

16. Gorge (3.86 hectares)

The gorge occurs along two sections of the Kimiākau/Shotover River. The gorge section next to Morning Star Reserve consists of unvegetated boulderfields surrounding the river and steep rocky cliffs. A few indigenous herb species are nestled within the crevices of a few large boulders, and include green cushion mountain daisy (*Celmisia bellidiodes*), *Leptinella* sp, Lyall's speedwell (*Veronica lyallii*) and *Veronica subalpina*. The steep upper banks of the gorge consist of exotic and indigenous shrubs (Plate 10). The gorge section in the middle of Arthurs Point was not well surveyed due to difficult access. Exotic trees line the upper steep cliffs of this southern gorge area.

Plate 10: Mikimiki, tūmatakura, buddleia and hawthorn on the steep upper bank of the gorge. 8 March 2022.

17. Stream (unmapped)

A small number of streams are present around Arthurs Point. One of these streams is called McChesney Creek. McChesney Creek flows through the sycamore forest, and banks adjoining the stream are covered in thick vegetation (Plate 11).

Plate 11: Prickly shield fern and blackberry on the banks of McChesney Creek. 8 March 2022.

A stream also runs through the crack willow forest at Big Beach on the true left of the Kimiākau/Shotover River. The stream is slow moving, and the adjoining banks contain areas of bare soil as well as areas of dense juvenile crack willow (Plates 12 and 13). A few infestations of monkey musk (*Erythranthe guttata*) and watercress (*Nasturtium officinale*) are present in the lower stretches of the stream.

Plate 12: Stream within a crack willow forest. 12 August 2022.

Plate 13: Dense juvenile crack willow on the banks of a stream. 12 August 2022.

18. Rock outcrops (unmapped)

Several rock outcrops are present on the upper banks of the Kimiākau/Shotover River and within shrublands and forests around Arthurs Point (Plate 14). Rock outcrops are mostly dry and consist mostly of exposed bare schist rock, but they contain many indigenous plants within the crevices and on ledges. A few indigenous ferns and herbs present include maidenhair spleenwort (*Asplenium trichomanes*), *Epilobium hectorii*, chickweed (*Stellaria gracilenta*), *Veronica colostylis*, mosses and lichens. Exotic grasses and herbs such as tussock hawkweed and hair grass (*Aira* sp.) are also present.

Plate 14: Schist rock outcrop with *Veronica colostylis* hanging in the middle. 2 March 2022.

19. Sand slip (0.43 hectares)

The sandy slip is located within the Oxenbridge Tunnel Recreation Reserve. The slip is mostly unvegetated, except for the occasional buddleia shrub (Plate 15). The sandy slip contains loose soils and has formed from a recent slip.

Plate 15: Sandy slip on a terrace above the Kimiākau/ Shotover River. 8 March 2022.

20. Conifer slash open area (3.09 hectares)

Recently, the WCG have controlled the exotic pines on the upper half of the Morning Star Reserve. This area contains a few piles of slash, bare soils and exotic grassland and herbfields.

21. Unsurveyed area (30.88 hectares)

A few areas within the project area were difficult to access safely. These areas have not been surveyed. Vegetation present within the Morning Star unsurveyed area is likely to be mountain beech treeland/forest, low-producing grassland and areas of grey shrubland. This is inferred from analysing aerial photography and observing the area from a distance. Exotic species will be present, mostly within the grassland areas.

6.3 Threatened, at risk, and locally uncommon plant species

Five plant species present in the Arthurs Point area have a national level classification of Threatened or At Risk (de Lange *et al*. 2018). These five plant species are all classed as At Risk and are listed below:

- Tūmatakura (*Discaria toumatou*; At Risk-Declining)
- Dwarf rush (*Juncus pusillus*; At Risk-Naturally Uncommon)
- Common mat daisy (*Raoulia australis*; At Risk-Declining)

- Mānuka (*Leptospermum scoparium*; At Risk-Declining)
- Fragrant tree daisy (*Olearia fragrantissima*; At Risk-Declining)

One of the indigenous species present in the Morning Star Recreation Reserve is mānuka. Mānuka is classified as nationally At Risk-Declining. This species is in the myrtle plant family (Myrtaceae). All indigenous Myrtaceae species are at risk of infection by myrtle rust (*Austropuccinia psidii*), a potentially devastating invasive fungus that cannot be controlled at a landscape scale. Along with other myrtle species that were previously classified as Not Threatened, the threat status of mānuka has been elevated as a precautionary measure based on the potential threat posed by myrtle rust (see de Lange *et al*. (2018). Prior to the arrival of myrtle rust, mānuka was classified as Not Threatened (de Lange *et al*. 2013). Mānuka is otherwise relatively common and widespread in the Otago Region, and myrtle rust has not yet been detected in the southern South Island.

Tūmatakura is located within the shrublands in the Morning Star Recreation Reserve and Oxenbridge Tunnel Reserve. Tūmatakura is classified as Not Threatened for most of its range, including in Otago. However, it is very uncommon and under threat throughout the North Island, where it is now known from only a very few sites and viable populations.

The common mat daisy is present in several locations along the braided river. This species is under threat due to habitat loss and modification through weed invasion and agricultural development (particularly irrigation and fertilisation of dryland habitats).

Fragrant tree daisy is present within the restoration plantings. Fragrant tree daisy is At-Risk due to its sparse distribution and lack of natural recruitment at many locations (de Lange 2022). Fragrant tree daisy is included in a Recovery Plan for eastern South Island *Olearia* species overseen by DOC.

6.4 Environmental weeds and pest plant species

Environmental weeds are plant species that have a negative impact on ecosystems (Howell 2008). The 45 environmental weeds present at Arthurs Point are listed in Table 2. All these species should be controlled within the project area as time and finances allow. Eight of the environmental weeds are classified as pest plant species in the Otago Regional Pest Management Plan 2019-2029 (ORC 2019).

Table 2: Environmental weeds and pest plants observed at Arthurs Point, Kimiākau/ Shotover River. The pest plant status of the environmental weeds in the Otago Regional Pest Management Plan 2019-2029 is provided.

Scientific Name	Common Name(s)	Otago RPMP
Acer pseudoplatanus	Sycamore	Site-led programme
Berberis glaucocarpa	Common barberry	Not listed
Buddleja davidii	Buddleia	Not listed
Calystegia silvatica	Great bindweed	Not listed
Cirsium arvense	Californian thistle	Not listed
Clematis tangutica	Chinese clematis	Not listed
Clematis vitalba	Old man's beard	Progressive Containment Programme

Scientific Name	Common Name(s)	Otago RPMP
Conium maculatum	Hemlock	Not listed
Cotoneaster franchetii	Franchet's cotoneaster	Not listed
Crataegus monogyna	Hawthorn	Not listed
Cupressus macrocarpa	Macrocarpa, Monterey cypress	Not listed
Cytisus scoparius	Scotch broom	Sustained Control Programme
Daphne laureola	Daphne	Not listed
Daucus decipiens	Parsnip palm	Not listed
Dryopteris filix-mas	Male fern	Not listed
Echium vulgare	Vipers bugloss	Not listed
Erythranthe guttata	Monkey musk	Not listed
Erythranthe moschata	Musk	Not listed
Festuca rubra	Red fescue	Not listed
Hedera helix	Ivy	Not listed
Hieracium lepidium	Tussock hawkweed	Not listed
Jacobaea vulgaris	Ragwort	Sustained Control Programme
Juncus effusus	Soft rush	Not listed
Larix decidua	Larch	Progressive Containment Programme
Lupinus arboreus	Tree lupin	Not listed
Lupinus polyphyllus	Russell lupin	Sustained Control Programme
Melilotus albus	Sweet clover	Not listed
Origanum vulgare	Wild marjoram	Not listed
Pinus radiata	Radiata pine	Progressive Containment Programme
Populus nigra	Black poplar, Lombardy poplar	Not listed
Pseudotsuga menziesii	Douglas fir	Progressive Containment Programme
Quercus robur	English oak	Not listed
Ribes uva-crispa	Gooseberry	Not listed
Rosa rugosa	Japanese rose, rugosa rose, sweet briar	Not listed
Rubus fruticosus	Blackberry	Not listed
Rumex obtusifolius	Broad-leaved dock	Not listed
Salix ×fragilis	Crack willow	Not listed
Salix cinerea	Grey willow	Not listed
Sambucus nigra	Elderberry	Not listed
Sedum acre	Stonecrop	Not listed
Solanum dulcamara	Bittersweet	Not listed
Sorbus aucuparia	Rowan	Not listed
Thymus vulgaris	Thyme	Not listed
Verbascum thapsus	Woolly mullein	Not listed
Vinca major	Periwinkle	Not listed

7. FAUNA

7.1 Avifauna

Six species were observed during the site visit: grey warbler/riroriro (*Gerygone igata*, Not Threatened), fantail/pīwakawaka (*Rhipidura fuliginosa*, Not Threatened), silvereye (*Zosterops lateralis*, Not Threatened), tomtit/Ngirungiru (*Petroica macrocephala*, Not Threatened), blackbird/manu pango (*Turdis melura*, Introduced and Naturalised) and house sparrow/tiu (*Passer domesticus*, Introduced and Naturalised). There are records of 73 species and one hybrid taxon within a 10 kilometre radius of Arthurs Point from

the online database eBird (Appendix 2). Of these 73 species, 50 are indigenous (26 of which are also endemic), and 24 are "Threatened" or "At Risk". Several species with eBird records near the Arthurs Point area are unlikely to be present as they are vagrant to the area (chestnut-breasted shelduck - *Tadorna tadornoides* and dusky moorhen - *Gallinula tenebrosa*) or have habitat requirements not present at the site (rock wren - *Xenicus gilviventris rineyi*, mohua - *Mohoua ochrocephala*, weka - *Gallirallus australis hector*, blue duck - *Hymenolaimus malacorhynchos* and spotted shag - *Stictocarbo punctatus*).

Eastern falcon will forage in areas of both indigenous and exotic forest, shrubland and scrub, as well as potentially foraging and nesting in gorge areas. The braided river areas will support foraging and nesting black-fronted tern/tarapirohe (*Chlidonias albostriatus*, Threatened-Nationally Endangered), banded dotterel/pohowera (*Charadrius bicintusbicintus*, At Risk-Declining), black-billed gull/tarāpuka (*Chroicocephalus bulleri*, At Risk-Declining), South Island pied oystercatcher/tōrea (*Haematopus finschi*, At Risk-Declining) and New Zealand pipit/pīhoihoi (*Anthus novaeseelandiae*, At Risk-Declining). The braided rivers will also provide foraging habitat for black shag/māpunga (*Phalacrocorax carbo*, At Risk-Relict) and little shag/ kawaupaka (*Phalacrocorax melanoleucos*, At Risk-Relict). The areas of indigenous forest and treeland may be used by migrating long-tailed cuckoo/Koekoeā (Threatened-Nationally Vulnerable).

7.2 Freshwater fish and invertebrates

There are 255 individual fish records in the New Zealand Freshwater Fish Database for the Kimiākau/Shotover River and its tributaries. These records indicate the presence of 16 species (Table 3), of which three are exotic (brown trout *Salmo trutta*, rainbow trout *Oncorhynchus mykiss*, and perch *Perca fluviatilis*).

At a smaller scale, there are 36 records of six species within 10 kilometres of the site, although 24 of these are from Lake Johnson. The removal of Lake Johnston records (as lentic and lotic systems support different species) leaves four remaining fish species likely to be present in the immediate area, which are indigenous longfin eel/tuna (*Anguilla dieffenbachii*) and kōaro (*Galaxias brevipinnis*) and introduced brown and rainbow trout.

There is wide variety in the character of the waterways present in the restoration area, from the large fast flowing main river to the smaller, slower side tributaries, and these different habitats will support different species. Smaller less powerful fish such as bullies are more likely to be common in the side streams, whereas larger fish such as trout would be expected to be more common in the main river.

Records note the presence of several migratory species. Many of these, particularly galaxiids, are known to form landlocked populations that will utilise Lake Wakatipu for larval rearing rather than requiring access to the sea. Conversely, eels must migrate to the sea to complete their life cycle at the end of their long period of residence within these inland waterways.

Table 3: Fish and large invertebrates detected in the 255 surveys recorded in the New Zealand Freshwater Fish Database for the Kimiākau/Shotover River and its tributaries. Threat classifications from Dunn *et al.* (2018) and Grainger *et al.* (2018).

Scientific Name	Common Name	Threat Status	Likelihood at Site	Number of Records
Anguilla australis	Shortfin eel	Not Threatened	Low	3
Anguilla dieffenbachii	Longfin eel	At Risk - Declining	High	21
Galaxias argenteus	Giant kōkopu	At Risk - Declining	Low	1
Galaxias brevipinnis	Kōaro	At Risk - Declining	High	23
Galaxias depressiceps	Flathead galaxias	Threatened - Nationally Vulnerable	Low	92
Galaxias fasciatus	Banded kōkopu	Not Threatened	low	24
Galaxias maculatus	Inanga, inaka	At Risk - Declining	Low	2
Geotria australis	Lamprey	Threatened - Nationally Vulnerable	Low	1
Gobiomorphus breviceps	Upland bully	Not Threatened	Low	2
Gobiomorphus cotidianus	Common bully	Not Threatened	Moderate	12
Gobiomorphus huttoni	Redfin bully	Not Threatened	Low	4
Oncorhynchus mykiss	Rainbow trout	Introduced and Naturalised	High	7
Paranephrops sp.	Kōura	At Risk - Declining	Low	17
Perca fluviatilis	Perch	Introduced and Naturalised	Moderate	18
Retropinna retropinna	Common smelt	Not Threatened	Low	1
Salmo trutta	Brown trout	Introduced and Naturalised	High	27

7.3 Herpetofauna

Five lizard species have been recorded within a 10 kilometre radius of the site in the DOC Bioweb Herpetofauna database (Table 4). Three of these species are likely to be present within the site (McCann's skink; *Oligosoma macanni,* southern grass skink; *O.* aff. *polychroma* Clade 5 and kōrero gecko; *Woodworthia* "Otago/Southland large"), and two species (short-toed gecko; *Woodworthia* "southern mini" and orange-spotted gecko; *Mokopirirakau "*Roys Peak") are highly unlikely to be present due to the montane habitat requirements of these species.

Of the species listed in Table 4, three were observed within six kilometres of the site, including McCann's skink, southern grass skink and kōrero gecko. Vegetation (where not shaded by willows) such as rank grass and shrubland and habitats such as rock outcrops within the site and along the river edge provide habitat for these species. Targeted surveys are therefore recommended to assess the presence of lizards and their populations within habitats along the track. Baseline surveys to determine populations and locations of lizards and species assemblages, and subseqent monitoring, would help in understanding restoration outcomes for lizard species within the enhanced areas.

Table 4: Results of the DOC Bioweb Herpetofauna database search within a 10 kilometre radius of the site and an assessment of the likelihood of the presence of these species at the site. Conservation status as per Hitchmough *et al.* 2021. The likelihood of occurrence for each species is given based on their known habitat preferences and distribution in the area and surrounds.

Species	Common Name	Threat Status	Nearest Record (kilometres)	Likelihood of Presence and Reasoning
Oligosoma maccanni	McCann's skink	Not Threatened	5.6	Highly likely – within rank grass and rocky areas
Oligosoma aff. *polychroma "*Clade 5"	Southern grass skink	At Risk – Declining	5.4	Possible – but commonly replaced by McCann's skink in this area
Woodworthia "Otago/Southland large*"*	Kōrero gecko	At Risk – Declining	3.8	Highly likely – populations likely around rock outcrops and older trees with loose bark
Woodworthia "southern mini"	Short-toed gecko	At Risk – Declining	9.3	Highly unlikely – found in montane/alpine habitats
Mokopirirakau "Roys Peak"	Orange-spotted gecko	At Risk - Declining	6.4	Highly unlikely – found in montane/alpine habitats

8. ECOLOGICAL VALUES PRESENT

8.1 Terrestrial vegetation

Indigenous shrubland and scrub containing mānuka, mikimiki and tūmatakura are also known as grey scrub or grey shrublands. The grey scrub/shrublands and mountain beech forest within Arthurs Point are of high ecological value. Grey scrub/shrublands and mountain beech forest contain indigenous plant species that provide shelter and resources for indigenous avifauna, lizards and invertebrates such as moths. The indigenous shrublands and scrub present are on steep areas and are important for slope stabilisation and protection from slips and erosion (Wassilief 2007). These two indigenous vegetation types also provide important ecosystem services in respect to carbon sequestration and improved water quality (Allen *et al*. 2013).

The gravelfield and lichen-mossfield on the braided river has moderate ecological value. Although the gravelfield and lichen-mossfield is slowly becoming degraded by the invasion of exotic shrubs and herbs, it hosts the At-Risk-Declining common mat daisy. The gravelfield is not a large example of its ecosystem type, but creates a continuous and connected habitat of gravelfield along the Kimiākau/Shotover River.

