

Ecological Enhancement Plan for The Point Solar Farm, Twizel

Contract Report No. 6621g

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Project Team:

Morgan Tracy-Mines – Report author, vegetation
Vikki Smith - Report author, invertebrates, pest mammal control
Samantha King – Report author, herpetofauna
Roland Payne – Report author, vegetation
Simon Curtis – Technical advice, restoration
Warren Chinn (DOC) – Technical advice, invertebrates
Des Smith – Project oversight, peer review

Prepared for:

Far North Solar Farms
Auckland

Reviewed and approved for release by:

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Des Smith

Senior Principal Ecologist, South Island Regional Manager, Director
Wildland Consultants Ltd

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Christchurch Office

238 Annex Road, Middleton, PO Box 9276, Tower Junction, Ph 03 338-4005

Head Office

99 Sala Street, PO Box 7137, Te Ngae, Rotorua Ph 07-343-9017 Fax 07-343-9018 Email: rotorua@wildlands.co.nz

www.wildlands.co.nz



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1.0 Introduction

Far North Solar Farms Ltd (FNSF) are applying for a resource consent to develop a solar farm in Twizel near Ōhau C power station, known as The Point (also referred to as **the proposed development**). The Point will be built upon approximately 678 hectares of flat land that is currently a farm (also referred to as **the site**). The site is flat, with farmland to the north and rivers on the eastern and western boundaries. The Twizel River flows along the western side of the site and the Tekapo River flows along the eastern side. The site is approximately 10 kilometres to the southeast of Twizel township. FNSF intend to install 720,048 solar panels across the site (Figure 1), with a 3.8-metre gap between each panel.

As part of effects management for The Point, FNSF intend to build and manage an ecological reserve of at least 89 hectares (referred to as **The Point reserve**), including indigenous plantings, weed control, habitat creation, and control of mammalian pests. The 89 hectares will include marginal space for visual screening of the solar farm. To remain aligned with the ecological goals of this enhancement plan, Wildlands has provided a species list to use for the visual screening zone (Section 10.1 – Table 3).

Far North Solar Farms have commissioned Wildland Consultants Ltd (Wildlands) to prepare an Ecological Enhancement Plan (EEP) for The Point reserve. The EEP and its implementation are referred to as **the project**.

2.0 Key stakeholders

Here is a summary of each stakeholder's responsibilities and commitment to the project:

Far North Solar Farms are the owners of the project. They will oversee, fund, and run the project, under guidance from suitably-qualified ecologists.

The Department of Conservation (DOC) are kaitiaki of environmental values, and manage the local kāki populations through their captive breeding facility and release programmes. DOC have a statutory responsibility for all wildlife protected under the Wildlife Act (1953).

Ngāi tahu are the iwi and kaitiaki of the Tekapo and Twizel regions. They are interested in being involved in the project at an advisory level, and can help with sourcing seed for planting through Arawhenua Native Nursery and Restoration.

Wildlands has been contracted to design the project, having previously completed the Ecological Impact Assessment for the proposed development.

3.0 Project Scope

3.1 The Point reserve boundaries

The Point reserve is a strip surrounding the proposed solar panels, following the perimeter of the south, east, and west boundaries of the site (Figure 1). Its northwestern boundary stops south of the centre-pivot irrigator (Figure 1).



3.2 Project goals and priorities

Far North Solar Farms have indicated that they will spend up to \$2 million New Zealand dollars on establishing and maintaining The Point reserve over five years. The budget will cover:

- Planting and nurturing the growth of indigenous plants.
- Establishing a reserve for robust grasshopper (*Sigaus robustus*; was *Brachaspis robustus*; Threatened – Nationally Endangered Trewick *et al.*, 2012).
- Enhancing habitat for invertebrates, plants, and lizards.
- Establishing predator control.

The costs of ongoing predator control, fence maintenance, and māwhitiwhiti/grasshopper reserve maintenance will be additional to the \$2 million budget.

The priority of restoration in The Point reserve is to restore and enhance habitat to be representative of indigenous Mackenzie Basin ecosystems.

More specifically the goals of the project are:

- To restore locally-indigenous vegetation, such as Maniototo peppercress (*Lepidium solandri* Threatened – Nationally Critical) and Dwarf broom (*Carmichaelia vexillata*, At Risk – Declining).
- To create habitat for locally-indigenous lizards and invertebrates, such as the robust grasshopper (previously *Brachaspis robustus*; now *Sigaus robustus* Trewick *et al.*, 2023).

4.0 Ecological Context

4.1 General overview

The site is located between the lowest reaches of the Tekapo and Twizel Rivers. The Tekapo River discharges into the head of Lake Benmore, a human-made hydro lake, immediately adjacent (east) of where the Ōhau River also discharges into the lake. The Twizel River flows into the Ōhau River about one kilometre upstream from the lake. A centre-pivot irrigator (diameter 1.5 kilometres) is present northwest of the site.