8.2 Braided river

Braided rivers and their associated gravel beds have been identified as a historically rare ecosystem type and are naturally uncommon on a national basis (Williams *et al.*

2007). Braided river ecosystems are therefore classified as Threatened-Endangered (Holdaway *et al.* 2012). Braided rivers in New Zealand are considered internationally important, due to the high endemism of indigenous plants and fauna that rely on these environments and provide critical breeding habitat for indigenous shorebird species (Gray and Harding 2007).

The Kimiākau/Shotover River is divided into three sections: upper Shotover (above Edith Cavell Bridge), Shotover Canyon (between Edith Cavell Bridge and Tucker Beach, and a commercial jetboating area) and lower Shotover (below Tucker Beach to Kawarau). The lower Shotover River is highly braided and very shallow except during high flows (Queenstown Lakes District Plan 2021). Braided rivers are dynamic ecosystems where water flows across a gravel floodplain in multiple mobile channels (Gray and Harding 2007). Small and large floods are common and are responsible for creating a highly diverse mosaic of habitats.

Records of the pre-human vegetation status of braided rivers do not exist. However, there are a few published observations in the 20th century, summarising braided rivers to be historically barren and stony, with a few species of *Epilobium* sp. present. The floodplains had cushion forming *Raoulia* sp. and creeping pōhuehue (*Muehlenbeckia axillaris*), and fixed river terraces contained indigenous tussocks and shrubs (Brummer 2016). The active riverbed of the Kimiākau/Shotover River is representative of historically known braided rivers, except for the lower abundance of indigenous herbaceous plants and the encroachment of woody and herbaceous weeds. The river terrace on Big Beach has minor, degraded remnants of typical species that would compose this ecosystem type.

8.3 Avifauna

The Kimiākau/Shotover River has been identified as an important bird area (IBA) and an outstanding natural feature (Forest and Bird 2016; Queenstown Lakes District Plan 2021). The braided river habitat in the Shotover River has high ecological value as it provides foraging and potentially breeding habitat for five Threatened or At Risk endemic bird species; black-fronted tern/tarapirohe, banded dotterel/pohowera, black-billed gull/tarāpuka, South Island pied oystercatcher/tōrea and New Zealand pipit. The high proportion of exotic vegetation in the Arthurs Point area has low-moderate ecological value for avifauna. It is likely to support small populations of endemic species such as grey warbler, New Zealand fantail and Eastern falcon.

8.4 Freshwater fish and invertebrates

There is a variety of stream and river habitats present within the area, which have the potential to support a number of freshwater fauna species. In particular, the area is known to contain At Risk species kōaro and longfin eel, species which are both facing population declines. Arthurs Point has limited upstream impacts in terms of agricultural inputs and hydrological modifications, so the waterways will provide good quality habitat to species present. Migratory routes of obligatory diadromous fish will be severely impeded by the hydroelectric generation schemes further downstream (for example the Clyde Dam), but many facultatively diadromous species are able to utilise Lake Wakatipu to complete their life cycle.

8.5 Herpetofauna

The indigenous shrubland, exotic grasslands and rock outcrops provide moderate-high ecological value, as it provides habitat for three species of indigenous lizards (McCann's skink, southern grass skink and korero gecko).

9. THREATS TO BIODIVERSITY VALUES

9.1 Overview

There are several threats to the current biodiversity values at Arthurs Point. Flooding, fire and river erosion have the potential to impact large areas at this site, generally in negative ways. The greatest threat is likely to be posed by accidental fires. Flooding can be beneficial to one habitat type, braided river, by clearing the habitat of any encroaching environmental weeds. Other threats to the site area are addressed below.

9.2 Human disturbance

Restoration efforts within the Kimiākau/Shotover River area will likely increase recreational walkers visiting and will also increase the presence of indigenous birds. Human activity and noise will not only cause birds to stop foraging, leave an area and become stressed, but also pose a physical threat to nests and eggs being accidentally stepped on due to their cryptic nature (Halfwerk *et al.* 2018). Similarly, any increase in unleashed dogs will increase the likelihood of abandonment of nests and chicks during the breeding season (August to January for most species) and destroy sites where birds are breeding (Forest and Bird 2016). Furthermore, any increase in river usage (e.g. jetboats) may have a cumulative effect. River usage can disturb nesting and foraging birds due to the close proximity of the activity. Jet-wash from jetboats can damage or wash nests away if near the water's edge (DOC 2012; Queenstown Lakes District Plan 2021).

9.3 Climate change

NIWA climate change modelling predicts that Otago will have progressively hotter summers over the next 35 years due to global climate change (NIWA 2022). This could potentially increase the incidence of fires and reduce the diversity of indigenous plant and animal species at the site due to more severe and prolonged summer droughts. Conversely, Otago is predicted to have increased frequency of extreme precipitation events, and associated high river flows may lead to increased seasonal changes to the extent and morphology of the river and its braid plain, which could impact, either negatively or positively, the available habitat for indigenous flora and fauna. Addressing climate change implications for this site is beyond the scope of this plan, although any actions to improve ecological resilience will likely confer improved capacity to accommodate climate change impacts, at least over short to medium term time scales.

9.4 Pest plants and environmental weeds

Environmental weeds (also known as invasive plants or pest plants) are a primary threat to wetlands and braided river habitats and the indigenous fauna species they support (Maloney *et al*. 1999). Environmental weeds colonise the braid plain, forcing the river to channelise. This can lead to more frequent flooding of bird breeding habitat, and reduce the number of gravel islands available for breeding. Scotch broom, gorse, sweet clover, thyme, wild marjoram, vipers bugloss, stonecrop, crack willow, Russell lupin, tree lupin and sweet briar are the most common environmental weeds observed on the braided river. All of these environmental weeds pose a threat to the functioning and ecological integrity of the braided river habitat.

Environmental weeds at Arthurs Point will directly compete with existing areas of indigenous vegetation and restoration plantings, inhibit the recruitment of indigenous seedlings and saplings, and act as a propagule source for nearby areas.

Douglas fir, larch and radiata pine are all introduced conifers that are dominating large areas within Arthurs Point. These conifers have outcompeted indigenous plant species within this area and will continue to be a seed source to neighbouring conservation areas, causing further ecological damage.

9.5 Pest animals

Possums (*Trichosurus vulpecula*), ship rats (*Rattus rattus*), Norway rats (*R. norvegicus*), mice (*Mus musculus*), hedgehogs (*Erinaceus europeaeus occidentalis*), feral and domestic cats (*Felis catus*), and mustelids (stoats *Mustela erminea*; ferrets *M. furo*; weasels *M. nivalis vulgaris*) are likely to be present within the project area. All of these mammalian pests are likely to be suppressing the indigenous fauna values at the site through the predation of indigenous birds (including Threatened and At-Risk bird species that nest on gravel riverbeds), lizards, and invertebrates.

A large herd of feral goats (*Capra aegagrus hircus*) was observed in the Morning Star Reserve. Feral goats are a threat to the present indigenous vegetation at Arthurs Point, in particular the mountain beech forests. Goats browse the forest understorey and reduce or eliminate palatable indigenous plant species (Sweetapple and Burns 2002). Goats also strip off bark on trees and browse on seedlings (Bay of Plenty Council 2022). This browsing behaviour of goats prevent forest regeneration and can also alter forest structure (Bay of Plenty Council 2022). Large herds of goats can also cause plant death by trampling vegetation and change soil dynamics by compacting soils. Goats also pose a threat to restoration plantings as they can still browse palatable plants such as kāpuku/broadleaf, even with a plant guard.

Rabbits (*Oryctolagus cuniculus*) and most likely hares (*Lepus europaeus*) are present at the site. Rabbits and hares (as well as possums, rats and mice) are all known to consume indigenous plants (King 2005). Of these, rabbits, hares and possums are the greatest threat to indigenous plant communities at the site as they can disrupt the regeneration of indigenous plant species (King 2005). Rats can also impact the regeneration of indigenous plants if they reach high population densities due to seed predation (Towns *et al*. 2006). However, although the rats and possums can negatively

impact indigenous vegetation, they are also capable of dispersing small-seeded indigenous plant species (Williams *et al*. 2001).

It is possible that feral pigs (*Sus scrofa*) and deer (most likely red deer; *Cervus elaphus*) are periodically present at the site, both of which are capable of causing significant damage to indigenous vegetation communities.

10. MANAGEMENT ACTIONS

10.1 Overview

The following section outlines general and specific restoration actions that need to be undertaken at Arthurs Point to improve the overall ecological integrity of the site.

10.2 Identify management units

To facilitate the timely implementation of management actions, it is suggested that the wider site is broken into smaller management areas and units. Management areas and units are primarily defined by the vegetation types that are present, and the management actions that are needed within the units (Table 4 and Figure 3).

10.3 Undertake targeted pest plant and environmental weed control

Controlling pest plant and environmental weeds listed in Table 2 is a high priority within the project area. These particular species have been identified as they are likely to quickly spread within the project area and inhibit the growth of existing indigenous vegetation and ecological restoration plantings. Appendix 3 lists the control methods for these species. Additional advice for pest plant management is available on the Weedbusters website (https://www.weedbusters.org.nz/).

Initially, the emphasis should be on controlling mature (flowering and fruiting) individuals of the target environmental weed species. In the medium term (within the first five years - depending on funding), and as environmental weed populations begin to reach manageable levels, control activities could then be rotated around the management units to control seedlings and saplings of the target species, as well as any mature plants that were missed during initial control efforts. The frequency of ongoing environmental weed control will be determined by the effectiveness of the control operations and the speed at which environmental weeds reestablish within the site; however, control should be undertaken at least once during the growing season (October-May) in each of the three years of the project.

Environmental weeds listed in Table 2 can also be prioritized, based on their level of invasiveness and ability to damage to ecosystems. Top priority species for control include: sycamore, common barberry, buddleia, old man's beard, Franchet's cotoneaster, hawthorn, scotch broom, male fern, larch, tree lupin, Russell lupin, wild marjoram, radiata pine, Douglas fir, sweet briar, grey willow, crack willow, gooseberry, and periwinkle. Medium priority species for control include: great bindweed, Chinese clematis, ivy, ragwort, soft rush, sweet clover, black poplar, elderberry and stonecrop. Low priority species include: Californian thistle, hemlock,

daphne, parsnip palm, vipers bugloss, monkey musk, musk, red fescue, tussock hawkweed, bittersweet and woolly mullein.

Regular surveys, conducted as part of ongoing restoration work, are needed to identify newly established pest plants, and contractors and volunteers should be encouraged to report any species that they consider to be emerging within the project area.

10.4 Undertake restoration plantings of indigenous plant species

To increase the extent of indigenous vegetation and habitats at Arthurs Point, ecological restoration plantings should be implemented following initial pest plant control within each management unit. Undertaking these plantings will, in time, provide additional habitat for indigenous fauna species. The indigenous plant species and the quantities that should be planted within the management units are outlined in Section 11. Specific guidelines for the plantings are provided in Section 12.

10.5 Undertake pest animal control and continually monitor outcomes

Pest animal control is already being undertaken by KAPOW in Arthurs Point. This should continue and expand into other areas. Control of rabbits, hares, possums and goats should be undertaken to prevent these species from further damaging indigenous vegetation and restoration plantings. Controlling these species is vital for allowing natural regeneration within the project area.

10.6 Engage contractors and assign project manager

This is a large-scale ecological restoration project and it will need input from various specialists and contractors. Assigning and/or employing a dedicated project manager will increase the success and sustainability of this project.

10.7 Develop a connected walking track

A walking track connecting the Shotover gorge and along the river should be considered and developed. This would align with historic cultural values of using the Kimiākau/Shotover River as a route to head to the coast. This walking track would also help people reconnect with the newly regenerating natural indigenous character of Arthurs Point and would also provide access for restoration monitoring and maintenance.

11. SPECIFIC MANAGEMENT ACTIONS NEEDED WITHIN THE MANAGEMENT AREAS AND UNITS

11.1 Overview

The following section summarises the management actions that are needed within the five management areas, illustrated in Figure 3. The timeline for implementing the management actions is provided in Section 15.

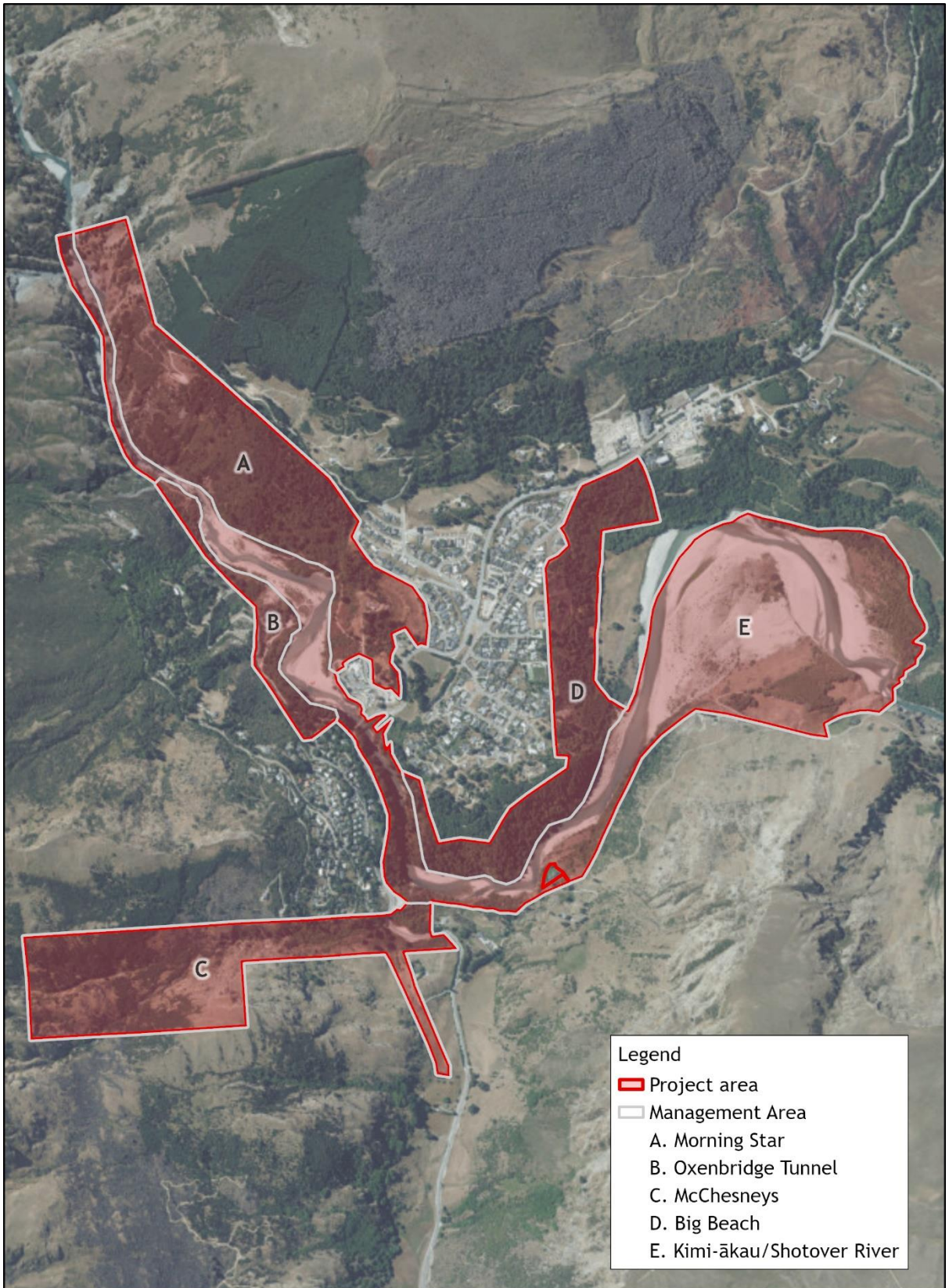

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Figure 3. Management Areas at Arthur's Point, Queenstown

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The project area has been divided into 20 management units based on the vegetation and habitats present, the required management actions and property boundaries (Table 5). During implementation each unit may need to be split up into smaller units depending on plants available and labour/contractors available.

Table 5: Management areas and units at Arthurs Point, Queenstown.