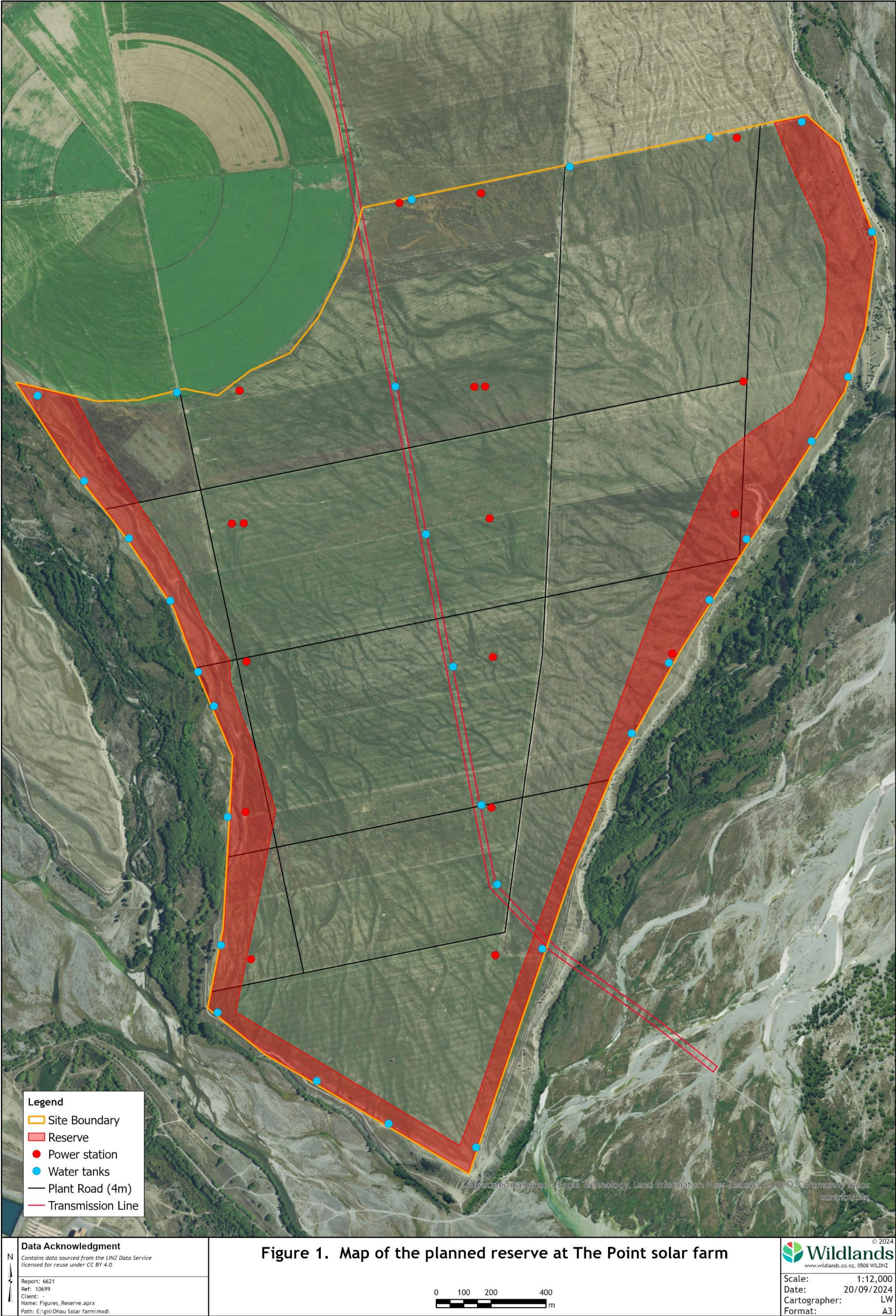
The site is largely flat land, c.400 metres above sea level, comprising the low interfluvium between the Tekapo and Twizel Rivers. As such, the site is underlain by alluvial gravels. The lower reaches of the Tekapo and Twizel Rivers are both braided systems, with a line of low eroded cliffs on the edges of the river channels.

Almost the entire site is currently grazed farmland and part of it is cultivated and cropped seasonally.

4.2 Pukaki Ecological District

The site is located in the Pukaki Ecological District and the following description is adapted from McEwen (1987).

Pukaki Ecological District is characterised by dry outwash plains between Lakes Tekapo and Benmore, mostly below 600 metres above sea level. The geology is fluvioglacial outwash deposits, with isolated greywacke and argillite hills. The climate is semi-arid to sub-humid with cold winters, warm summers and 600-1,600 mm of rainfall annually. Soils are moderately fertile but prone to drought in summer, they are easily erodible in steep areas with bare screes being common.





This Ecological District was historically typified by extensive red tussockland (*Chionochloa rubra*), replaced at altitude by snow tussock (*Chionochloa rigida*). Tussocklands had some kettlehole tarns and associated wetlands, areas of hard tussock (*Festuca novae-zelandiae*), and scattered blue tussock (*Poa colensoi*). Some prostrate mat plants, e.g. *Coprosma petriei*, *Raoulia subsericea* were scattered throughout, as well as some scrub, including tūmatakuru/matagouri (*Discaria toumatou*) with mingimingi (*Coprosma propinqua*).

Pasture now occupies much of this Ecological District, with some tussocklands and areas of scrub (tūmatakuru, *Coprosma* spp., kōwhai (*Sophora* spp. and *Corokia*) remaining. Grazing by sheep and rabbits has significantly affected grasslands.

Braided riverbeds provide important habitat to a number of bird species, there are also several notable rare insects in the area.

4.3 Nearby sites of natural significance

The entirety of the Ōhau River has been identified as a Site of Natural Significance in the Mackenzie District Plan. It is recognised primarily for its avifauna habitat values, as well as areas of wetland. It extends along the Ōhau River from Lake Benmore into, and including, areas of Lake Ruataniwha. This area overlaps with the northeastern boundary of the proposed development.

4.4 Naturally Uncommon Ecosystems

The site is located on an area of inland outwash gravel plain. A naturally uncommon ecosystem classified as 'critically endangered' (Holdaway *et al.*, 2012). These outwash plains are formed on terraces comprising late-Otiran fluvioglacial materials, that originated from the meltwater of retreating glaciers of this period. Weeds are major threat to this ecosystem, particularly wilding pines (*Pinus* spp.), Russell lupin (*Lupinus polyphyllus*), and stonecrop (*Sedum acre*). Many of the natural values of this system have been destroyed in upper Waitaki by irrigation and cultivation.

4.5 Threatened Environment Classification

The site is classified entirely as a 'critically underprotected' land environment, with more than 30% indigenous vegetation left and less than 10% indigenous vegetation protected (Cieraad *et al.*, 2015).

4.6 Land Cover Database (LCDB)

Two land cover types are mapped in the LCDB, with most of the site mapped as depleted grassland. An area of high producing exotic grassland is mapped where the centre pivot irrigator is located, in the northwest of the site.

4.7 Potential natural vegetation

The dry, central southeastern districts of the McKenzie Basin and Central Otago have proved difficult to reconstruct in terms of pre-Māori vegetation cover, as they have been thoroughly transformed, largely by fire induced clearance by both Māori and European. What scant fossil evidence remains suggests is that that small-leaved shrubland of matagouri with *Muehlenbeckia*, *Coprosma* and *Olearia* species was common in dry inland valleys of Central Otago, with kōwhai and kānuka (*Kunzea* spp.) along rivers and on deeper soils, and thin grassland or mat herbs and shrubs on the driest soils. On the glacial outwash surface plains of the Mackenzie Basin, mountain toatoa/celery pine (*Phyllocladus alpinus*) and bog pine (*Halocarpus bidwillii*) formed extensive stands (M. S. McGlone & Moar, 1998).



Fire would often sweep through these habitats and charcoal of kānuka and mānuka (*Leptospermum scoparium*) accompanies that of celery pine at many locations, suggesting that they played a role in the succession of vegetation after fire. As rainfall increased with altitude valley-bottom scrub with mountain toatoa, bog pine and mountain tōtara (*Podocarpus laetus*), gave way to beech (*Fuscospora* spp. *Lophozonia menziesii*) forest (McGlone, 2004)

The site would likely have historically been scrub, shrubland and tussock-grassland.

4.8 Important Bird Area

The site is immediately adjacent to an Important Bird Area (IBA)¹ which includes the Ōhau, Pukaki, Twizel, and Tekapo Rivers. The site is in the wedge that forms the Ōhau-Tekapo Delta, where the Ōhau and Tekapo Rivers enter Lake Benmore. The full suite of endemic braided river birds is found in braided river habitat at the Delta, including kakī.

This area is part of the Department of Conservation's Project River Recovery programme. Far North Solar Farms has committed to contributing to Kakī recovery on the Twizel River delta in collaboration with the Department of Conservation.

4.9 Braided rivers

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). Sixty-four percent of Aotearoa New Zealand's braided rivers occur in Canterbury. The braided rivers of the Mackenzie Basin drain into the Waitaki River and braided rivers and wetlands of the upper Waitaki Basin are under active restoration as part of "Project River Recovery" The programme is run by the Department of Conservation and funded by Meridian Energy and Genesis Energy under a compensatory agreement that recognises the impact of hydroelectric power development on these rivers and wetlands (DOC 2020).

4.10 Notable existing environmental modifications

The site is close in proximity to the Ōhau C hydro power station on the Ōhau canal network, which is part of the larger Waitaki hydro scheme. This scheme comprises of five hydro-generation stations in the Upper Waitaki and three in the Lower Waitaki as well as a series of dams and canals to optimise generation potential. The Ōhau canal network runs from Lake Ōhau down through Lake Ruataniwha and into Lake Benmore. It is also fed by the Pukaki Canal, which brings water from Lakes Tekapo and Pukaki. Development of this hydro scheme has caused notable modifications to the surrounding environment through the construction of dams, formation of lakes (e.g. Lake Benmore), and diversion of water, and has drastically altered the hydrological regimes of the rivers in the Mackenzie basin.

All of the site is classified as improved pasture, as identified by the Department of Conservation in 2018.

¹ Forest & Bird 2016: New Zealand Seabirds - Sites on Land, Rivers, estuaries, coastal lagoons & harbours. *The Royal Forest & Bird Protection Society of New Zealand*, Wellington. 177 p.



5.0 Threats to biodiversity values

5.1 Overview

Wildlands (2024) identified the key biodiversity values on the site and its habitats, which have been used to inform specific restoration actions in this plan (summarised in Table 1). The actions outlined within this EEP are intended to specifically address ecological threats (Table 1) as well enhance the overall values of the site.

Ecological threats are interrelated and so are their remedies. For example, restoration planting (once established) will help exclude weeds and improve habitat for indigenous fauna species by providing host plants and food sources. Further actions, including pest mammal control (Section 15.0), are also required to help plantings thrive and reduce predation pressure on indigenous fauna. Additionally, many actions are required to address the threat of climate change, including restoration planting.

Table 1 – Threats to biodiversity, and management actions to restore an enhance the ecological values of the Point reserve.

Ecological Threat	Potential Impact	Management Actions
Ongoing decline of outwash plain dryland habitat.	Loss of threatened dryland flora and fauna communities.	Enrichment planting in suitable areas. Control of invasive weeds and grasses as required, if necessary.
Pest mammals.	Predation of indigenous fauna. Browsing damage and loss of indigenous plants, including restoration plantings.	Survey for mammalian predators (e.g. mustelids, rodents, feral cats) and browsers (e.g. rabbits, hares, possums). Develop and implement pest mammal management plan (Section 15.0).
Pest plants (weeds).	Wilding pines, broom, sweet briar and other woody and herbaceous pest plants (re)invade and change the natural character of the site.	Ongoing monitoring and spot control as needed of woody weeds and other target pest plants.
Livestock access and agricultural runoff.	Browsing damage to indigenous plants, increased nutrient inputs to drylands.	Stock exclusion and fencing.
Climate change.	Increased weather extremes including drought risk and fire risk.	Planting of drought and fire-resistant species within The Point reserve.

6.0 Ecological enhancement

6.1 Overview

The vision for ecological enhancement at The Point is to create a relatively self-sustaining¹ reserve around the perimeter of the site, with vegetation and habitat typical of naturally-occurring outwash plains in the Mackenzie Basin. The objective is to catalyse the restoration process over five years, after

¹ Recognising that some ongoing maintenance cannot be avoided, such as spot-control of weeds, trap checking, and repairing fences as necessary.



which only minimal restoration will be undertaken. This document acts as a full ecological enhancement prescription and implementation plan. Any requirements for this further information to optimise implementation are outlined below, and throughout the subsequent sections, alongside the best practice methods that will be adopted to ensure successful ecological enhancement of the reserve.

6.2 Strategies for enhancement implementation

Strategies for enhancement are aimed at building a robust, cost-effective restoration programme that will persist long-term with minimal maintenance. Surveying and mapping should first be completed, followed by planning and implementation. Here, the basic strategies are outlined in approximate order of execution. The subsequent sections of the EEP then provide more detail on each of these components.

6.2.1 Habitat mapping

Habitats will be mapped and identified in detail throughout The Point reserve as the first step of implementation, prior to planting, using a UAV (Section 7.0). Habitats that will be mapped and delineated include:

- Areas with topsoil suitable for revegetation and natural regeneration.
- Skeletal soils for dryland vegetation and fauna management.
- Rocky areas suitable for lizard habitat management.
- Areas of short-stature, medium-stature, and complex microhabitats for invertebrates (Section 10.0).
- Weed-infested areas.

6.2.2 Conduct baseline surveys for invertebrates and lizards

Prior to restoration planting, The Point reserve will be surveyed for invertebrates and lizards to give a current snapshot of approximate diversity and abundance as recommended in (Wildland Consultants Ltd, 2024). This is important for prioritising locations for targeted invertebrate and lizard restoration, within the reserve. If funding or research opportunities become available, future monitoring will be able to compare post-restoration results with the current state of the fauna.

6.2.3 Create a robust grasshopper reserve

A predator-proof fence and suitably-restored habitat will form a reserve in the northeast corner of the site for robust grasshoppers (Section 9.2.1). This will help to boost any current population, but will also be a potential site for research and translocation of robust grasshoppers, creating a protected population outside the previously-established robust grasshopper reserve, which is northwest of the site.

6.2.4 Create and maintain existing lizard habitats

Results from the baseline lizard survey will help to inform a plan for maintaining existing lizard habitats, and creating new habitats. Guidelines and recommendations are presented in Section 8.0 for planning lizard habitat enhancement.