Management Area	Management Unit	Management Unit Description	Intended Vegetation Type	Area (hectares)
A (Morning Star)	A-1	Unsurveyed area	Not applicable	4.45
	A-2	Grey shrubland and mountain beech forest	Tūmatakura-mikimiki-mānuka scrub, tūmatakura shrubland and mountain beech forest	10.33
	A-3	Indigenous-exotic shrubland	Tūmatakura-mikimiki-mānuka scrub, and beech-podocarp forest	24.54
	A-4a	Exotic grassland and restoration plantings	Beech-podocarp forest	2.17
	A-4b	Exotic grassland and restoration plantings	Beech-podocarp forest	0.99
B (Oxenbridge Tunnel)	B-1	Grey shrubland	Tūmatakura-mikimiki-mānuka shrubland	1.36
	B-2	Exotic shrubland, treeland and forest	Tūmatakura-mikimiki-mānuka shrubland, mountain beech-Hall's totara treeland	6.23
C (McChesneys)	C-1	Sycamore forest	Kāpuku-kōtukutuku forest	2.29
	C-2	Sycamore forest	Kāpuku-kōtukutuku forest	1.30
	C-3	Scotch broom shrubland	Tūmatakura-mikimiki-mānuka shrubland	2.77
	C-4	Rautahi marsh and exotic grassland and treeland	Pūrei/rautahi marsh, tī kōuka-kōwhai/harakeke treeland and tūmatakura-mikimiki-mānuka shrubland	2.12
	C-5	Unsurveyed area	Not applicable	25.11
D (Big Beach)	D-1	Sycamore-Douglas fir forest	Podocarp-beech forest	16.48
	D-2	Larch-(Douglas fir) forest	Mountain beech forest, mānuka-kōhūhū scrub	9.46
E (Kimiākau/Shot over River)	E-1	Gorge (upstream)	Gorge, rock out-crops, boulderfield, tūmatakura-mikimiki shrubland	4.42
	E-2	Braided river (Morning Star)	Gravelfield, lichen-mossfields	9.82
	E-3	Gorge (downstream)	Gorge, rock out-crops, boulderfield, podocarp-beech forest	6.69
	E-4	Braided river	Gravelfield, lichen-mossfields, matai-tōtara-kahikatea forest, hard tussock-silver tussock grassland and exotic grassland	49.29
	E-5	Exotic scrub and treeland	Tūmatakura-mikimiki-mānuka scrub	7.34
	E-6	Crack willow forest	Matai-tōtara-kahikatea forest	4.50
	Total			**191.65**

Intended vegetation types have been carefully selected by using information from historic descriptions (McEwen 1987) and using the potential vegetation of New Zealand layers on the LRIS portal (LRIS Portal 2022). Historic information and suggested potential vegetation of New Zealand suggest that mountain beech forest would have been the dominant vegetation type in Arthurs Point. Other potential vegetation types in Arthurs Point are silver beech forest, matai-kahikatea-tōtara forest, scrub, shrubland and tussock-grassland below the treeline.

The above information suggests that the restoration outcome for planting areas around Arthurs Point should be primarily mountain beech forest, but guidelines for beech (*Fuscospora* sp. and *Lophozonia* sp.) forest restoration are scarce and small-scale projects have had various degrees of success (van Galen *et al*. 2021). Beech tree species form obligate, symbiotic relationships with ectomycorrhizal fungi. The reliance of beech tree species on forming ectomycorrhizal fungi may limit the restoration success of this species. Due to this potential limiting factor, mountain beech forest has not been the dominant vegetation type of choice for this restoration plan. Beech trees that are included in this restoration plan should be monitored. If growth is limited, inoculating the soils with ectomycorrhizal fungi could be considered. Mānuka has been selected to be planted near beech trees as mānuka (and kānuka) can facilitate the establishment of beech trees by altering mycorrhizal communities and microclimate conditions (van Galen *et al.* 2021).

Fast growing species such as kōhūhū have been selected for most planting lists due to their ability to provide shelter for slower growing species (e.g. Hall's tōtara). Fast growing species will also more rapidly form a closed canopy, leading to earlier suppression of environmental weeds and to microclimates that favour succession towards indigenous forest.

All plant species selected are robust and appropriate for the Shotover Ecological District.

11.2 Management Area A (Morning Star)

Management Area A consists of the Morning Star Recreation Area. Five management units (MUs) have been assigned to this area (Figure 4). MU A-1 consists of the upper reach of the Kimiākau/Shotover River of the project area. This management unit contains unsurveyed areas. MU A-2 consists of indigenous scrub, exotic grassland, mountain beech forest/treeland and tūmatakura shrubland. This MU also contains the carpark and activity area of the Shotover River Canyon Swing. MU A-3 consists of mixed indigenous-exotic shrubland, exotic grassland and conifer slash open area. There are two MUs that are at the southern end and beginning of the Morning Star Recreation Reserve (A-4a, A-4b). Both MU's already have some areas that have restoration plantings already. The following management actions should be undertaken in this area:

<u>Management Unit A-1</u>

- Gain access through private land and survey area to identify ecological values and threats.
- Undertake environmental weed control.

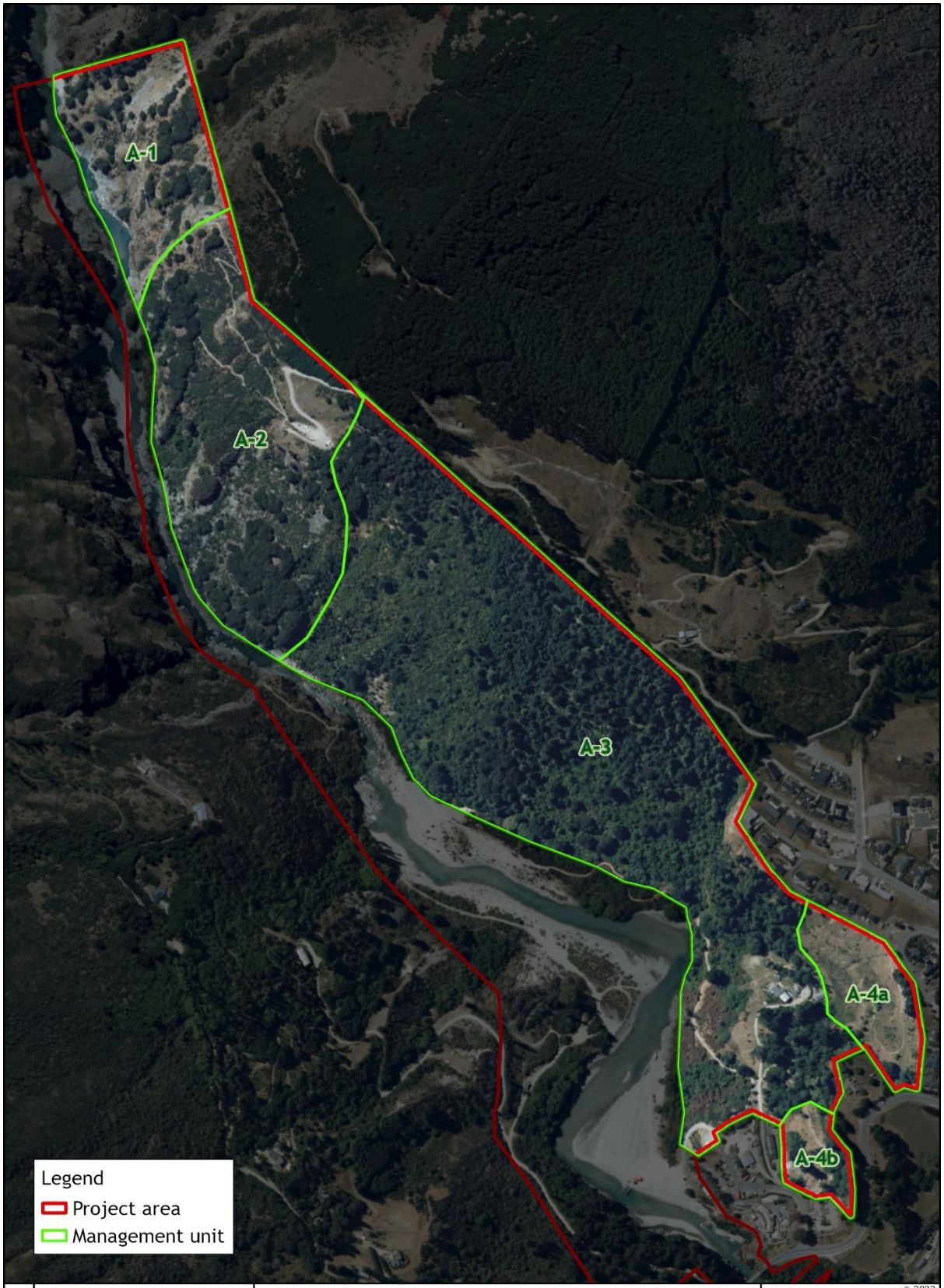

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Figure 4. Morning Star management area and units at Arthur's Point, Queenstown

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- Set up and undertake ongoing pest animal control and monitoring.
- Undertake ongoing environmental weed control at least once per year.

Management Unit A-2

- Undertake environmental weed control.
- Within the (hawthorn)/tūmatakura-mikimiki-mānuka scrub, undertake 'seed-bearing slash' method with mānuka in gaps left by controlling environmental weeds (see Section 15.1 for method).
- Prepare the exotic grassland near the Shotover River Canyon Swing carpark for planting by spraying any leftover pest plants/exotic grasses with herbicide.
- Plant and guard indigenous plant species listed in Table 5 into the exotic grassland.
- Undertake planting area maintenance and monitoring at least three times per year.
- Undertake infill planting.
- Undertake ongoing environmental weed control at least once per year.

Management Unit A-3

- Undertake environmental weed control.
- Prepare the exotic grassland, conifer slash open area and areas cleared of environmental weeds for planting by spraying any leftover pest plants/exotic grasses with herbicide.
- Plant and guard indigenous plant species listed in Table 6 into the above areas. Plant beech (*Fuscospora* sp.) trees in clusters of 6-10 of each species. Plant red beech predominantly in the flatter and less sloped areas at the southern end of the MU.
- Undertake planting area maintenance and monitoring at least three times per year.
- Undertake infill planting.
- Undertake ongoing environmental weed control at least once per year.

Management Unit A-4a and A-4b

- Undertake environmental weed control.
- Remove/control large exotic trees.
- Prepare the exotic grassland areas cleared of environmental weeds for planting by spraying any leftover pest plants/exotic grasses with herbicide.
- Plant and guard indigenous plant species listed in Table 6 into the above areas.
- Undertake planting area maintenance and monitoring at least three times per year.
- Undertake infill planting.
- Undertake ongoing environmental weed control at least once per year.

Table 6: Indigenous plant species to be planted in Management Area A (Morning Star), Arthurs Point, Queenstown.

Species	Common Name	Spacing (m)	Number of plants			
			MU A-2	MU A-3	MU A-4a	MU A-4b
Aristotelia serrata	Wineberry, makomako	1			433	296
Carmichaelia petriei	Desert broom	1	126			
Carpodetus serratus	Marbleleaf, piripiriwhata	1.2			120	82
Cordyline australis	Cabbage tree, tī kōuka	1.2		5,964		
Coprosma crassifolia	Thick-leaved coprosma, mikimiki	1	126		433	296
Coprosma intertexta		1	126			
Coprosma lucida	Karamū	1			433	296
Coprosma propinqua	Mingimingi, mikimiki	1	378	8,589	433	296
Coprosma rigida	Stiff coprosma	1	126	8,589		
Corokia cotoneaster	Korokio	1	126	8,589	433	296
Discaria toumatou	Matagouri, tūmatakuru	1	252	17,177		
Fuscospora cliffortioides	Mountain beech	1.2		11,929	301	206
Fuscospora fusca	Red beech	1.2		11,929	301	206
Griselinia littoralis	Broadleaf, kāpuka	1.2			602	411
Leptospermum scoparium	Mānuka, tea tree	1.2	350	11,929	301	206
Myrsine australis	Māpou	1.2			301	206
Myrsine divaricata	Weeping matipo, weeping māpou	1.2	88	5,964	301	206
Olearia avicenniifolia	Mountain akeake	1.2			301	206
Olearia fimbriata		1.2	88	5,964		
Olearia odorata	Scented tree daisy	1.2	88	5,964		
Ozothamnus leptophyllus	Tauhinu, cottonhead	1	126	3,436		
Pennantia corymbosa	Kaikōmako, ducks foot	1.2			120	82
Pittosporum eugenioides	Tarata	1.2			120	82
Pittosporum tenuifolium	Kōhūhū	1.2		11,929	602	411
Podocarpus laetus	Thin-bark tōtara, Hall's tōtara	1.5		1527	385	263
Prumnopitys taxifolia	Matai, black pine	1.5			193	132
Pseuopanax colensoi	Horopito, peppertree	1.2			301	206
Pseudopanax crassifolius	Lancewood, horoeka	1			433	296
Sophora microphylla	Small-leaved kōwhai	1.2	175	2386		
Total			**2,175**	**121,865**	**6,414**	**4,385**

11.3 Management Area B (Oxenbridge Tunnel)

Management Area B consists of the Oxenbridge Tunnel Recreation Reserve and is made up of two management units (Figure 5). MU B-1 consists of the northern section of the Oxenbridge Tunnel Recreation Reserve. MU B-2 consists of the middle and southern section of the Oxenbridge Tunnel Recreation Reserve. MU B-2 is currently dominated with exotic trees and shrubs such as radiata pine, sycamore, crack willow, buddleia and Scotch broom. The following management actions should be undertaken in this management area.

<u>Management Unit B-1</u>

- Undertake environmental weed control.
- Continue ongoing pest animal control.

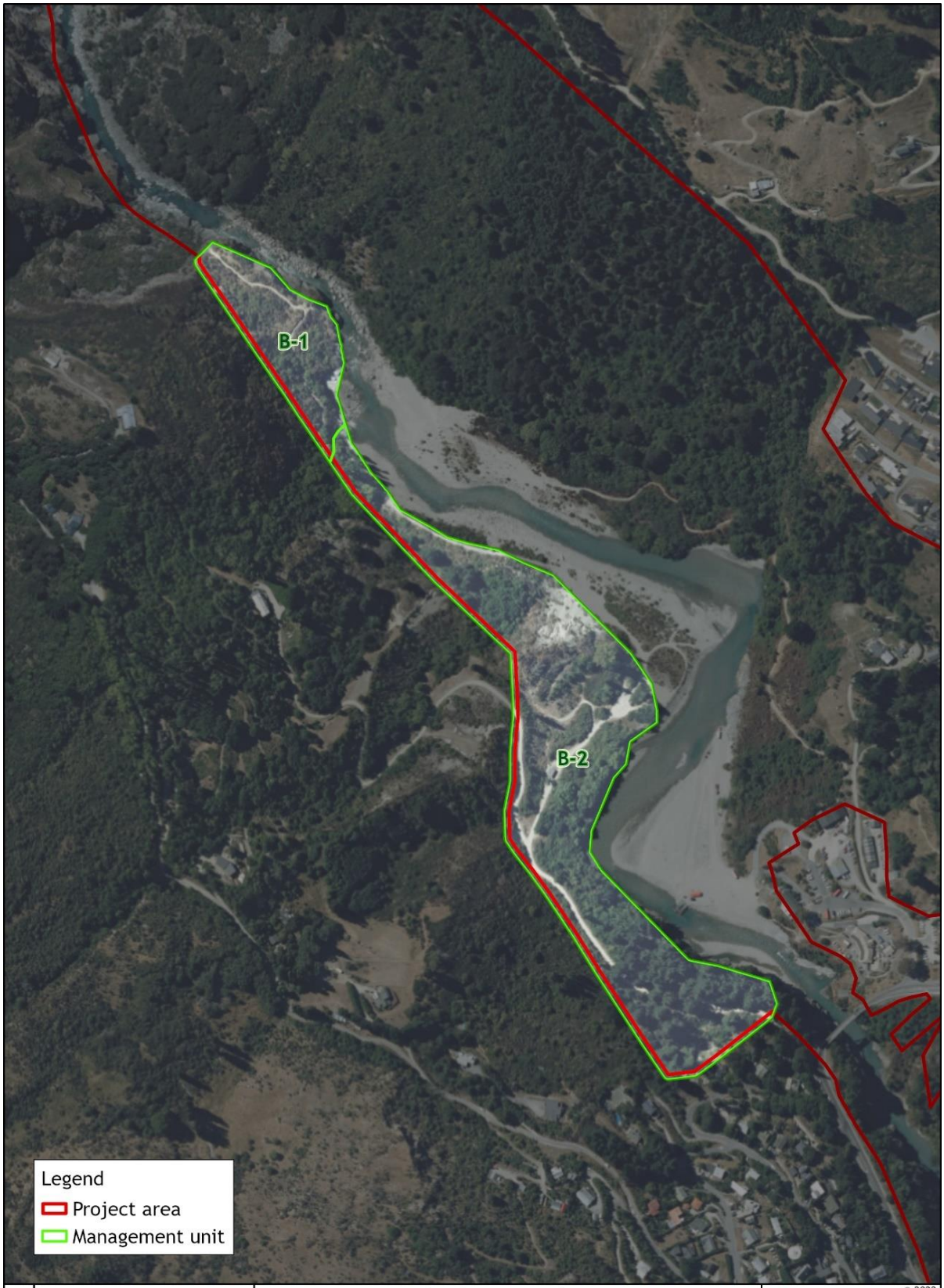

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Figure 5. Oxenbridge Tunnel management area and units at Arthur's Point, Queenstown

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- Within the hawthorn/tūmatakura-mikimiki-mānuka scrub (indigenous scrub), undertake 'seed-bearing slash' method with manuka in gaps left by controlling environmental weeds.
- Prepare open areas left from environmental weed control for planting by spraying any leftover pest plants/exotic grasses with herbicide.
- Plant and guard indigenous plant species listed in Table 7 into the open areas left from environmental weed control.
- Undertake planting area maintenance and monitoring at least three times per year.
- Undertake infill planting.
- Undertake ongoing environmental weed control at least once per year.