6.2.5 Restoration planting

Dense clusters of indigenous plants will be created in suitable areas to catalyse revegetation and provide seed source to surrounding habitat (Section 10.0). Plant types and planting layout will consider the structure of the original outwash plain vegetation communities, alongside lizard and invertebrate



habitat needs. This will become evident through the results of the habitat mapping, which will aid in identifying the suitability of plant species to different habitats.

6.2.6 Pest plant management

Control woody weeds, only where necessary, as the project progresses (Section 12.0). Weed management is not intended to be a large ongoing expense, but occasional spot control is essential to prevent The Point reserve ecological enhancement goals being compromised by weeds.

6.2.7 Pest animal control and monitoring

Rabbit proof fencing will be installed around the perimeter of the site. A pest mammal survey should first be undertaken, so that pest mammal species activity, and relative abundance, throughout the site can be assessed (Section 15.0). The results of the survey, should be used to inform the design of a pest mammal management plan.

6.2.8 Creation of rock stacks for lizards and invertebrates

In the medium-stature and complex microhabitats, rock stacks will be erected to provide hides for beetles and spiders. These are essentially piles of rocks, and can be integrated with requirements for lizards to have pebble stacks. For invertebrates, 5-10 rock stacks should be sufficient, depending on habitat availability throughout the site. Rock stacks may attract mice, so mouse control should be increased around them (Section 15.0). Rock stacks may also provide habitat for lizards, depending on lizard species on-site.

Rock stacks for lizard habitat enhancement should comprise embedded cobbled piles. These will also benefit invertebrates, and can be included in the 5-10 rock stacks placed for invertebrates. To create embedded cobble piles, shallow depressions should be dug (for example, by a small excavator) and trenched in order to allow for drainage. All cobbles should be thoroughly cleaned and rinsed, then placed into the depressions to prevent unwanted seed dispersal. Embedded cobbles can be placed in areas such as at the base of terraces or slopes, where these habitats were likely present prior to land conversion. The cobble piles should be monitored long-term for invasion of pest plant or ground cover species that are not favourable for lizards, or that attract mammalian predators such as mice.

Lizard species such as McCann's skink often begin to occupy rock piles nearly immediately following creation, but other species (such as Southern Alps gecko) are less likely to occupy rock piles unless within close proximity to existing habitats, or only after several years (Herbert *et al.*, 2023).

7.0 Habitat mapping

Habitat mapping is needed to identify specific management units for ecological enhancement. Given the large scale of the reserve area and fine detail required for mapping, the fastest and most efficient method of mapping these habitats would be to use an unmanned aerial vehicle (UAV), or drone to capture high-resolution images and multispectral data across the reserve. The exact flight path can also be replicated in the future, which would allow the dataset to be reused for ongoing UAV orthomosaic photo monitoring of The Point reserve (Section 14.1.17.0).

The reserve will be managed for the enhancement of natural dryland vegetation and fauna, that would have naturally occurred on the site prior to vegetation clearance and agricultural conversation. This was a matrix habitat with low growing ground cover plants in the dry and rocky areas (with thin or skeletal soils) and taller tussocks and shrubby vegetation in areas with deeper soils. Hence the need to identify and differentiate these areas through habitat mapping. The areas with deeper soils are also



those most prone to weed invasion (which includes exotic grasses) and therefore, these areas will be the primary focus for dense cluster planting, to limit habitat availability for weeds. Additionally, dry rock areas with little top soil are difficult to establish plantings in, less prone to weed invasion, and much more suitable for natural revegetation.

8.0 Lizards

8.1 Current understanding of lizard values at The Point

Walk-through surveys have previously been undertaken for lizards. The targeted lizard surveys recommended in Wildlands (2024) have not yet been undertaken. Walk-through assessments provide basic information on lizard habitats, and may provide an initial indication of the presence of some species, but targeted lizard surveys are important for detecting more cryptic species, and understanding the relative abundance, habitats and overall diversity of species present on site.

The walk-through surveys found areas of high-quality lizard habitat, which are incorporated into The Point reserve. Salvage and relocation of lizards from the development may be required under WAA, subject to a site-specific Lizard Management Plan. The Point reserve may be a potential release site, subject to further surveys. The recommendations below will likely form part of the Lizard Management Plan.

8.2 Before, after, control impact study

Current understanding of lizard ecology in Aotearoa New Zealand is limited, therefore habitat enhancement for lizards is typically experimental. Lizard habitat enhancement at The Point reserve may be a good opportunity for research, that could benefit wider lizard conservation initiatives (Section 16.0).

Restoration options provided throughout this EEP are likely to be beneficial for lizards, for example planting indigenous species, which provide food and habitat for lizards (Section 6.2.5), and the creation of rock stacks (Section 6.2.8). Pest animal control (Section 6.2.7) may benefit lizards, though controlling mice is vital to lizard population support. Poorly implemented and monitored pest mammal control programmes may be harmful to lizards (Monks *et al.*, 2024).

Restoration efforts should include robust before, after control impact (BACI) studies, based on the results from targeted lizard surveys, to best inform a lizard management plan (LMP) (Herbert *et al.*, 2023). Simultaneously, adjacent off-site locations should be selected for surveys. These areas will provide control sites, where the equivalent habitats, species and abundance of lizards are present, in order to compare against the restoration site within The Point reserve. Control areas are likely to be present throughout the adjacent public conservation land.

The following schedule of work will be undertaken:

1. Baseline surveys across the entire reserve following the relevant Department of Conservation Inventory and Monitoring Toolbox for Herpetofauna (Hare 2012a 2012b), using methods which can be easily repeated and used for statistical analysis.
2. Inventory species present and determine key habitats for lizard-based restoration management.
3. Monitor the site for a period without restoration. A statistical power analysis should be used to inform how long this period will be for.
4. Simultaneously, undertake surveys of sites outside of The Point reserve area to use as a control site as part of the BACI programme. A suitably qualified herpetologist will monitor this site, ideally for at least five years.



5. Plan and prepare enhancement of lizard management areas within The Point reserve. This may include, habitat enhancement or enrichment planting, that is integrated with other enrichment planting plans.
6. Implement restoration and enhancement as required.
7. Continue monitoring for five years.
8. Adapt and manage lizard management areas as required.

Monitoring will be undertaken following the methods determined in the baseline surveys by a suitably qualified herpetologist familiar with the project.

9.0 Terrestrial invertebrates

The Mackenzie District is a rare and highly valuable habitat for Aotearoa New Zealand’s invertebrate fauna, supporting many At Risk, Threatened, and locally-endemic species (Wakelin *et al.*, 2024). The reserve area presents a highly-degraded portion of dryland terrace habitat, which will be restored to provide a sanctuary for invertebrates. During and after restoration, The Point reserve could present key opportunities for invertebrate research, conservation, and even reintroduction of less mobile species which are found locally.

9.1 Current understanding of terrestrial invertebrate values at The Point

A walk-through and sweep net survey of the site was undertaken in February 2023 (Wildland Consultants Ltd, 2024). The site was found to be lacking in invertebrate values, both in terms of habitat and species found during the field survey. However, four species of interest were identified as possibly being present: Tekapo ground wētā (*Hemiandrus “furoviarius”*; Threatened - Nationally Critical Trewick *et al.*, 2012), robust grasshopper, Otago short-horned grasshopper (*Phaulacridium otagensis*; At Risk - Declining), and minute grasshopper (*Sigaus minutus*; Threatened – Nationally Vulnerable). One notable species was confirmed present: New Zealand blue butterfly (*Zizina oxleyi*; Not Threatened Hoare *et al.*, 2017). Various species of ground beetle and indigenous short-range moth are found within the local area, and may also be present on-site. A breakdown of these taxa, their notability, and their preferred habitats is presented in Table 2.

Table 2 – Notable species found, or suspected to be present, at the site.

Species Common Name	Presence On-Site	Notability	Ideal Habitat
New Zealand blue butterfly	Confirmed	Suspected to be declining	Open, sunny rocky areas with leguminous plants (such as <i>Carmichaelia</i> spp.) nearby as a larval food source
Minute grasshopper	Possible	Threatened – Nationally Vulnerable	Open, sunny areas with bare soil or rocks, and short-stature herbfield plants to feed upon.
Tekapo ground wētā	Likely	Threatened – Nationally Endangered	Braided rivers. Habitat constraints are not well-understood.
Robust grasshopper	Possible	Threatened – Nationally Endangered	Open, sunny braided river beds.



Species Common Name	Presence On-Site	Notability	Ideal Habitat
Otago short-horned grasshopper	Likely	At Risk - Declining	Open, sunny areas with bare soil or rocks, and short-stature herbfield plants to feed upon.
Ground beetles	Likely	Many are short-range endemics, vulnerable to predation and habitat loss	Differs depending on species, but dry rocky areas and indigenous vegetation suit most local species.
Short-range endemic moths	Possible	Many are short-range endemics, vulnerable to predation and habitat loss	Differs depending on species, but indigenous plants including grasses, herbfield species, and shrubs suit most local species.

9.1.1 Gaps in our knowledge

Potential habitat areas have been pinpointed in various locations from walk-through surveys and satellite maps, but the habitat types available in The Point reserve are not well-understood. Mapping The Point reserve area with a UAV (Section 14.0) will improve understanding of the habitat types available.

Some invertebrate species, including the robust grasshopper, have well-studied habitat requirements. However, ground beetles, the Tekapo ground wētā, and most other invertebrates are not so well-understood. Invertebrate enhancement at The Point reserve will present potential avenues for scientific research into invertebrate habitat requirements, helping to fill in the gaps in our knowledge.

9.2 Invertebrate habitat enhancement methods

9.2.1 Grasshopper reserve

A 4.5 hectare area at the northeast corner of the site has been proposed for grasshopper conservation, including a 1.34 hectare predator-proof-fenced grasshopper reserve (Chinn, 2024; W. Chinn, pers. comm.). An improvement would be to fulfil the requirements of other invertebrates throughout The Point reserve, through mosaic planting and habitat creation (Section 10.3). The 4.5 hectare area will therefore be enhanced more specifically, to create habitat for robust grasshopper. Minute and Otago short-horned grasshopper will also benefit from the same conditions within the grasshopper reserve:

- Remove topsoil and replenish with locally-sourced pebbles and gravel.
- Remove weeds and shrubs, mechanically or by hand.
- Plant sparsely with short-stature herbfield species (Table 5).
- Erect a circular predator-proof fence around 1.34 hectares.
- Eradicate all mammalian pests within the predator-proof fence (Section 15.7). Brodifacoum poisoning in bait stations may be needed for rodents.

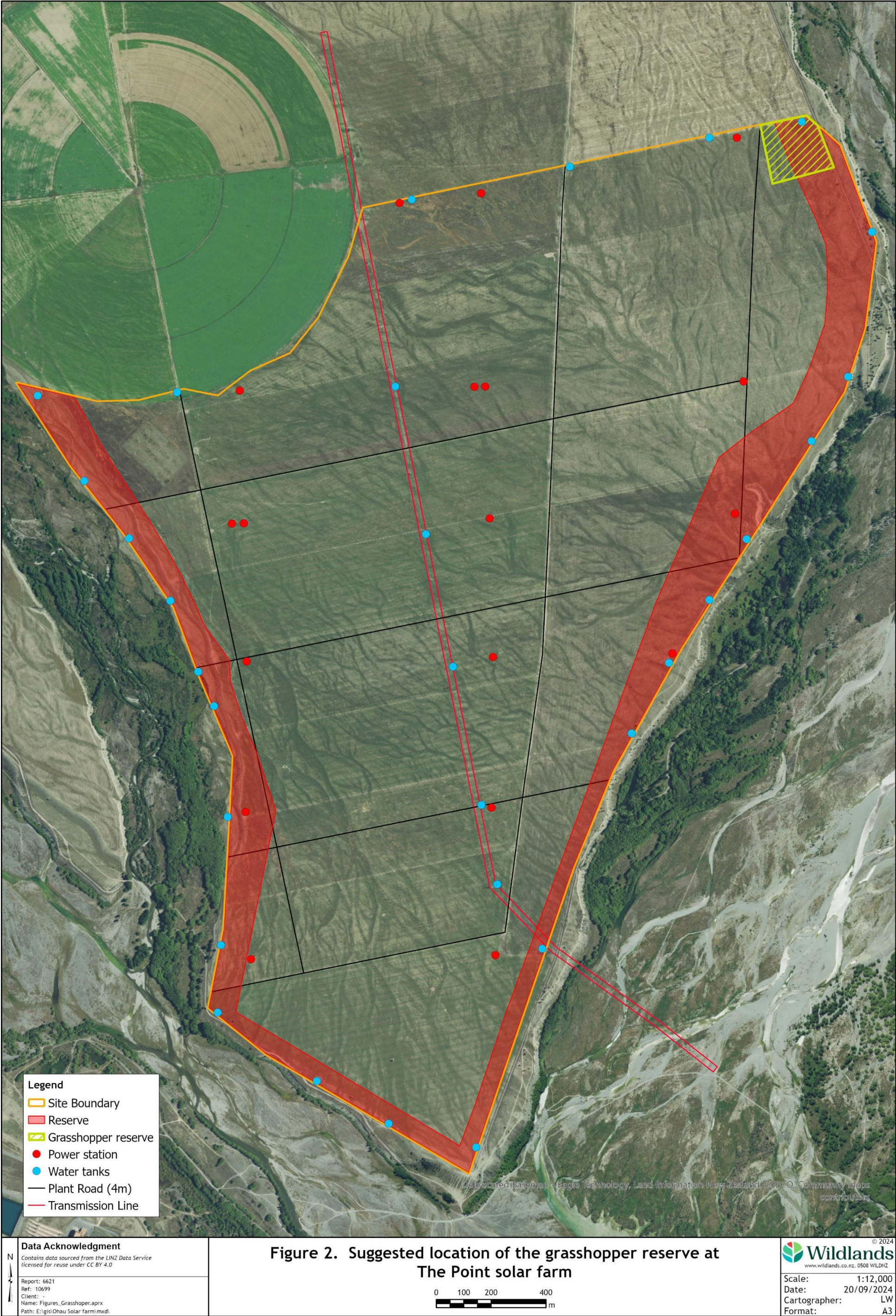
The grasshopper reserve will be built in a location that facilitates integration with The Point reserve. This will facilitate connectivity between grasshopper populations inside and outside the grasshopper reserve (Figure 2).