Management Unit B-2

- Undertake environmental weed control.
- Undertake vegetation clearance of exotic trees and shrubs.
- Set up and undertake ongoing pest animal control
- Prepare MU for planting by spraying any leftover pest plants/exotic grasses with herbicide.
- Plant and guard indigenous plant species listed in Table 7. Plant mountain beech, red beech and Hall's totara near the southern end of the MU. Mountain beech can be planted in clusters of 6-8 plants. Do not plant the sand slip, leave open.
- Undertake planting area maintenance and monitoring at least three times per year.
- Undertake infill planting.
- Undertake ongoing environmental weed control at least once per year.

Table 7: Indigenous plant species to be planted in Management Area B (Oxenbridge Tunnel), Arthurs Point, Queenstown.

Species	Common Name	Spacing (m)	Number of plants	
			MU B-1	MU B-2
Aristotelia serrata	Wineberry, makomako	1		2492
Carmichaelia petriei	Desert broom	1	204	
Carpodetus serratus	Marbleleaf, piripiriwhata	1.2		692
Cordyline australis	Cabbage tree, tī kōuka	1.2		1,731
Coprosma crassifolia	Thick-leaved coprosma, mikimiki	1	204	
Coprosma intertexta		1	204	
Coprosma lucida	Karamū	1		2,492
Coprosma propinqua	Mingimingi, mikimiki	1	408	2,492
Coprosma rigida	Stiff coprosma	1	204	997
Corokia cotoneaster	Korokio	1	204	997
Discaria toumatou	Matagouri, tūmatakuru	1	204	2,492
Festuca novae-zelandiae	Fescue tussock, hard tussock	0.5	816	
Fuscospora cliffortioides	Mountain beech	1.2		5,192
Fuscospora fusca	Red beech	1.2		3,462
Griselinia littoralis	Broadleaf, kāpuka	1.2		1,731
Leptospermum scoparium	Mānuka, tea tree	1	408	2,492
Melicytus alpinus	Porcupine shrub	1	204	
Myrsine australis	Māpou	1.2		1,731
Myrsine divaricata	Weeping matipo, weeping māpou	1.2	142	692
Olearia avicenniifolia	Mountain akeake	1.2		1,731
Olearia fimbriata		1.2	142	
Olearia lineata		1.2	142	
Olearia odorata	Scented tree daisy	1.2	142	692
Ozothamnus leptophyllus	Tauhinu, cottonhead	1	204	

Species	Common Name	Spacing (m)	Number of plants	
			MU B-1	MU B-2
Pennantia corymbosa	Kaikōmako, ducks foot	1.2		692
Pittosporum eugenioides	Tarata	1.2		692
Pittosporum tenuifolium	Kōhūhū	1.2		3,462
Poa colensoi	Blue tussock	0.5	816	
Podocarpus laetus	Thin-bark tōtara, Hall's tōtara	1.5		443
Prumnopitys taxifolia	Matai, black pine	1.5		
Pseuopanax colensoi	Horopito, peppertree	1.2		1,731
Pseudopanax crassifolius	Lancewood, horoeka	1		997
Sophora microphylla	Small-leaved kōwhai	1.2	283	692
Total			**4,931**	**38,325**

11.4 Management Area C (McChesneys)

Management Area C consists of the McChesney's Conservation Area. This management area contains five management units (Figure 6). MU C-1 and C-2 consist of the McChesney Creek and sycamore forest. The sycamore forest and Scotch broom shrubland within MA C can be used as a natural shelter and can be underplanted with indigenous plants (Meurk 1997). The following management actions should be undertaken in the area:

Management Unit C-1 and C-2

- Reduce sycamore abundance by around 25% by drill and felling.
- Set up and undertake ongoing pest animal control and monitoring.
- Undertake environmental weed control.
- Prepare the site for planting by spraying any leftover pest plants/exotic grasses with herbicide.
- Plant understorey with indigenous species listed in Table 8.
- Avoid damaging indigenous species present such as prickly shield fern.
- Undertake planting area maintenance and monitoring at least three times per year.
- Undertake ongoing environmental weed control at least once per year.
- Reduce sycamore another 25% after two years of initial planting in this MU.
- Undertake infill planting.
- Control the rest of the sycamore after four years of initial planting in this MU.

Management Unit C-3

- Control radiata pine and black poplar by felling and removing tree debris.
- Reduce Scotch broom abundance by controlling around 25% of these exotic shrubs.
- Set up and undertake ongoing pest animal control and monitoring.
- Undertake environmental weed control.
- Prepare the site for planting by spraying any leftover pest plants/exotic grasses with herbicide.
- Plant indigenous plants in listed Table 8 in between Scotch broom.
- Undertake planting area maintenance and monitoring at least three times per year.
- Undertake ongoing environmental weed control at least once per year.

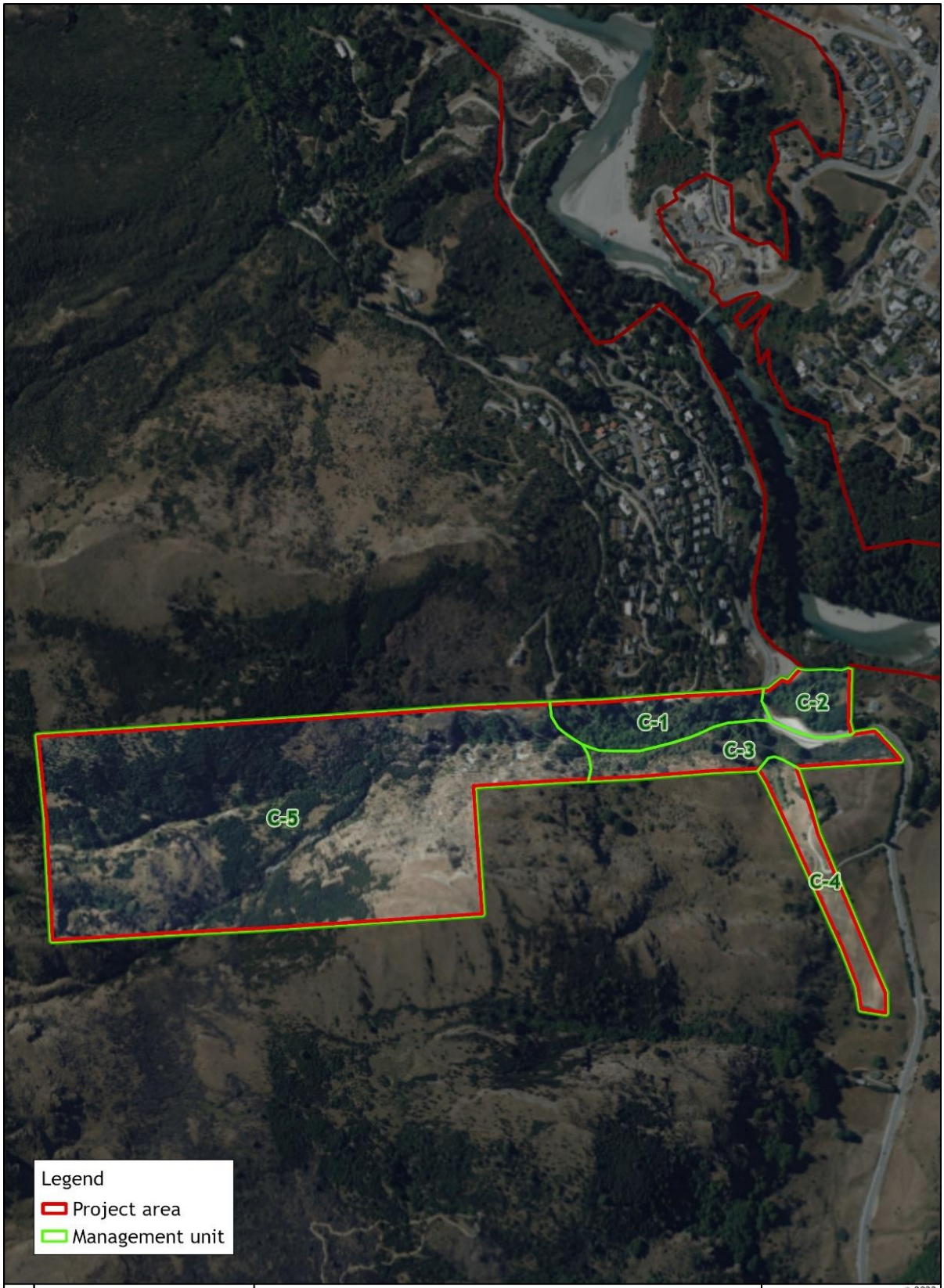

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Figure 6. McChesney's management area and units at Arthur's Point, Queenstown

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- Reduce Scotch broom another 25% after two years of initial planting in this MU.
- Undertake infill planting.
- Control the rest of the Scotch broom after four years of initial planting in this MU.

Management Unit C-4

- Control hawthorn by felling and removing tree debris.
- Reduce Scotch broom by controlling around 25% of these exotic shrubs.
- Set up and undertake ongoing pest animal control and monitoring.
- Undertake environmental weed control.
- Plant indigenous plants listed in Table 8 in between Scotch broom. Plant pūrei (*Carex secta*) and rautahi around the marsh and in wet areas. Plant harakeke, toetoe and tī kōuka (*Cordyline australis*) around the outer wetland margins. Plant kowhai and kāpuka in between the upper bank of the wetland areas. Plant dryland species on dry grassland slopes. Plant hard tussock in clusters on upper slopes. Pūrei, rautahi, toetoe and harakeke do not need plant guards, but weed mats are still necessary for these species.
- Undertake planting area maintenance and monitoring at least three times per year.
- Undertake ongoing environmental weed control at least once per year.
- Undertake infill planting.

Management Unit C-5

This management unit contains unsurveyed area.

- Gain access through private land and survey area to identify ecological values and threats.
- Undertake environmental weed control.
- Set up and undertake ongoing pest animal control and monitoring.
- Undertake ongoing environmental weed control at least once per year.

Table 8: Indigenous plant species to be planted in Management Area C (McChesneys), Arthurs Point, Queenstown.

Species	Common Name	Spacing (m)	Number of Plants			
			MU C-1	MU C-2	MU C-3	MU C-4
Aristotelia serrata	Wineberry, makomako	1	1,143	909		
Austroderia richardii	Toetoe	1				339
Carmichaelia petriei	Desert broom	1			1,108	339
Carpodetus serratus	Marbleleaf, piripiriwhata	1.2	794	631		
Carex coriacea	Cutty grass, rautahi	0.5				1,357
Carex secta	Pūrei, pūkio	1				339
Cordyline australis	Cabbage tree, tī kōuka	1.2	397	316	769	1,178
Coprosma crassifolia	Thick-leaved coprosma, mikimiki	1	571	454	1,108	
Coprosma crassifolia	Thick-leaved coprosma, mikimiki	1	571	454	1,108	

Species	Common Name	Spacing (m)	Number of Plants			
			MU C-1	MU C-2	MU C-3	MU C-4
Coprosma crassifolia	Thick-leaved coprosma, mikimiki	1	571	454	1,108	848
Coprosma intertexta		1	571	454	1,108	848
Coprosma propinqua	Mingimingi, mikimiki	1	571	454	2,215	848
Coprosma rigida	Stiff coprosma	1	571	454	1,108	848
Coprosma rotundifolia	Round-leaved coprosma, mikimiki	1	571	454		
Corokia cotoneaster	Korokio	1	571	454	1,108	848
Discaria toumatou	Matagouri, tūmatakuru	1			2,215	1,696
Fuchsia excorticata	Tree fuchsia, kōtukutuku	1.5	254	202		
Festuca novae-zelandiae	Fescue tussock, hard tussock	0.5			4,430	3,391
Griselinia littoralis	Broadleaf, kāpuka	1.2	1,190	947		236
Leptospermum scoparium	Mānuka, tea tree	1			3,323	1,696
Myrsine divaricata	Weeping matipo, weeping māpou	1.2	397	316	769	589
Olearia arborescens	Common tree daisy, glossy tree daisy	1.2	397	316		
Olearia fimbriata		1.2			769	236
Olearia lineata		1.2				236
Olearia odorata	Scented tree daisy	1.2			769	589
Ozothamnus leptophyllus	Tauhinu, cottonhead	1			1,108	848
Pennantia corymbosa	Kaikōmako, ducks foot	1.2	397	316		
Pittosporum eugenioides	Tarata	1.2	397	316		
Phormium tenax	Lowland flax, harakeke	1		91	222	339
Prumnopitys taxifolia	Matai, black pine	1.5	254	202		
Pseudopanax crassifolius	Lancewood, horoeka	1	571	454		
Sophora microphylla	Small-leaved kōwhai	1.2	397	316	1,538	1,178
Total			**8,871**	**7,147**	**23,667**	**18,487**

11.5 Management Area D (Big Beach)

Management Area D consists of the Big Beach/Shotover River Conservation Area. This management area contains two management units (Figure 7). The following management actions should be undertaken in the area:

Management Unit D-1

- Control exotic conifers by felling and removing tree debris. Leave stumps of exotic trees in steep areas to help with ground stabilisation. Stumps may need to be drill and filled to ensure they are dead.
- Continue ongoing pest animal control and monitoring.
- Undertake environmental weed control.

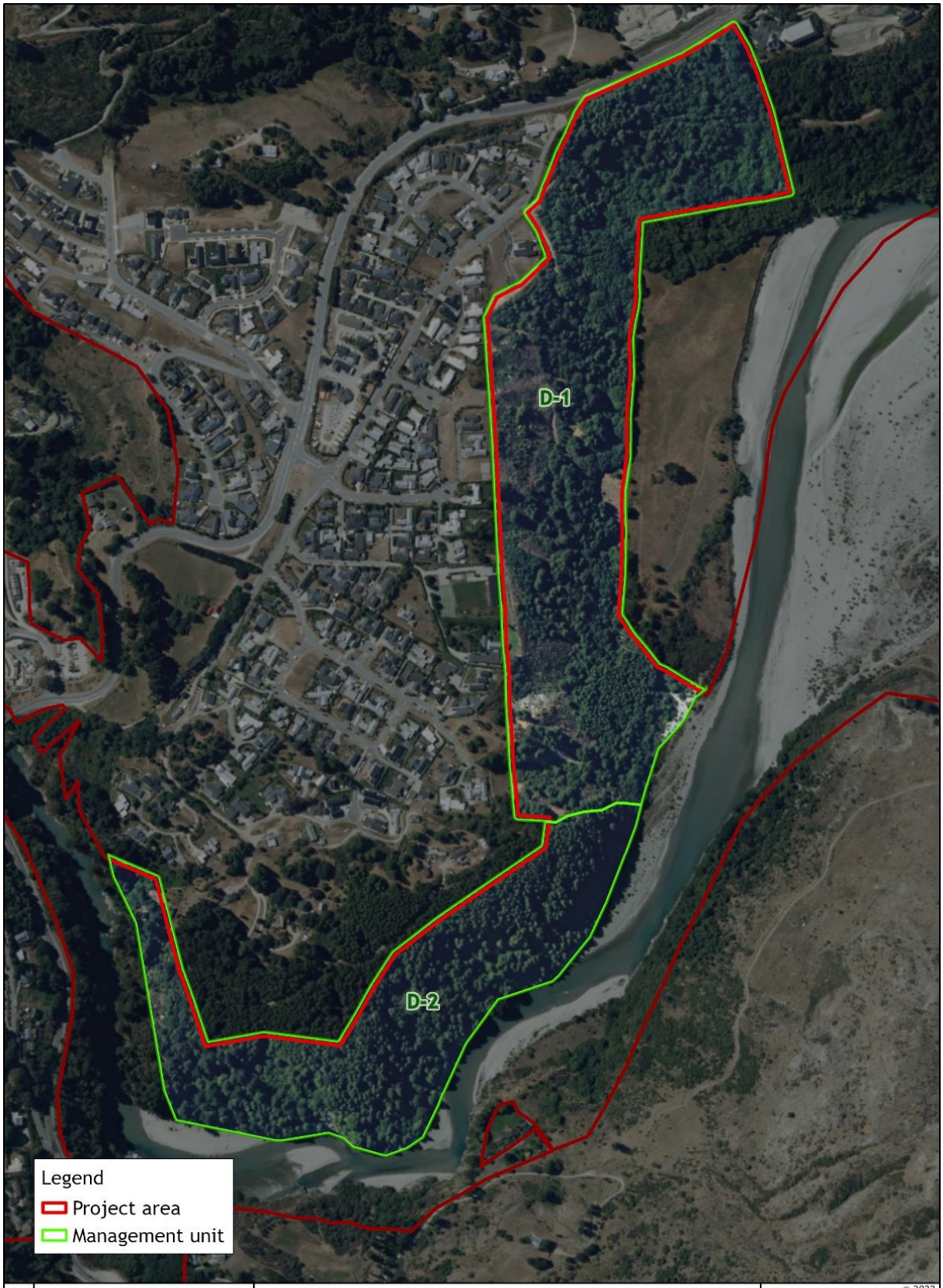

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Figure 7. Big Beach management area and units at Arthur's Point, Queenstown

0 100 200 400 m

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Cartographer: TP
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- Prepare the site for planting by spraying any leftover pest plants/exotic grasses with herbicide.
- Plant indigenous plants listed in Table 9.
- Undertake planting area maintenance and monitoring at least three times per year.
- Undertake ongoing environmental weed control at least once per year.
- Undertake infill planting.