9.2.2 Habitat mosaic planting

Invertebrate habitats described by Chinn (2024) can be integrated across the entirety of The Point reserve, as pest mammal control including mouse control (Section 15.0) will enable most locally-adapted invertebrate species to thrive outside the predator-proof fence. Expanding invertebrate



habitat restoration throughout The Point reserve will increase the abundance, diversity, and resilience of the invertebrate fauna on-site, and facilitate connectivity with off-site populations of the more mobile species.





Small mosaic areas that are interconnected will facilitate invertebrate movement and genetic connectivity through the landscape. Section 10.0 provides detail on recommended planting to benefit invertebrates. After current habitats are mapped, restoration planting needs to incorporate the species listed in Tables 3-5, ensuring appropriate plants are placed in appropriate habitats for their type, and for the environment that is being created. A mosaic of different-sized patches of habitat will result, and will be physically connected or easily crossed by invertebrate species, enabling invertebrates to move across the landscape between populations. This is important in South Canterbury, as many species (such as ground beetles and moths) are highly limited in their ability to disperse across the landscape, and rely on particular habitat elements (such as specific food plants) for survival.

Three main habitat types are proposed to be created (Section 10), but factors such as sunlight availability, camber, and moisture levels will vary at small scales across the landscape resulting from restoration, so that different areas will form microhabitats for different invertebrate species, and community composition will vary once communities are established, promoting biodiversity.

10.0 Restoration planting

10.1 Overview

The vegetation cover of the Mackenzie Basin and The Point reserve site has been thoroughly transformed by vegetation clearance, agricultural conversion, and introduced browsing animals. Therefore, the goal of 'restoration' planting is to restore a dominance of indigenous species, that would have been historically present, but also suited to current conditions of the site. This will be achieved by establishing plantings in three broad habitats:

- Treeland and scrub (Table 3). These species will also be used for visual screening zones.
- Tussock shrubland mosaic (Table 4).
- Dryland herbfield (Table 5).

The intention is not to plant the whole of the site, but to establish these species and communities in appropriate areas where they can provide a seed source to naturally spread and become self-supporting on the site. Based on aerial imagery and site visits, planting habitats will be split proportionally as follows: The tussock shrubland mosaic will make up most of the planting (60%, approximately 60,000 plants over five years), while the treeland and scrub planting will be 30% (approximately 30,000 plants over five years), and dryland herbfield planting 10% (approximately 10,000 plants over five years).

The species selected have been chosen based on their appropriateness to the Mackenzie high country, their suitability to provide habitat for indigenous lizards and invertebrates, and the capacity to eco-source individual plants.

Treeland and scrub

Treeland and scrub planting aims to establish taller vegetation in the reserve, but within the confines of the historic vegetation cover of the site. In these areas clusters of taller vegetation will be planted, with species clumped together (e.g. groups of kōwhai or mountain toatoa) with shrubs and tussocks around the outside or occasionally intermixed (Tables 3 and 4). In general, to help suppress weeds this planting mix should be established on the convex bars with deeper soils and abundant exotic grass cover, or woody weeds (e.g. pines).



Table 3: Indigenous species suitable for treeland and scrub planting (and visual screening) within The Point reserve¹. This planting mix will constitute 30% of the total planting areas. Butterflies, moths, grasshoppers, crickets (including wētā), beetles, and spiders will benefit from all of these plantings.

Species	Common Name	Form (Threat Status*)	Notes
<i>Aristotelia fruticosa</i>	Mountain wineberry	Trees & Shrubs	Plant sparingly. Slow growing, small tree, can reach 9 m tall though often is shrublike. Tolerates wide range of soils and exposed site conditions, but establishes better with some cover. Beneficiaries: skinks and geckos. Some passerine bird species will also benefit.
<i>Chionochloa rigida</i> ssp. <i>rigida</i>	Narrow-leaved snow tussock	Grasses	Plant sparingly. Large tussock, medium growth rate, tolerant of a wide range of conditions, but prefers a well-drained soil. Beneficiaries: skinks, moths.
<i>Austroderia richardii</i>	Toetoe	Grasses	Plant generally. Hardy, prefers full sun or partial shade and well-drained soil, but grows well in riparian zones. Propagation easy from fresh seed and division of established plants. Beneficiaries: skinks, geckos, moths and beetles.
<i>Coprosma dumosa</i>	Mikimiki	Trees & Shrubs	Plant generally. Hardy, small shrub, can grow in range of conditions, but does best with some cover and deeper soil. Propagation easy from fresh seed, and semi-hardwood cuttings. Beneficiaries: skinks and geckos.
<i>Coprosma propinqua</i> var. <i>propinqua</i>	Mikimiki	Trees & Shrubs	Plant widely. Very hardy shrub, can grow in wide range of conditions. Beneficiaries: moths, spiders, beetles, flies, skinks and geckos. Some passerine bird species will also benefit.
<i>Corokia cotoneaster</i>	Korokio,	Trees & Shrubs	Plant widely. Very hardy to drought, wind and cold and can grow in rocky places. Widely cultivated species. Beneficiaries: skinks and geckos. Some passerine bird species will also benefit.

¹ Not all species listed need to be planted and species substitutions can be made provided they are ecological suitable and meet the eco-sourcing requirements.