Management Unit D-2

- Control exotic conifers by felling and removing tree debris. Leave stumps of exotic conifers in steep areas to help with ground stabilisation. Stumps may need to be drill and filled to ensure they are dead.
- Continue ongoing pest animal control and monitoring.
- Undertake environmental weed control.
- Prepare the site for planting by spraying any leftover pest plants/exotic grasses with herbicide.
- Plant indigenous plants listed in Table 9.
- Undertake planting area maintenance and monitoring at least three times per year.
- Undertake ongoing environmental weed control at least once per year.
- Undertake infill planting.

Table 9: Indigenous plant species to be planted in Management Area D (Big Beach), Arthurs Point, Queenstown.

Species	Common Name	Spacing (m)	No. of Plants	
			MU D-1	MU D-2
Aristotelia serrata	Wineberry, makomako	1	1,484	
Carpodetus serratus	Marbleleaf, piripiriwhata	1.2	5,151	
Cordyline australis	Cabbage tree, tī kōuka	1.2	2,061	
Coprosma lucida	Karamū	1	7,418	
Coprosma propinqua	Mingimingi, mikimiki	1	7,418	8,518
Corokia cotoneaster	Korokio	1	7,418	
Fuscospora cliffortioides	Mountain beech	1.2	5,151	29,576
Griselinia littoralis	Broadleaf, kāpuka	1.2	5,151	2,958
Leptospermum scoparium	Mānuka, tea tree	1	7,418	12,777
Lophozonia menziesii	Silver beech	1.2	10,303	
Myrsine australis	Māpou	1.2	5,151	2,958
Myrsine divaricata	Weeping matipo, weeping māpou	1.2	5,151	
Olearia avicenniifolia	Mountain akeake	1.2	5,151	
Olearia odorata	Scented tree daisy	1.2	5,151	
Pennantia corymbosa	Kaikōmako, ducks foot	1.2	5,151	
Pittosporum eugenioides	Tarata	1.2	5,151	
Pittosporum tenuifolium	Kōhūhū	1.2	10,303	8,873
Podocarpus laetus	Thin-bark tōtara, Hall's tōtara	1.5	3,297	
Prumnopitys taxifolia	Matai, black pine	1.5	3,297	
Pseuopanax colensoi	Horopito, peppertree	1.2	2,061	
Pseudopanax crassifolius	Lancewood, horoeka	1	2,967	
Total			**110,320**	**65,660**

11.6 Management Area E (Kimiākau/Shotover River)

This management area consists of the braided river, gorge and upper/outer river banks. Six management units have been designated to this management area (Figure 8). The following management actions should be undertaken in the area:

Management Unit E-1: Upper gorge

- Undertake environmental weed control on cliff edges and steep terraces along the gorge areas. This will action need specialist rope access to undertake this task.
- Undertake ongoing environmental weed control at least once per year.

Management Unit E-2: Braided River (upper reach)

- Undertake environmental weed control on the braided river. Avoid indigenous riverbed species such as *Raoulia* sp. and willowherbs (*Epilobium* sp.) if using a foliar spray method to control exotic shrubs. Two At Risk species are present on the riverbed and should be avoided (common mat daisy and dwarf rush).
- Undertake regular bird surveys near and during avifauna breeding season and put-up warning signs for areas public need to avoid.
- Continue pest animal control along the braided river edges.
- Undertake ongoing environmental weed control at least once per year.

Management Unit E-2: Lower gorge

- Undertake environmental weed control on cliff edges and steep terraces along the gorge areas. This action will need specialist rope access.
- Control exotic conifers by felling and removing tree debris. Leave stumps of exotic conifers in steep areas to help with ground stabilisation. Stumps may need to be drill and filled to ensure they are dead.
- Set up ongoing pest animal control and monitoring.
- Undertake environmental weed control.
- Prepare the site for planting by spraying any leftover pest plants/exotic grasses with herbicide.
- Plant indigenous plants listed in Table 10.
- Undertake planting area maintenance and monitoring at least three times per year.
- Undertake infill planting.
- Undertake ongoing environmental weed control at least once per year.

Management Unit E-3:

- Control exotic conifers by felling and removing tree debris. Leave stumps of exotic conifers in steep areas to help with ground stabilisation. Stumps may need to be drill and filled to ensure they are dead. Try to avoid damaging indigenous species present.
- Set up ongoing pest animal control and monitoring.
- Undertake environmental weed control.

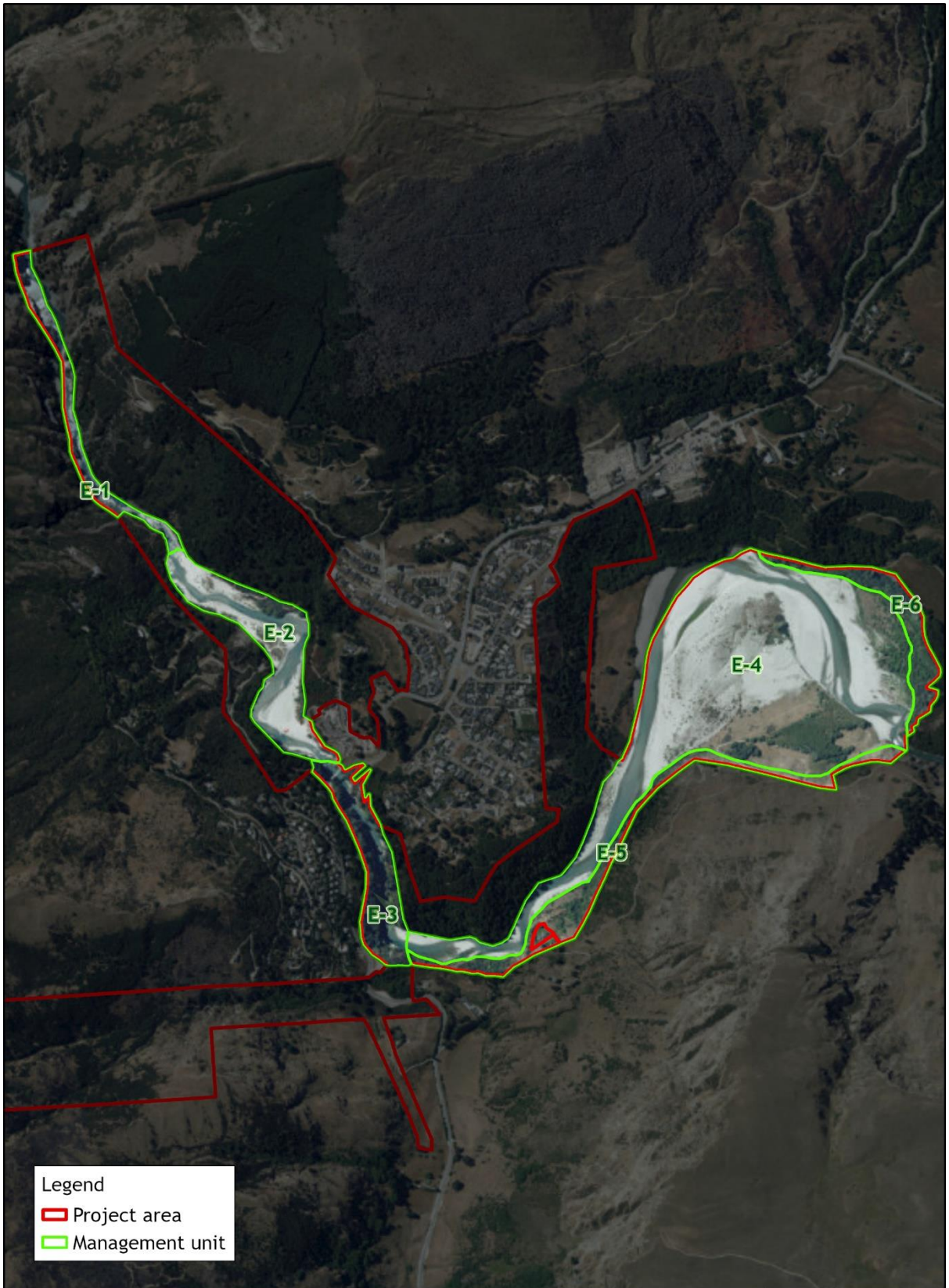

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Figure 8. Kimi-ākau/Shotover River management area and units at Arthur's Point, Queenstown

0 100 200 400 m

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Table 10: Indigenous plant species to be planted in Management Area E (Kimiākau/Shotover River), Arthurs Point, Queenstown.

Species	Common Name	Spacing (m)	Number of plants				
			MU E-3	MU E-4a	MU E-4b	MU E-5	MU E-6
Aristotelia serrata	Wineberry, makomako	1	402				1,798
Carmichaelia petriei	Desert broom	1			59	1,174	
Carpodetus serratus	Marbleleaf, piripiriwhata	1.2	279				
Cordyline australis	Cabbage tree, tī kōuka	1.2	279			2,038	
Coriaria arborea	Tree tutu	1.2				815	250
Coprosma crassifolia	Thick-leaved coprosma, mikimiki	1				2,935	
Coprosma intertexta		1				2,935	
Coprosma lucida	Karamū	1	1,004				1,798
Coprosma propinqua	Mingimingi, mikimiki	1	1,004	2,592	59	5,870	1,798
Coprosma rigida	Stiff coprosma	1			59	2,935	
Corokia cotoneaster	Korokio	1		1,296	59	2,935	1,798
Dacrycarpus dacrydioides	Kahikatea	1.2		900			2,497
Discaria toumatou	Matagouri, tūmatakuru	1			59	5,870	
Festuca novae-zelandiae	Fescue tussock, hard tussock	0.5			1,404		
Fuscospora cliffortioides	Mountain beech	1.2	697				
Fuscospora fusca	Red beech	1.2	697				
Griselinia littoralis	Broadleaf, kāpuka	1.2	697	900			1,249
Hoheria angustifolia	Narrow-leaved lacebark, houhere	1.2		900		2,038	1,249
Hoheria glabrata	Lacebark, houhere	1.2	697	900		2,038	1,249
Leptospermum scoparium	Mānuka, tea tree	1				5,870	
Melicytus alpinus	Porcupine shrub	1			59		
Myrsine australis	Māpou	1.2	697	900			1,249
Myrsine divaricata	Weeping matipo, weeping māpou	1.2	697	900		2,038	1,249
Olearia avicenniifolia	Mountain akeake	1.2	697				
Olearia fimbriata		1.2				1,631	
Olearia odorata	Scented tree daisy	1.2	697			2,038	
Ozothamnus leptophyllus	Tauhinu, cottonhead	1				2,348	
Pennantia corymbosa	Kaikōmako, ducks foot	1.2	697	900			1,249
Pittosporum eugenioides	Tarata	1.2	697	1,800			1,249
Pittosporum tenuifolium	Kōhūhū	1.2	1,394	900		1,631	1,249
Poa cita	Silver tussock, wī	0.5			1,170		
Poa colensoi	Blue tussock	0.5			702		
Podocarpus laetus	Thin-bark tōtara, Hall's tōtara	1.5	892	1,728			1,598
Prumnopitys taxifolia	Matai, black pine	1.5	892	1,728			1,598
Pseuopanax colensoi	Horopito, peppertree	1.2	418				
Pseudopanax crassifolius	Lancewood, horoeka	1	602				
Sophora microphylla	Small-leaved kōwhai	1.2		900		2,038	1,249
Veronica salicifolia	Koromiko	1				2,348	1,798
Total			**13,734**	**17,244**	**3,630**	**51,525**	**24,376**

- Prepare the site for planting by spraying any leftover pest plants/exotic grasses with herbicide.
- Plant indigenous plants listed in Table 10. Plant tree tutu (*Coriaria arborea*) near the bottom of the slope, near the river.
- Undertake planting area maintenance and monitoring at least three times per year.
- Undertake infill planting.
- Undertake ongoing environmental weed control at least once per year.

Management Unit E-4: Braided River

- Undertake environmental weed control on the braided river. Priority environmental weeds include: Scotch broom, buddleia, crack willow, gorse, and tree lupin. Avoid indigenous riverbed species such as *Raoulia* sp. and willowherbs (*Epilobium* sp.) if using a foliar spray method to control exotic shrubs. Two At Risk species are present on the riverbed and should be avoided (common mat daisy and dwarf rush).
- Approach landowner of Lot 1 DP 399651 and ask to manage/restore braided river areas on their property.
- Undertake regular bird surveys near and during avifauna breeding season and put-up warning signs for areas public need to avoid.
- Reduce crack willow forest abundance by 50% (MU E-4b).
- Mark 15 circular plots (five metre radius each) within the exotic grassland area and foliar spray area (MU E-4b).
- Prepare the site for planting by spraying any leftover pest plants/exotic grasses with herbicide.
- Plant and guard species in Table 10 into the willow forest and cleared circular plots.
- Continue ongoing pest animal control along the braided river edges.
- Undertake ongoing environmental weed control at least once per year.
- Control the rest of the crack willow after four years of initial planting

Management Unit E-5

- Control exotic trees by felling and removing tree debris.
- Reduce Scotch broom abundance by controlling around 25% of these exotic shrubs.
- Set up and undertake ongoing pest animal control and monitoring.
- Undertake environmental weed control.
- Prepare the site for planting by spraying any leftover pest plants/exotic grasses with herbicide.
- Plant indigenous plants listed in Table 10 in between Scotch broom.
- Undertake planting area maintenance and monitoring at least three times per year.
- Undertake ongoing environmental weed control at least once per year.
- Reduce Scotch broom another 25% after two years of initial planting in this MU.
- Undertake infill planting.
- Control the rest of the Scotch broom after four years of initial planting in this MU.

Management Unit E-6: Braided River

- Reduce crack willow forest abundance by 50%.
- Prepare the site for planting by spraying any leftover pest plants/exotic grasses with herbicide.
- Plant and guard species listed in Table 10 into the willow forest and exotic grassland areas. Plant kahikatea nearby wetter areas.
- Continue ongoing pest animal control along the braided river edges.
- Undertake ongoing environmental weed control at least once per year.
- Control the rest of the crack willow after four years of initial planting.

12. SPECIFIC GUIDANCE FOR RESTORATION PLANTINGS

12.1 Plant sourcing

12.1.1 Eco-sourcing of indigenous species

The use of 'eco-sourced' indigenous plants is highly beneficial to maintain and enhance the ecological integrity of the indigenous vegetation and habitats at Arthurs Point. Eco-sourcing is the propagation of indigenous plants from seeds (or sometimes cuttings) that have been collected from naturally occurring indigenous vegetation within the same ecological district (in this case, Shotover Ecological District). The aim is to collect seed from as close to the planting site as possible to ensure that local genetic traits are maintained. The use of locally adapted plants will also help to maximise the survival rates of the restoration plantings. The project is to use best endeavours to eco-source where possible.

The provenance (seed source) of all plants used in the restoration plantings should be documented and this information held with the project planting plans and files.

12.1.2 Plant size and quality

- 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 from herbivorous animal pests (e.g. rabbits, possums), competition from weeds, and they are more resilient to frosts and other environmental extremes.

- 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.

- Ensure that all nursery grown trees and shrubs are a minimum of 20 centimetres tall and with a root collar/basal stem diameter of at least two millimetres. This will make sure that the plants are of a sufficient stature to survive the first growing season. Plants that are too young will have a poor root structure, sparse vegetative growth, and are unlikely to survive. Conversely, plant stock that is root bound will also likely result in poor plant growth or survival.

- All plants should be hardened off (exposing them to sun, wind and temperatures that are similar to the climatic conditions at the site) by the nursery prior to planting.
- All plants should be free from pests and diseases.

12.1.3 Care of plants between the nursery and planting

Plants should be kept well-watered from the time of departure from the nursery until the day of planting, and handled with care to reduce plant damage. If planting of a site is to be undertaken over an extended period of time (e.g. weeks not days), a temporary nursery for holding and watering the stock prior to planting should be built. Note that plants that undergo drought stress prior to planting have a much higher chance of mortality within restoration sites.

12.2 Planting

12.2.1 Site access

Provision for vehicle and foot access is important for site planting preparation, undertaking the plantings, and future pest plant management. Access tracks are not specified for each Management Area, although at most sites existing tracks will be able to be utilised and where necessary new tracks may need to be formed.

12.2.2 Vegetation clearance

Heavy machinery can be used to clear dense exotic vegetation. Any indigenous species present should be identified and avoided.

Biosecurity

All vegetation clearance contractors should be made aware of the risk of dispersing propagules or seeds of pest plants, soil-borne pathogens, and pest animals on earthmoving equipment and materials (including gravel) that are contaminated with soil or biological materials.

All equipment should be steam-cleaned (at a temperature of greater than 100°C) and carefully inspected before being brought into the project area. Particular attention should be paid to the wheel wells of wheeled vehicles, the tracks of excavators and other tracked vehicles, and the under-carriages of all vehicles. Inspections of equipment should be undertaken prior to the first day that contractors work at the sites, to ensure compliance with these measures.

12.2.3 General site preparation and planting guidelines

Site preparation requirements are dependent on the species that dominate the existing vegetation of a planting site and the proposed planting density. Site preparation required for the plantings will vary according to the habitat and vegetation type. The particular requirements of the area to be restored should be assessed on a case-by-case basis before each planting. One month prior to planting, all existing vegetation should be removed from the planting patches by spot-spraying or screefing (skimming off surface vegetation with a spade or grubber) to reduce competition for water and light. Clearing too large an area should be avoided as pest plants will re-invade any disturbed ground

(Porteous 1993). Mulching the cleared ground will reduce pest plant invasion and conserve soil moisture, although this can be impractical on large-scale projects.

The following guidelines will provide general site preparation information:

- An assessment of the area to be planted should be undertaken at least six months prior to planting to identify any problem pest plant species which may require sustained control.
- Herbicide control over water must be undertaken with great care. Only glyphosate can be used over water without a resource consent.
- In areas where threatened or locally important plant species are present, weed control should be undertaken manually to avoid unwanted damage to threatened species.
- Some species (e.g. blackberry) are best controlled in spring or early summer, therefore these species should be ideally controlled a year in advance of planting.
- The current status of pest animals at the site should be determined immediately prior to planting. If necessary, hares, rabbits and possums should be controlled prevent them impacting the plantings.

12.2.4 Plant layout and spacing

In general, lower growing species (e.g. grasses or sedges) should be planted close together at approximately 0.5 metre centres. However, pūrei and toetoe need to be planted at one metre spacings as they are large sedges/grasses. Shrubs should be planted at one metre spacings, small trees should be planted at 1.2 metre spacings and large tree species (e.g. Halls tōtara) at 1.5 metre spacings. Planting at these spacings will ensure that a dense canopy quickly forms, thereby reducing competition with exotic grasses and pest plants.

12.2.5 Timing of planting

Timing of planting will be dictated by the rainfall patterns in the intended planting season, but in general should be timed from late autumn, once soil moisture levels reach field capacity. Wetland areas and the margins of ponds (e.g. Management Unit C-4) should be planted in either September or October once any standing water has drained. The goal in these areas should be to plant while there is adequate soil moisture to allow the plants to establish before summer droughts. Soil moisture levels within wetlands will vary depending upon the amount of winter rainfall, and these areas should be visited prior to planting to determine the timing of planting.

12.2.6 Planting technique

The importance of good planting technique should not be under-estimated, and the following guidelines should be followed:

- Ideally all planting should be undertaken by experienced workers in accordance with recognised industry best practice. If volunteers are used, they must be briefed and thoroughly supervised to ensure correct planting techniques are used.

- Care should be taken to ensure that the root ball is not excessively disturbed during container removal or planting.
- The planting hole should be two times the size of the root mass and the soil broken up with a spade as it is dug out of the hole.
- Plants should be planted just above the level of the potting mix. This will prevent the potting soil being exposed to the air and drying out.
- The planting hole, when filled in, should form a very shallow depression, to enable rain water to collect and soak in. Once planted, the plant should resist being pulled out of the ground when given a gentle tug.

If plants start to show signs of water stress (e.g. wilting leaves), watering should be carried out to reduce plant losses.

If planting on a slope, cut out a bench area into the slope using a spade. This should create a flat area for the plant to now be planted into. The bench also creates a small catchment for water accumulate, which is beneficial to the plant.

12.2.7 Plant protection

- Newly-planted trees and shrubs can be decimated by rabbits, so protection against rabbit browse is critical.
- Individual plant guards should be used to protect each plant from browsing. 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.
- Mulching/weed mats retain moisture, reduce soil temperature fluctuations, and suppress pest plant growth (Dollery *et al*. 2018). Consideration should be given to using these mats at the planting sites.
- A weed roll mat is highly recommended for planting sedges and rushes around wetland areas. Selecting a biodegradable roll mat is recommended to allow for the mat to be left onsite. We suggest using EcoJute mulch mat rolls or EcoWool mulch mat rolls. Biodegradable pins will also be necessary to hold the weed rool mat in place. If metal pins are used, they should be taken out of the ground once plants are established.
- We suggest using FiberGuard (300 millimetre) for plant protection. This plant guard is robust and biodegradable. Two bamboo stakes are needed for each guard. Exposed windy sites need three bamboo stakes. Suggested weed mats are Ecowool Mulch Mats (250 millimetre) or TerraFiber Hemp Mulch Mats (300 millimetre).
- Some plants will not need plant guards due to their unpalatability or growth form. Sedges, rushes, grasses and harakeke to not need plant guards due to their growth form and resilience. Weed mats are still recommended for all plants.

12.2.8 Mulching

Mulching around the plants will help suppress weeds, retain moisture in the soil and provide soil insulation. Mulching will greatly increase the survival of plants on dry or open sites (Porteous 1993). Mulching is generally not necessary for sheltered forested areas. Before starting to mulch the area, ensure the area is weed-free. Ideally the area is mulched onto wet ground, either mulch straight after a rainy day or water area (if possible). Mulch the entire area of planting around each plant, with a depth of around 10 centimetres deep. Mulch will need to be renewed over time. Once the plants are established and the canopy closed, mulching is no longer necessary.

Mulching around plants can be expensive. The cheapest method would be use 'on-site' material, such as grass from surrounding areas or wood chip from cut down trees. Using organic material is also best for mulch as it can also break down and supply nutrients to the soil. Organic mulches can include newspaper, fine bark chips, saw dust (from untreated wood), wood shavings (from untreated wood), wool mats, coconut matting and straw/hay or dead vegetation. There is potential that using straw/hay can introduce weeds. Lucerne hay is the best mulch as it does not have many weed seeds (Porteous 1993).

Do not mulch around wet areas and stream edges. This can lead to mulch being washed away and cause blockages.

12.2.9 Planting maintenance

The plantings should be inspected at least three times per year during the first three years following planting, and annually for the next three years. During these visits, plants should be released (weeding around plantings) from exotic vegetation to ensure they receive sufficient sunlight. As the plants become established (once they achieve >75% canopy cover), they will begin to out-compete other exotic species and the amount of maintenance required will decrease. Areas comprising low growing species may require some ongoing maintenance as pest plants will continue to invade from surrounding areas.

Grasses have the greatest impact on the establishment of indigenous plantings and so it is important that they are controlled during Years 1 and 2 using a glyphosate-based herbicide. As the plantings mature (during Years 3-5), the use of a grass-specific herbicide (e.g. haloxyfop) should be considered. However, this herbicide cannot be used near indigenous grasses (e.g. toetoe) or over water.

The use of a brushcutter between restoration plants is not advisable because of the risk of damage to stems, unless used by a skilled operator or the plants have guards around them.

12.2.10 Infill planting

Infill planting to replace plants that have died may be required and should be undertaken in Years 2 and 3 after the original planting, as necessary. The number and species of infill plants should be identified in the February or March proceeding the planting season.

13. MONITORING

13.1 General monitoring of restoration plantings

Regular monitoring of the plantings should be undertaken so that:

- Management is appropriate to ensure the successful survival, growth and establishment of all species.
- Lessons learned in the early years of the programme can be incorporated into later stages of the planting plans and site management.
- Monitoring of weather patterns and plant health to determine any extra actions that need to take place. For example, if the area is experiencing a drought the plants should have a planned watering visit. Monitoring can be done in conjunction with maintenance visits.
- Newly established pest plants can be identified and managed.

In the long-term (i.e. after the initial 10 years of planting), it would be useful to monitor changes in the vegetation at the planting sites in order to determine if regeneration of indigenous species is occurring within the restored plant communities and whether there is any natural colonisation of these communities by indigenous plant species.

13.2 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 20 photopoints are established within the wider site. The photopoints should be established at sites where there are relatively unobstructed views (i.e. not in front of dense stands of trees or lianes). Each photopoint should be marked with a wooden post and the location recorded with a handheld GPS. A compass should be used to gauge a bearing to the center of the frame of the photopoint. The photos should then be printed to provide a reference for future revisits. The photopoints should be resampled every two years.

14. PEST ANIMAL CONTROL AND MONITORING

Rabbits and hares can be monitored using a modified McLean scale (see NPCA 2012) or by monitoring for damage to restoration plantings. Both rabbits and hares should be controlled to low levels, ideally by night shooting, or in the case of rabbits using Pindone Pellets. The effectiveness of this control should be constantly monitored to ensure that rabbits and hares do not negatively impact restoration plantings during the first three to four years after planting. After this time, any damage to the plantings is unlikely to reach levels where they negatively affect restoration plantings.

Possum control may not be needed during the first four to five years following planting as the plantings are immature and therefore less likely to be damaged. However, as the

plantings mature, possums should be monitored using chewcards[1], placed out throughout the site to gauge population densities. Again, once the plantings mature, possum populations should be maintained at or below the 10% chewcard index (CCI) (NPCA 2015). Possums can be controlled by night shooting, traps (Sentinel or Trapinator traps), and by using Feracol Strikers, containing Cholecalciferol, attached to trees at 50 metre spacings around the perimeter of each management unit.

Feral pigs can be controlled by shooting and trapping, following the National Pest Control Agencies guidelines (NPCA 2018). Feral goats should be controlled by shooting.

Control of rats, mice, hedgehogs, feral cats, and mustelids is a lower priority at this point compared with restoring habitats. However, once ecological restoration is undertaken in wider areas of the site, these species should be controlled using traps. Ideally, a pest management plan would be developed for these species prior to the control being undertaken. Table 11 provides control methods for rabbits, hares, possums, goats and pigs.

Table 11: Methods of pest animal control at Arthurs Point, Queenstown.

Target Species	Method	Timing	Frequency	Detailed Guidance and Best Practice Methods
Rabbits	Night shooting	Continuous until plantings no longer vulnerable	At least monthly (adjust frequency as required)	NPCA 2012 Pest rabbits-monitoring and control A5[2].
	Back-up method: Hand-laid Pindone cereal pellets	As required	As required during dry ground conditions if shooting is not providing adequate level of control.	
Hares	Night shooting	Continuous until plantings no longer vulnerable	At least monthly (adjust frequency as required).	NPCA 2015 Pest hares-monitoring and control A7[1].
Possums	Night shooting	Continuous until plantings no longer vulnerable	At least monthly (adjust frequency as required)	NPCA 2015 Possum control tools and techniques A3[1]. NPCA 2015 Responsible use of bait stations A13[1].
	Sentinel or Trapinator traps	Place out at site when possum damage is encountered.	Set out around perimeter of site following manufacturer's instructions and check and rebait monthly	
	Feracol strikers (Cholecalciferol)	Place out at site when possum damage is encountered.	As needed once restoration plantings begin to mature (four-five years post planting).	
Goats	Shooting	Continuous	Once per year.	

[1] See Sweetapple and Nugent (2011) for more details.

[2] National Pest Control Agencies (NPCA) 'A' Series Best Practice Vertebrate Pest Control http://www.npca.org.nz/index.php/a-series-best-practice.html

Target Species	Method	Timing	Frequency	Detailed Guidance and Best Practice Methods
Pigs	Shooting or trapping	Continuous until plantings no longer vulnerable. Implement trapping if certain pigs are difficult to remove.	As required.	NPCA 2018 Feral pig monitoring and control techniques A10[1].

Pest control should only be carried out by suitably trained, skilled, and experienced personnel. Appropriate notification needs to be given to neighbours before and during pest control to advise them of the use of toxins and associated risks to dogs or people who ingest the toxins. Neighbours should be notified prior to undertaking shooting to ensure humans, livestock, and private property is not harmed.

Regular monitoring of the effects of pest mammals on existing areas of indigenous vegetation and restoration plantings (such as inspecting plants for browse damage) should be carried out to inform ongoing management decisions regarding the amount and frequency of pest animal control that is needed at the site.

15. OTHER RESTORATION ACTIONS

15.1 Seed-bearing slash

Mānuka (and kānuka) can be established using the 'seed-bearing slash' method. This method involves cutting seed-bearing branches from mature trees and placing them in layers directly onto soil (Saunders 2017).

Collecting mānuka seed-bearing branches should be done when the greatest number of capsules are on the branches. This is typically around July and August each year. Ensure branches are collected from multiple mānuka plants and that not too much is taken from each mānuka plant to ensure it continues to thrive and survive. Branches should be immediately spread across prepared soil areas (Saunders 2017). Seek permission from relevant landowner and council before collecting mānuka branches.

Vegetation cover needs to be low for a greater germination and establishment rate. If vegetation cover is dense, reduce or remove vegetation by using methods that disturb the soil the least. The layers of branches should be approximately 30-40 centimeters deep and cover around 80-90 percent of the ground. Seedlings will germinate under the slashed branches cover and emerge through it (Saunders 2017).

If the seed-bearing method is used on a slope, the branches may slide down. A grid of biodegradable pins hammered into the ground may be used to stop branches from sliding down.

15.2 Bird survey and management

Threatened and At Risk bird species occupy and breed on the braided river. Bird surveys should be undertaken near breeding season to identify any breeding pairs. If any breeding pairs are identified the public will need to be temporarily advised to avoid

these areas. If this is the case, signs may need to erected to notify the public. This information could also be posted on community boards/web pages.

16. PRIORITY ACTIONS

Priorities of this ecological restoration plan are outlined below in Table 12.

Table 12: Priority ecological restoration actions within all Management Areas at Arthurs Point.

Management Area/Unit	Management/restoration action	Reason
All management areas	Engage local community and iwi with ecological restoration ambitions and goals.	Restoration projects are more successful with community input.
All management areas	Apply for funding to implement restoration actions.	This large-scale restoration project will be expensive and needs funding to progress.
All management areas	Assign/employ project manager and approach potential contractors for quotes and availability.	The success of the restoration project will depend on a dedicated project manager. Contractors for this type of work need to have specialist skills and need to be available to undertake work at particular times of the year.
MU:A	Order eco-sourced plants for first management area.	It takes at least two years for plants to be ready from the time of sourcing the seed.
MU E-4	Undertake environmental weed control and continue pest animal control on the braided river (MU E-4).	Indigenous avifauna that occupy the braided river depend on these actions to survive in this habitat.
MA: A	Undertake goat control in the Morning Star Recreation Reserve.	Goats are causing significant damage to the vegetation and regeneration should be encouraged as soon as possible.
MU A-2, A-3, and B-1	Undertake environmental weed control and continue pest animal control in areas with indigenous vegetation	Protecting the ecological indigenous values present is a high priority, so they do not become more degraded.
MU A-3	Undertake indigenous planting in cleared areas of Morning Star Recreation Reserve (MA: A)	This area will quickly be invaded by environmental weeds. Planting this area will keep site preparation costs down.

17. FUTURE CONSIDERATIONS

17.1 Extend environmental weed management area

Environmental weeds were observed in the areas surrounding the project area. These weed populations will continue to be a seed source of re-invasion into the project site. Controlling these weeds would prevent this.

17.2 Further biodiversity enhancement

To further enhance the biodiversity and ecosystem functions of the indigenous forest, consideration should be given to the introduction of lianes, invertebrates, fungi, and other leaf litter and soil organisms to the ecological restoration plantings. These actions would greatly add to the "naturalness" of the restoration plantings and facilitate the ecology of the forests in the long-term, including nutrient recycling, decomposition, pollination, and the development of natural food chains involving birds and reptiles.

The following management actions should be considered once canopy closure has been achieved in the ecological restoration plantings:

- Supplementary plantings of indigenous liane species, especially those in the genera *Parsonsia*, *Rubus*, *Clematis*, *Passiflora*, and *Muehlenbeckia* (i.e. *M. complexa*). These genera were mostly not included in planting plans as their establishment and management would not be easy in open sites and they are not trees. Planting of 15-20 plants of each species per hectare would be sufficient.

- Translocation of invertebrate groups. Invertebrates are often immobile or disperse only short distances and will usually not be able to colonise the plantings without assistance. Selected invertebrates can be added species-by-species (e.g. for rare species) or en masse by the addition of leaf litter and dead wood material from suitable nearby natural indigenous forests. This could be undertaken by spreading 30-50 sacks of forest floor litter per hectare under the closed canopy.

- Addition of ground cover species, fungi and other leaf litter and soil organisms. The addition of leaf litter and dead and decaying wood material (also known as duff) from appropriate indigenous forests would introduce a range of organisms that are not able to be planted (e.g. orchids, ferns, herbs). This could be undertaken by spreading 30-50 sacks of forest floor litter per hectare under the closed canopy.

18. CONCLUSION

This ecological restoration plan has been developed with historic and current ecological values in mind. Indigenous planting in Arthurs Point will help create habitat for indigenous avifauna, invertebrates, and lizards. Pest animal control will help protect indigenous fauna, and will also allow for successful restoration plantings and natural regeneration. Monitoring of this project will help identify necessary reactive management actions and will also aid in lessons learnt that will contribute to future restoration projects. Cultural values were not investigated in depth. More time could be spent on this aspect to gain more information. Nearby areas outside of the restoration site contain exotic trees and shrubs, and these potential environmental weeds will

continue to invade the project area and nearby conservation areas. Environmental weed control over the long term should ideally extend beyond the project area outlined in this plan. Implementation of the ecological restoration plan will increase biodiversity in Arthurs Point, and will provide valuable connection with the surrounding conservation areas.