Species	Common Name	Form (Threat Status*)	Notes
<i>Discaria toumatou</i>	Matagouri, tūmatakuru	Trees & Shrubs At Risk – Declining	Plant widely. Medium growth rate. Shrub growing to 2-3 m but can get taller. Propagation easy from seed. Fixes atmospheric nitrogen, making it available for other plants. Threats: under threat throughout the North Island, but stable in much of its South Island range. Beneficiaries: moths.
<i>Festuca novae-zelandiae</i>	Fescue tussock, hard tussock	Grasses	Plant widely. Tussock, very hardy, tolerates poor soils and dry conditions. Commonly sold by retail plant nurseries. Beneficiaries: moths, skinks.
<i>Muehlenbeckia complexa</i> var. <i>complexa</i>	Small-leaved pōhuehue, scrub pōhuehue, wire vine	Lianes & Related Trailing Plants	Plant widely. Climbing plant. Hardy, can grow in wide range of conditions. Provides habitats of insects and lizards Beneficiaries: moths, butterflies, beetles, flies, spiders, skinks and geckos.
<i>Olearia odorata</i>	Scented tree daisy	Trees & Shrubs - Dicotyledons	Plant generally. Shrub, medium growth. Very hardy, withstanding wind and drought conditions. Commonly sold by retail plant nurseries
<i>Ozothamnus vauvilliersii</i>	Mountain tauhinu, Cottonwood	Trees & Shrubs	Plant widely. Shrub, medium growth. Very hardy. Colonising species of dry, exposed sites.
<i>Poa cita</i>	Silver tussock	Grasses	Plant widely. Large tussock, rapid growth. Hardy and resilient, grows particularly well in dry, exposed sites and can adapt to poor soils. Beneficiaries: moths, skinks.
<i>Sophora microphylla</i>	Kōwhai	Trees & Shrubs - Dicotyledons	Plant generally. Tree, slow growth, can grow in deep soils or in rocky habitats. Propagation is easy from seed, also widely sold by retail plant nurseries. Important food source for indigenous birds. Beneficiaries: some bird species will benefit.
<i>Veronica odora</i>	Hebe	Trees & Shrubs - Dicotyledons	Plant generally. Shrub, medium growth. Hardy, prefers well-drained soils. Commonly sold by retail plant nurseries.

*Threat status is included where applicable.



Table 4: Indigenous species suitable for tussock shrubland mosaic planting within The Point reserve¹. This planting mix will constitute 60% of the total planting areas. Butterflies, moths, flies, grasshoppers, crickets (including wētā), beetles, and spiders will benefit from all these plantings.

Species	Common Name	Form (Threat status*)	Notes
<i>Aciphylla aurea</i>	Golden spaniard, golden speargrass	Herbs - Dicotyledons other than Composites	Plant generally. Large herb. Hardy, prefers dry well drained site. Tolerates rocky areas and frost/wind exposure.
<i>Aristotelia fruticosa</i>	Mountain wineberry	Trees & Shrubs	Plant sparingly. Slow growing, small tree, can reach 9 meters tall though often is shrublike. Tolerates wide range of soils and exposed site conditions, but establishes better with some cover.
<i>Austroderia richardii</i>	Toetoe	Grasses	Plant generally. Hardy, prefers full sun or partial shade and well-drained soil, but grows well in riparian zones. Propagation easy from fresh seed and division of established plants.
<i>Chionochloa rigida</i> ssp. <i>rigida</i>	Narrow-leaved snow tussock	Grasses	Plant sparingly. Large tussock, medium growth rate, tolerant of a wide range of conditions, but prefers a well-drained soil. Other <i>Chionochloa</i> species could be experimented with for enrichment (<i>C. macra</i> <i>C. rubra</i> <i>C. flavescens</i>). Propagation of these species is easy from fresh seed and the division of whole plants. However, can be slow growing and harder to establish, than <i>C. rigida</i>
<i>Clematis marata</i>	Clematis	Lianes	Plant sparingly (or supplementary planting). Vine, restricted to river terraces, rock outcrops and dry hillsides and scrub habitats.
<i>Coprosma dumosa</i>	Mikimiki	Trees & Shrubs	Plant generally. Hardy, small shrub, can grow in range of conditions, but does best with some cover and deeper soil. Propagation easy from fresh seed, and semi-hardwood cuttings.
<i>Coprosma propinqua</i> var. <i>propinqua</i>	Mikimiki	Trees & Shrubs	Plant widely. Very hardy shrub, can grow in wide range of conditions.
<i>Corokia cotoneaster</i>	Korokio,	Trees & Shrubs	Plant widely. Very hardy to drought, wind and cold and can grow in rocky places. Widely cultivated species.

¹ Not all species listed need to be planted and species substitutions can be made provided they are ecological suitable and meet the eco-sourcing requirements



Species	Common Name	Form (Threat status*)	Notes
<i>Discaria toumatou</i>	Matagouri, tūmatakuru	Trees & Shrubs At Risk – Declining	Plant widely. Medium growth rate. Shrub growing to 2-3 m but can get taller. Propagation easy from seed. Fixes atmospheric nitrogen, making it available for other plants. Threats: under threat throughout the North Island, but stable in much of its South Island range.
<i>Festuca novae-zelandiae</i>	Fescue tussock, hard tussock		Plant widely. Tussock, very hardy, tolerates poor soils and dry conditions. Commonly sold by retail plant nurseries.
<i>Halocarpus bidwillii</i>	Bog pine	Trees & Shrubs - Gymnosperms	Plant sparingly (or supplementary planting). Small tree or shrub, very slow growing. Mostly found in wetland margins, bogs, poorly draining heathland, but also dry, stony ground and tussock grassland. Propagation easy from seed but can be fickle. Not widely propagated or planted.
<i>Muehlenbeckia axillaris</i>	Creeping pōhuehue, creeping muehlenbeckia	Lianes & Related Trailing Plants	Plant generally. Hardy, Tolerant of hot, dry conditions.
<i>Muehlenbeckia complexa</i> var. <i>complexa</i>	Small-leaved pōhuehue, scrub pōhuehue, wire vine	Lianes & Related Trailing Plants	Plant widely. Climbing plant. Hardy, can grow in wide range of conditions. Provides habitats of insects and lizards
<i>Olearia odorata</i>	Scented tree daisy	Trees & Shrubs - Dicotyledons	Plant generally. Shrub, medium growth. Very hardy, withstanding wind and drought conditions. Commonly sold by retail plant nurseries
<i>Olearia nummulariifolia</i>		Trees & Shrubs - Dicotyledons	Plant generally. Shrub, medium growth. Very hardy, colonising species, withstanding wind and drought conditions.
<i>Ozothamnus vauvilliersii</i>	Mountain tauhinu, Cottonwood	Trees & Shrubs	Plant widely. Shrub, medium growth. Very hardy. Colonising species of dry, exposed sites.
<i>Phormium cookianum</i>	Wharariki, mountain flax	Grasses	Plant generally. Large grass, rapid growth. Hardy, remarkable tolerance to dry, cold, and exposed conditions. Commonly sold by retail plant nurseries.
<i>Pimelea prostrata</i> subsp. <i>prostrata</i>	Pinātoro, New Zealand daphne, Strathmore weed	Trees & Shrubs - Dicotyledons	Plant sparingly (or supplementary planting). Small shrub grows in well drained sites, open scrub, and low grassland, Propagation easy from semi-hardwood cuttings and rooted pieces. Seed is difficult to germinate.
<i>Poa colensoi</i>	Blue tussock	Grasses	Plant sparingly, small grass. Hardy, exposure tolerant, but highly palatable. Beneficiaries: moths
<i>Poa cita</i>	Silver tussock	Grasses	Plant widely. Large tussock, rapid growth. Hardy and resilient, grows particularly well in dry, exposed sites and can adapt to poor soils.