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APPENDIX 1

VASCULAR AND NON-VASCULAR PLANT SPECIES RECORDED AT ARTHURS POINT, QUEENSTOWN

Scientific Name	Common Name(s)	Life Form	Species Status	Threat Status
Acaena species	Bidibidi, piripiri	Dicot herb		
Acaena agnipila	Australian sheeps spur	Dicot herb	Exotic	
Acaena caesiiglauca	Bidibidi, piripiri	Dicot herb	Indigenous	Not Threatened
Acer pseudoplatanus	Sycamore	Tree	Exotic	
Achillea millefolium	Yarrow	Dicot herb	Exotic	
Agrostis capillaris	Brown top	Grass	Exotic	
Aira species		Grass	Exotic	
Anaphalioides bellidioides	Everlasting daisy, hells bells	Dicot herb	Indigenous	Not Threatened
Anisotome aromatica	Kopoti	Dicot herb	Indigenous	Not Threatened
Anthoxanthum odoratum	Sweet vernal	Grass	Exotic	
Aristotelia serrata	Wineberry, makomako	Tree	Indigenous	Not Threatened
Asplenium flabellifolium	Necklace fern	Fern	Indigenous	Not Threatened
Asplenium richardii	Richard's spleenwort	Fern	Indigenous	Not Threatened
Asplenium trichomanes	Maidenhair spleenwort	Fern	Indigenous	Not Threatened
Austroblechnum lanceolatum	Lance fern, nini, rereti	Fern	Indigenous	Not Threatened
Austroderia richardii	Toetoe	Grass	Indigenous	Not Threatened
Bellis perennis	Daisy	Dicot herb	Exotic	
Berberis glaucocarpa	Common barberry	Tree	Exotic	
Blechnum penna-marina	Little hard fern	Fern	Indigenous	Not Threatened
Bromus diandrus	Ripgut brome	Grass	Exotic	
Bromus hordeaceus	Soft brome	Grass	Exotic	
Buddleja davidii	Buddleia	Shrub	Exotic	
Calystegia silvatica	Great bindweed	Vine	Exotic	
Callitriche stagnalis	Starwort	Dicot herb	Exotic	
Carex coriacea	Cutty grass, rautahi	Sedge	Indigenous	Not Threatened
Carex species		Sedge	Indigenous	
Carex species		Sedge		
Carpodetus serratus	Marbleleaf, piripiriwhata, putaputawētā	Tree	Indigenous	Not Threatened
Celmisia bellidioides	Green cushion mountain daisy	Dicot herb	Indigenous	Not Threatened
Centaurium erythraea	Centaury	Dicot herb	Exotic	
Cerastium fontanum	Mouse-ear chickweed	Dicot herb	Exotic	
Chionochloa rigida	Narrow-leaved snow tussock	Grass	Indigenous	Not Threatened
Chionochloa rubra	Red tussock	Grass	Indigenous	Not Threatened
Cirsium arvense	Californian thistle	Dicot herb	Exotic	
Clematis tangutica	Chinese clematis	Vine	Exotic	
Clematis vitalba	Old man's beard	Vine	Exotic	
Colobanthus species		Dicot herb	Indigenous	
Conium maculatum	Hemlock	Dicot herb	Exotic	
Coprosma crassifolia	Thick-leaved coprosma, mikimiki	Shrub	Indigenous	Not Threatened
Coprosma dumosa	Mikimiki	Shrub	Indigenous	Not Threatened
Coprosma linariifolia	Yellow-wood	Tree	Indigenous	Not Threatened
Coprosma lucida	Karamū	Tree	Indigenous	Not Threatened
Coprosma propinqua	Mingimingi, mikimiki	Shrub	Indigenous	Not Threatened
Coprosma rugosa		Shrub	Indigenous	Not Threatened

Scientific Name	Common Name(s)	Life Form	Species Status	Threat Status
Coprosma serrulata		Shrub	Indigenous	Not Threatened
Coprosma virescens	Mikimiki	Shrub	Indigenous	Not Threatened
Cordyline australis	Cabbage tree, tī kōuka	Tree	Indigenous	Not Threatened
Corokia cotoneaster	Korokio	Shrub	Indigenous	Not Threatened
Coriaria plumosa	Feathery tutu, mountain tutu	Shrub	Indigenous	Not Threatened
Coriaria sarmentosa	Tutu	Shrub	Indigenous	Not Threatened
Cotoneaster franchetii	Franchet's cotoneaster	Shrub	Exotic	
Crassula species		Dicot herb		
Crataegus monogyna	Hawthorn	Tree	Exotic	
Cucurbita maxima	Pumpkin	Vine	Exotic	
Cupressus macrocarpa	Macrocarpa, Monterey cypress	Tree	Exotic	
Cytisus scoparius	Scotch broom	Shrub	Exotic	
Dactylis glomerata	Cocksfoot	Grass	Exotic	
Daphne laureola	Daphne	Shrub	Exotic	
Daucus decipiens	Parsnip palm	Dicot herb	Exotic	
Discaria toumatou	Matagouri, tūmatakuru	Tree	Indigenous	At Risk-Declining
Dryopteris filix-mas	Male fern	Fern	Exotic	
Echium vulgare	Vipers bugloss	Dicot herb	Exotic	
Epilobium ciliatum	Tall willowherb	Dicot herb	Exotic	
Epilobium hectorii	Willow herb	Dicot herb	Indigenous	Not Threatened
Epilobium komarovianum	Creeping willow herb	Dicot herb	Indigenous	Not Threatened
Epilobium melanocaulon	Willow herb	Dicot herb	Indigenous	Not Threatened
Epilobium nummulariifolium	Creeping willow herb	Dicot herb	Indigenous	Not Threatened
Erythranthe guttata	Monkey musk	Dicot herb	Exotic	
Erythranthe moschata	Musk	Dicot herb	Exotic	
Euphorbia peplus	Petty spurge, milkweed	Dicot herb	Exotic	
Festuca novae-zelandiae	Fescue tussock, hard tussock	Grass	Indigenous	Not Threatened
Festuca rubra	Red fescue	Grass	Exotic	
Fragaria vesca	Alpine strawberry	Dicot herb	Exotic	
Fuchsia excortica	Fuchsia	Tree	Indigenous	Not Threatened
Fuscospora cliffortioides	Mountain beech	Tree	Indigenous	Not Threatened
Fuscospora fusca	Red beech	Tree	Indigenous	Not Threatened
Galium aparine	Cleavers	Dicot herb	Exotic	
Gaultheria crassa	lily of the valley shrub	Shrub	Indigenous	Not Threatened
Geranium brevicaule	Short-flowered cranesbill	Dicot herb	Indigenous	Not Threatened
Geranium molle	Dovesfoot cranesbill	Dicot herb	Exotic	
Griselinia littoralis	Froadleaf, kāpuka	Tree	Indigenous	Not Threatened
Gunnera dentata	Native gunnera	Dicot herb		
Hedera helix	Ivy	Vine	Exotic	
Helichrysum lanceolatum	Niniao	Shrub	Indigenous	Not Threatened
Hieracium lepidulum	Tussock hawkweed	Dicot herb	Exotic	
Hoheria glabrata	Lacebark, houhere	Tree	Indigenous	Not Threatened
Holcus lanatus	Yorkshire fog	Grass	Exotic	
Hordeum species	Barley	Grass	Exotic	
Hydrocotyle heteromeria	Pennywort	Dicot herb	Indigenous	Not Threatened
Hydrocotyle moschata	Pennywort	Dicot herb	Indigenous	Not Threatened
Hypnum cupressiforme	Cypress-leaved plait moss	Moss	Indigenous	Not Threatened
Hypochaeris radicata	Catsear	Dicot herb	Exotic	
Isolepis setacea		Sedge	Exotic	
Jacobaea vulgaris	Ragwort	Dicot herb	Exotic	
Juncus articulatus	Jointed rush	Rush	Exotic	
Juncus effusus	Soft rush	Rush	Exotic	

Scientific Name	Common Name(s)	Life Form	Species Status	Threat Status
Juncus novae-zelandiae	Dwarf rush	Rush	Indigenous	Not Threatened
Juncus pusillus	Dwarf rush	Rush	Indigenous	At Risk-Naturally Uncommon
Juncus squarrosus		Rush	Exotic	
Juncus tenuis	Slender rush	Rush	Exotic	
Lapsana communis	Nipplewort	Dicot herb	Exotic	
Larix decidua	Larch	Tree	Exotic	
Leptinella species	Button daisy	Dicot herb	Indigenous	
Leptospermum scoparium	Mānuka	Tree	Indigenous	At Risk-Declining
Leucanthemum vulgare	Oxeye daisy	Dicot herb	Exotic	
Linum catharticum	Purging flax	Dicot herb	Exotic	
Lobelia angulata	Pratia	Dicot herb	Indigenous	Not Threatened
Lophozonia menziesii	Silver beech	Tree	Indigenous	Not Threatened
Lotus pedunculatus	Lotus	Dicot herb	Exotic	
Lupinus arboreus	Tree lupin	Shrub	Exotic	
Lupinus polyphyllus	Russell lupin	Dicot herb	Exotic	
Matricaria matricarioides	Rayless camomile	Dicot herb	Exotic	
Melilotus albus	Sweet clover	Dicot herb	Exotic	
Melicytus alpinus	Porcupine shrub	Shrub	Indigenous	Not Threatened
Muehlenbeckia australis	Large-leaved pōhuehue	Vine	Indigenous	Not Threatened
Muehlenbeckia axillaris	Creeping pōhuehue	Vine	Indigenous	Not Threatened
Mycelis muralis	Wall lettuce	Dicot herb	Exotic	
Myosotis species		Dicot herb		
Nasturtium officinale	Watercress	Dicot herb	Exotic	
Nertera balfouriana	Nertera	Dicot herb	Indigenous	Not Threatened
Olearia avicenniifolia	Mountain akeake	Tree	Indigenous	Not Threatened
Olearia fragrantissima	Fragrant tree daisy	Tree	Indigenous	At Risk-Declining
Olearia odorata	Scented tree daisy	Shrub	Indigenous	Not Threatened
Origanum vulgare	Wild marjoram	Dicot herb	Exotic	
Ozothamnus leptophyllus	Tauhinu, cottonhead	Shrub	Indigenous	Not Threatened
Bellardia viscosa	Tarweed	Dicot herb	Exotic	
Parsonsia capsularis var. tenuis	Native jasmine, akakaikiore	Vine	Indigenous	Not Threatened
Phleum pratense	Timothy	Grass	Exotic	
Phormium tenax	Lowland flax, harakeke	Monocot herb	Indigenous	Not Threatened
Pilosella officinarum	Mouse-ear hawkweed	Dicot herb	Exotic	
Pinus radiata	Radiata pine	Tree	Exotic	
Pittosporum tenuifolium	Kōhūhū	Tree	Indigenous	Not Threatened
Plantago major	Broad-leaved plantain	Dicot herb	Exotic	
Plagianthus regius	Lowland ribbonwood, mānatu	Tree	Indigenous	Not Threatened
Poa annua	Annual poa	Grass	Exotic	
Poa cita	Silver tussock, wī	Grass	Indigenous	Not Threatened
Poa colensoi	Blue tussock	Grass	Indigenous	Not Threatened
Poa pusilla		Grass	Indigenous	Not Threatened
Podocarpus laetus	Hall's tōtara	Tree	Indigenous	Not Threatened
Polystichum vestitum	Prickly shield fern, pūniu	Fern	Indigenous	Not Threatened
Polytrichum juniperinum	Juniper polytricum moss	Moss	Indigenous	Not Threatened
Populus nigra	Black poplar, Lombardy poplar	Tree	Exotic	
Prunus species		Tree	Exotic	
Prunella vulgaris	Selfheal	Dicot herb	Exotic	
Pseudopanax colensoi	Mountain five-finger	Tree	Indigenous	Not Threatened
Pseudotsuga menziesii	Douglas fir	Tree	Exotic	

Scientific Name	Common Name(s)	Life Form	Species Status	Threat Status
Pteridium esculentum	Bracken, rārahu, rauaruhe	Fern	Indigenous	Not Threatened
Quercus robur	English oak	Tree	Exotic	
Racomitrium species	Woolly moss	Moss	Indigenous	
Ranunculus species	Native buttercup	Dicot herb	Indigenous	
Ranunculus repens	Creeping buttercup	Dicot herb	Exotic	
Raoulia australis	Common mat daisy	Dicot herb	Indigenous	At Risk-Declining
Raoulia haastii		Dicot herb	Indigenous	Not Threatened
Raoulia subsericea	Turf mat daisy, turf scabweed	Dicot herb	Indigenous	Not Threatened
Ribes uva-crispa	Gooseberry	Shrub	Exotic	
Rosa rugosa	Japanese rose, rugosa rose	Shrub	Exotic	
Rubus fruticosus	Blackberry	Shrub	Exotic	
Rubus schmidelioides	Bush lawyer, tātarāmoa	Vine	Indigenous	Not Threatened
Rumex acetosella	Sheeps sorrel	Dicot herb	Exotic	
Rumex obtusifolius	Broad-leaved dock	Dicot herb	Exotic	
Rytidosperma species	Danthonia	Grass	Indigenous	
Sagina procumbens	Procumbent pearlwort	Dicot herb	Exotic	
Salix cinerea	Grey willow	Tree	Exotic	
Salix ×fragilis	Crack willow	Tree	Exotic	
Sambucus nigra	Elderberry	Tree	Exotic	
Schoenus pauciflorus	Bog rush	Sedge	Indigenous	Not Threatened
Sedum acre	Stonecrop	Dicot herb	Exotic	
Senecio minimus	Native fireweed	Dicot herb	Indigenous	Not Threatened
Silene coronaria	Rose campion	Dicot herb	Exotic	
Solanum species		Dicot herb		
Solanum dulcamara	Bittersweet	Vine	Exotic	
Sonchus asper	Prickly sow thistle	Dicot herb	Exotic	
Sophora microphylla	Small-leaved kōwhai	Tree	Indigenous	Not Threatened
Sorbus aucuparia	Rowan	Tree	Exotic	
Stellaria gracilenta	Chickweed	Dicot herb	Indigenous	Not Threatened
Stellaria parviflora	Native chickweed	Dicot herb	Indigenous	Not Threatened
Tanacetum parthenium	Feverfew	Dicot herb	Exotic	
Thymus vulgaris	Thyme	Dicot herb	Exotic	
Trifolium arvense	Haresfoot trefoil	Dicot herb	Exotic	
Trifolium dubium	Suckling clover	Dicot herb	Exotic	
Trifolium pratense	Red clover	Dicot herb	Exotic	
Trifolium repens	White clover	Dicot herb	Exotic	
Uncinia species	Hook grass	Sedge	Indigenous	
Veronica colostylis		Dicot herb	Indigenous	Not Threatened
Veronica lyallii	Lyall's parahebe	Dicot herb	Indigenous	Not Threatened
Veronica salicifolia	Koromiko	Dicot shrub	Indigenous	Not Threatened
Veronica subalpina	Hebe	Dicot shrub	Indigenous	Not Threatened
Verbascum thapsus	Woolly mullein	Dicot herb	Exotic	
Verbascum virgatum	Moth mullein	Dicot herb	Exotic	
Vicia sativa	Vetch	Dicot herb	Exotic	
Vinca major	Periwinkle	Dicot herb	Exotic	
Zealandia pustulata subsp. pustulata	Hound's tongue, kōwaowao	Fern	Indigenous	Not Threatened

APPENDIX 2

AVIFAUNA SPECIES RECORDED ON EBIRD NEAR ARTHURS POINT, QUEENSTOWN

Common Name(s)	Scientific Name	Threat Classification 2021
Indigenous		
Tarapirohe, black-fronted tern	*Chlidonias albostriatus*	Threatened - Nationally Endangered
Kea	*Nestor notabilis*	Threatened - Nationally Endangered
Pīwauwau, rock wren	*Xenicus gilviventris rineyi*	Threatened - Nationally Endangered
Whio, blue duck	*Hymenolaimus malacorhynchos*	Threatened - Nationally Vulnerable
Kārearea, eastern falcon	*Falco novaeseelandiae novaeseelandiae*	Threatened - Nationally Vulnerable
Pūteketeke, great crested grebe	*Podiceps cristatus*	Threatened - Nationally Vulnerable
Pārera, grey duck	*Anas superciliosa*	Threatened - Nationally Vulnerable
Kākā, kaka	*Nestor meridionalis meridionalis*	Threatened - Nationally Vulnerable
Koekoeā, long-tailed cuckoo	*Eudynamys taitensis*	Threatened - Nationally Vulnerable
Kawau tikitiki, spotted shag	*Stictocarbo punctatus*	Threatened - Nationally Vulnerable
Pohowera, banded dotterel	*Charadrius bicinctus bicinctus*	At Risk - Declining
Tarāpuka, black-billed gull	*Chroicocephalus bulleri*	At Risk - Declining
Kotoreke, marsh crake	*Porzana pusilla*	At Risk - Declining
Pīhoihoi, New Zealalnd pipit	*Anthus novaeseelandiae*	At Risk - Declining
Tarāpunga, red-billed gull	*Chroicocephalus novaehollandiae*	At Risk - Declining
Tōrea, South Island pied oystercatcher	*Haematopus finschi*	At Risk - Declining
Kakaruai, South Island robin	*Petroica australis australis*	At Risk - Declining
Mohua, yellowhead	*Mohoua ochrocephala*	At Risk - Declining
Kākāriki, yellow-crowned parakeet	*Cyanoramphus auriceps*	At Risk - Declining
Māpunga, black shag	*Phalacrocorax carbo*	At Risk - Relict
Kawaupaka, little shag	*Phalacrocorax melanoleucos*	At Risk - Relict
Weka	*Gallirallus australis hector*	At Risk - Relict
Australian coot	*Fulica atra*	At Risk - Naturally Uncommon
Kawau tūī, little black shag	*Phalacrocorax sulcirostris*	At Risk - Naturally Uncommon
Kāhu, Australasian harrier	*Circus approximans*	Not Threatened
Kuruwhengi, Australasian shoveler	*Anas rhynchotis*	Not Threatened
Korimako, bellbird	*Anthornis melanura*	Not Threatened
Kakīānau, black swan	*Cygnus atratus*	Not Threatened
Pīpipi, brown creeper	*Mohoua novaeseelandiae*	Not Threatened
Tētē-moroiti, grey teal	*Anas gracilis*	Not Threatened
Riroriro, grey warbler	*Gerygone igata*	Not Threatened
Ruru, morepork	*Ninox novaeseelandiae*	Not Threatened
Pīwakawaka, New Zealand fantail	*Rhipidura fuliginosa*	Not Threatened
Kererū, New Zealand pigeon	*Hemiphaga novaeseelandiae*	Not Threatened
Pāpango, New Zealand scaup	*Aythya novaeseelandiae*	Not Threatened
Pūtangitangi, paradise shelduck	*Tadorna variegata*	Not Threatened
Poaka, pied stilt	*Himantopus himantopus*	Not Threatened
Pūkeko, pukeko	*Porphyrio melanotus*	Not Threatened
Tītitipounamu, rifleman	*Acanthisitta chloris chloris*	Not Threatened
Kōtare, sacred kingfisher	*Todiramphus sanctus*	Not Threatened
Pīpīwharauroa, shining cuckoo	*Chrysococcyx lucidus*	Not Threatened

Common Name(s)	Scientific Name	Threat Classification 2021
Tauhou, silvereye	*Zosterops lateralis*	Not Threatened
Karoro, southern black-backed gull	*Larus dominicanus*	Not Threatened
Spur-winged plover	*Vanellus miles*	Not Threatened
Ngirungiru, tomtit	*Petroica macrocephala macrocephala*	Not Threatened
Tūī, tui	*Prosthemadera novaeseelandiae*	Not Threatened
Warou, welcome swallow	*Hirundo neoxena*	Not Threatened
Matuku moana, white-faced heron	*Egretta novaehollandiae*	Not Threatened
Chestnut-breasted shelduck	*Tadorna tadornoides*	Non-resident Native - Vagrant
Dusky moorhen	*Gallinula tenebrosa*	Non-resident Native - Vagrant
Introduced:		
Makipai, Australaian magpie	*Gymnorhina tibicen*	Introduced and Naturalised
Tikaokao, California quail	*Callipepla californica*	Introduced and Naturalised
Kuihi, Canada goose	*Branta canadensis*	Introduced and Naturalised
Cape Barren goose	*Cereopsis novaehollandiae*	Introduced and Naturalised
Pahirini, chaffinch	*Fringilla coelebs*	Introduced and Naturalised
Chukar	*Alectoris chukar*	Introduced and Naturalised
Cirl bunting	*Emberiza cirlus*	Introduced and Naturalised
Dunnock	*Prunella modularis*	Introduced and Naturalised
Manu pango, Eurasian blackbird	*Turdus merula*	Introduced and Naturalised
Kōurarini, European goldfinch	*Carduelis carduelis*	Introduced and Naturalised
European greenfinch	*Carduelis chloris*	Introduced and Naturalised
Tāringi, European starling	*Sturnus vulgaris*	Introduced and Naturalised
Kuihi, greylag goose	*Anser anser*	Introduced and Naturalised
Tiu, house sparrow	*Passer domesticus*	Introduced and Naturalised
Lesser redpoll	*Carduelis flammea*	Introduced and Naturalised
Ruru nohinohi, little owl	*Athene noctua*	Introduced and Naturalised
Rakiraki, mallard	*Anas platyrhynchos*	Introduced and Naturalised
Ring-necked pheasant	*Phasianus colchicus*	Introduced and Naturalised
Kererū Aropari, rock pigeon	*Columba livia*	Introduced and Naturalised
Kairaka, skylark	*Alauda arvensis*	Introduced and Naturalised
Manu-kai-hua-rakau, song thrush	*Turdus philomelos*	Introduced and Naturalised
Korukoru, wild turkey	*Meleagris gallopavo*	Introduced and Naturalised
Hurukōwhai, yellowhammer	*Emberiza citrinella*	Introduced and Naturalised
Mallard × grey duck hybrid	N/A	N/A

APPENDIX 3

RECOMMENDED HERBICIDE TREATMENTS FOR ENVIRONMENTAL WEEDS AT ARTHURS POINT

Pest Plant	Control Method(s)	Chemical(s)	Application Rate	Timing	Remarks
Bittersweet (*Solanum dulcamara*)	Cut and treat stumps	Glyphosate gel 120g/kg	Paste with glyphosate gel	October-March	
		Glyphosate 510g/L	250ml glyphosate/1L water (25% glyphosate)	October-March	
	Knapsack - foliar spray	Glyphosate 510g/L	70ml glyphosate/10L water	October-March	
Blackberry (*Rubus fruticosus*)	Cut and treat stumps	Glyphosate gel 120g/kg	Paste with glyphosate gel	October-March	
	Knapsack - foliar spray	Triclopyr 600g/L	60ml triclopyr/10L water	October-March	Preferred choice close to water.
Common barberry *(Berberis glaucocarpa*) and buddleia (*Buddleja davidii*)	Hand pull seedlings/small plants	-	-	Year round	
	Cut and treat stumps	Glyphosate gel 120g/kg	Paste with glyphosate gel	Year round	
		Glyphosate 510g/L	250ml glyphosate/1L water (25% glyphosate)	Year round	
	Knapsack - foliar spray	Triclopyr 600g/L	60ml triclopyr/10L water	October-March	
		Glyphosate 510g/L	70ml glyphosate/10L water	October-March	
	Drill and inject/bore and spray	Glyphosate 360g/L	500ml glyphosate/1L water (50% glyphosate) or 100% glyphosate	Year round	Undiluted glyphosate will be more effective in Autumn/Winter.
	Basal bark application	Triclopyr 600g/L	2L triclopyr + 8L Syntol oil or 100% X-tree basal	October-April	
Hemlock (*Conium maculatum*)	Knapsack - foliar spray	Glyphosate 510g/L	70ml glyphosate/10L water	October-April	
Scotch broom (*Cytisus scoparius*)	Hand pull seedlings/small plants			Year round	
	Cut and treat stumps	Glyphosate gel 120g/kg	Paste with glyphosate gel	Year round	
	Knapsack - foliar spray	Triclopyr 600g/L	60ml triclopyr/10L water	November-February	Just after flowering is the best time to spray (December). Do not spray if seed pods have turned brown.
	Gunspray - foliar spray	Triclopyr 600g/L	300ml triclopyr/100L water	November-February	
Elderberry (*Sambucus nigra*)	Hand pull seedlings/small plants	-	-	Year round	
	Ring bark or fell larger trees	-	-	Year round	

Pest Plant	Control Method(s)	Chemical(s)	Application Rate	Timing	Remarks
	Drill and inject/bore and spray	Glyphosate 510g/L	250ml glyphosate/1L water (25% glyphosate)	Year round	50% or undiluted glyphosate will be more effective in Autumn/Winter.
Cotoneaster (*Cotoneaster sp*.)	Dig out by hand				Leave onsite to decompose.
	Cut and treat stumps	Glyphosate gel 120g/kg	Paste with glyphosate gel	Year round	
		Metsulfuron 600g/kg	5g metsulfuron + 2ml organosilicone/1L water	October-April	
	Drill and inject/Bore and spray	Metsulfuron 600g/kg	5g metsulfuron + 2ml organosilicone/1L water	October-April	
		Glyphosate 510g/L	250ml glyphosate/1L water (25% glyphosate)	October-April	
	Basal bark application	Triclopyr 600g/L	2L triclopyr + 8L Syntol oil or 100% X-tree basal	October-April	ONLY on trees with base diameter <30cm
Crack willow (*Salix xfragilis*) and grey willow (*Salix cinerea*)	Knapsack - foliar spray	Metsulfuron 600g/kg	2.5g metsulfuron/10L water	Year round	
	Drill and inject/Bore and spray	Metsulfuron 600g/kg	5g metsulfuron + 2ml organosilicone/1L water	October-April	Preferred option as leaving the tree standing avoids broken twigs/branches resprouting on ground.
		Glyphosate 510g/L	250ml glyphosate/1L water (25% glyphosate)	October-April	
	Basal bark application	Triclopyr 600g/L	2L triclopyr + 8L Syntol oil or 100% X-tree basal	October-April	ONLY on trees with base diameter <30cm
	Knapsack - foliar spray	Metsulfuron 600g/kg	2.5g metsulfuron/10L water	Year round	
Daphne (*Daphne laureola*)	Dig out by hand including the root system	-	-	Year round	Dispose of plant material at a refuse station.
Gooseberry (*Ribes uva-crispa*)	Dig out root crown by hand	-	-	Year round	Dispose of plant material at a refuse station.
	Cut and treat stumps	Glyphosate gel 120g/kg	Paste with glyphosate gel	Year round	
	Knapsack - foliar spray	Glyphosate 510g/L	70ml glyphosate/10L water	October-March	
Gorse (*Ulex europaeus*)	Cut and treat stumps	Glyphosate gel 120g/kg	Paste with glyphosate gel	October-March	
	Knapsack – foliar spray	Triclopyr 600g/L	60ml triclopyr + 10ml organosilicone/10L water	October-March	
		Metsulfuron 600g/kg	5g metsulfuron + 10ml organosilicone/10L water	October-March	
		Clopyralid 300g/L	125ml Clopyralid/10L water	October-January	
Great bindweed (*Calystegia sylvatica*)	Dig out by hand including the root system	-	-	Year round	Dispose of plant material at a refuse station.
	Cut and treat stumps	Glyphosate gel 120g/kg	Paste with glyphosate gel	October-March	
		Glyphosate 510g/l	250ml glyphosate/1L water (25% glyphosate)	October-March	
	Knapsack – foliar spray	Glyphosate 510g/l	70ml glyphosate + 2ml organosilicone/10L water	October-March	

Pest Plant	Control Method(s)	Chemical(s)	Application Rate	Timing	Remarks
Hawthorn (*Crataegus monogyna*) and English oak (*Quercus robur*)	Hand pull seedlings/small plants	-	-	Year round	
	Fell larger trees	-	-	Year round	Needed for large trees. Specialist arborist/driver needed for this type of work
	Basal bark application	Triclopyr 600g/L	2L triclopyr + 8L Syntol oil or 100% X-tree basal	October-April	ONLY on trees with base diameter <30cm
	Drill and inject/bore and spray	Glyphosate 360g/l	500ml glyphosate/1L water (50% glyphosate) or 100% glyphosate	Year round	Undiluted glyphosate will be more effective in Autumn/Winter.
Ivy (*Hedera helix*) and periwinkle (*Vinca major*)	Dig out by hand	-	-	-	Burn or dispose of at a refuse station.
	Cut and treat stumps	Glyphosate gel 120g/kg	Paste with glyphosate gel	October-March	
		Glyphosate 510g/l	250ml glyphosate/1L water (25% glyphosate)	October-March	
	Knapsack - foliar spray	Glyphosate 510g/L	70ml glyphosate + 2ml organosilicone/10L water	October-March	
Old man's beard and Chinese clematis (*Clematis vitalba* and *Clematis tangutica*)	Cut and treat stumps	Glyphosate gel 120g/kg	Paste with glyphosate gel	October-March	Aerially hang cut vegetation
		Glyphosate 510g/L	250ml glyphosate/1L water (25% glyphosate)	October-March	
	Knapsack - foliar spray	Glyphosate 510g/L	70ml glyphosate/10L water	October-March	
Pampas grass (*Cortaderia selloana*)	Physical control			Year round	Dig/grub out seedlings/juveniles. Digger is needed for adults.
	Foliar spray	Glyphosate 510g/L	100ml glyphosate + 20ml organosilicone/10L water	Year round	
Conifers: radiata pine, European larch, macrocarpa, and Douglas fir	Hand pull seedlings/small plants	-	-	Year round	
	Ring bark or fell larger trees	-	-	Year round	
	Drill and inject/bore and spray	Glyphosate 360g/L	500ml glyphosate/1L water (50% glyphosate) or 100% glyphosate	Year round	Undiluted glyphosate will be more effective in Autumn/Winter.
Male fern (*Dryopteris filix-mas*)	Foliar spray	Metsulfuron 600g/kg	5g metsulfuron/10L water	October-March	
	Granule application	Glyphosate dry 680-800g/kg	5g/plant	October-March	Apply dry granules to centre of plant
Monkey musk (*Erythranthe guttuta*) and musk (*Erythranthe moschata*)	Dig out by hand	-	-	Year round	Burn, bury or dispose of at a refuse station.
	Knapsack – foliar spray	Glyphosate 510g/L	70ml glyphosate + 2ml organosilicone/10L water	Year round	

Pest Plant	Control Method(s)	Chemical(s)	Application Rate	Timing	Remarks
Ragwort (*Jacobaea vulgaris*)	Knapsack - foliar spray	Glyphosate 510g/L	70ml glyphosate/10L water	October-April	If flowering, cut seed heads first and dispose of at a refuse station.
Soft rush (*Juncus effusus*)	Dig out by hand	-	-	Year round	Not practical for large infestations.
	Knapsack – foliar spray	Glyphosate 510g/L	70ml glyphosate + 2ml organosilicone/10L water	Year round	
Stonecrop (*Sedum acre*)	Dig out by hand	-	-	Year round	Burn, bury or dispose of at a refuse station.
	Knapsack – foliar spray	Metsulfuron 600g/kg, Glyphosate 510g/L	5g metsulfuron + 70ml glyphosate + 2ml organosilicone/10L water	October-March	
Sweet briar (*Rosa rubiginosa*)	Cut and treat stumps	Glyphosate gel 120g/kg	Paste with glyphosate gel	Year round	
	Knapsack - foliar spray	Glyphosate 510g/l	70ml glyphosate/10L water	October-March	
Sweet clover (*Melilotus albus*)	Hand pull	-	-	October-March	Pull plant out before flowering.
Sycamore (*Acer pseudoplatanus*), black poplar (*Populus nigra*) and rowan (*Sorbus aucuparia*)	Hand pull seedlings	-	-	Year round	
	Cut and treat stumps	Glyphosate gel 120g/kg	Paste with glyphosate gel	October-March	
		Glyphosate 510g/L	250ml glyphosate/1L water (25% glyphosate)	October-March	
	Ring bark or fell larger trees	-	-	Year round	
	Basal bark application	Triclopyr 600g/L	2L triclopyr + 8L Syntol oil or 100% X-tree basal	October-April	ONLY on trees with base diameter <30cm
	Drill and inject/bore and spray	Glyphosate 360g/l	500ml glyphosate/1L water (50% glyphosate) or 100% glyphosate	Year round	Undiluted glyphosate will be more effective in Autumn/Winter.
Thyme (*Thymus vulgaris*)	Hand pull	-	-	Year round	
	Cut and treat stumps	Glyphosate gel 120g/kg	Paste with glyphosate gel	Year round	
Tussock hawkweed (*Hieracium lepidium*), broad-leaved dock (*Rumex obtusifolius*), woolly mullein (*Verbascum thapsus*) parsnip palm (*Daucus decipiens*) and Californian Thistle (*Cirsium arvense*)	Dig out by hand	-	-	Year round	-
	Knapsack – foliar spray	Glyphosate 510g/L	70ml glyphosate + 2ml organosilicone/10L water	October-March	
		Metsulfuron 600g/kg	5g metsulfuron + 10ml organosilicone/10L water	October-March	
Tree lupin (*Lupinus arboreus*) and Russell	Cut and treat stumps	Glyphosate gel 120g/kg	Paste with glyphosate gel	October-March	Hang cut vegetation aerially
		Glyphosate 510g/L	250ml glyphosate/1L water (25% glyphosate)	October-March	

Pest Plant	Control Method(s)	Chemical(s)	Application Rate	Timing	Remarks
lupin (*Lupinus polyphyllus*)	Knapsack - foliar spray	Glyphosate 510g/L	70ml glyphosate/10L water	October-March	
Vipers bugloss (*Echium vulgare*)	Dig out by hand	-	-	Year round	Burn, bury or dispose of at a refuse station.
	Knapsack – foliar spray	Glyphosate 510g/L	70ml glyphosate + 2ml organosilicone/10L water	October-March	
Wild marjoram (*Oreganum vulgare*)	Hand pull	-	-	Year Round	
	Knapsack - foliar spray	Glyphosate 510g/l	70ml glyphosate/10L water	October-March	

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