Species	Common Name	Form (Threat status*)	Notes
<i>Sophora microphylla</i>	Kōwhai	Trees & Shrubs - Dicotyledons	Plant generally. Tree, slow growth, can grow in deep soils or in rocky habitats. Propagation is easy from seed, also widely sold by retail plant nurseries.
<i>Sophora prostrata</i>	Prostrate kowhai	Trees & Shrubs - Dicotyledons	Plant sparingly, slow growing divaricating shrub. Hardy, very tough, grows on exposed, cold, dry sites.
<i>Veronica rakaiensis</i>	Hebe	Trees & Shrubs - Dicotyledons	Plant sparingly. Shrub, medium growth. Hardy, prefers well-drained soils. Commonly sold by retail plant nurseries.
<i>Veronica odora</i>	Hebe	Trees & Shrubs - Dicotyledons	Plant generally. Shrub, medium growth. Hardy, prefers well-drained soils. Commonly sold by retail plant nurseries.

*Threat status is included where applicable.



Table 5: Indigenous species suitable for selected dryland herbfield enrichment planting within The Point reserve¹. This planting mix will constitute 10% of the total planting areas. Grasshoppers, wētā, crickets, and moths will benefit from all these plantings. ** requires seed sourcing or propagation and is not currently offered by nurseries.

Species	Common Name	Form (Threat status*)	Notes
<i>Carmichaelia petriei</i>	Desert broom	Trees & Shrubs At Risk – Declining	Plant very sparingly. Dwarf native broom, grows river terraces, terrace risers, disturbed soils.
<i>Carmichaelia crassicaulis</i> <i>subsp. crassicaulis</i>	Coral broom	Trees & Shrubs At Risk – Declining	Plant very sparingly. Native broom found in upland and subalpine grassland, scrub and rock. Propagation is easy from fresh seed. Can be grown with some difficulty from semi hardwood cuttings. Dislikes humidity and once established should not be moved.
<i>Carmichaelia vexillata</i> **	Dwarf broom	Trees & Shrubs At Risk – Declining	Plant very sparingly. Dwarf native broom, grows on moraines, alluvium, river terraces, terrace risers, disturbed soils, and soils derived from schist parent material. Propagation is easy from fresh seed and semi hardwood cuttings. Threats: At threat from weeds and browsing animals which inhibit flowering and fruit set. However, it must be recognised that without browsing animals many of the habitats occupied by this broom would vanish due to weed regrowth. This species survival now requires a delicate balance of allowing some browsing to reduce weeds but not too much which will damage or even kill <i>Carmichaelia</i> .
<i>Coprosma petriei</i> **	Turfy coprosma	Trees & Shrubs	Plant sparingly. Mat forming coprosma found open, well-drained or rocky sites in tussock grassland or on moraine or gravel river flats. Once established can form extensive mats.
<i>Lepidium solandri</i> **	Maniototo peppercress	Herbs - Dicotyledons other than Composites Threatened – Nationally Critical	Experimental planting. Plant very sparingly, a small herb of short and tall tussock grassland, bare hillsides, salt pans, grey scrub and other poorly vegetated ground. Propagation is easy from fresh seed. Threats: Less than 1,000 plants are known in the wild. Few sites protected. All sites threatened by weed competition, animal browsing, and for most sites changes in land-use management.

¹ Not all species listed need to be planted and species substitutions can be made provided they are ecological suitable and meet the eco-sourcing requirements.



Species	Common Name	Form (Threat status*)	Notes
<i>Muehlenbeckia axillaris</i>	Creeping pōhuehue, creeping muehlenbeckia	Lianes & Related Trailing Plants	Plant generally. Hardy, Tolerant of hot, dry conditions.
<i>Muehlenbeckia ephedroides</i>	Leafless pōhuehue,	Lianes & Related Trailing Plants	Plant very sparingly. A ground cover species of river flats, outwash gravels and river terraces, also found in grey scrub. Favouring open, dry, free-draining but fertile sites, usually on gravel and sandy soils, in habitats naturally free from other taller plants. Propagation is easy from fresh seed, rooted pieces and semi-hardwood cuttings. Does not like much shade. Once established very drought tolerant.
<i>Raoulia australis</i> **	Mat daisy	Herbs - Dicotyledonous composites At Risk – Declining	Plant sparingly, mat daisy/cushion plant of drylands, riverbeds, open places, rocky ground, in grassland and fellfield. Threats: Habitat loss/modification through weed invasion and agricultural development (particularly irrigation and fertilisation of dryland habitats).
<i>Raoulia parkii</i> **	Celadon mat daisy	Herbs - Dicotyledonous composites At Risk – Declining	Plant sparingly, mat daisy/cushion plant of upland to subalpine open places, rocky ground, in grassland and fellfield. Propagation easy from rooted pieces. Likes freely draining soil and hot sunny conditions. Intolerant of humidity.
<i>Senecio dunedinensis</i> **		Herbs - Dicotyledonous composites Threatened – Nationally Endangered	Experimental planting. Plant very sparingly (or supplementary planting). Prefers shaded sites, under cover or amongst boulders, but has been gathered from open grassland. Propagation easy from fresh seed, best treated as an annual. Prefers semi-shade. Threats: Never common with an apparently naturally sporadic distribution.
<i>Styphelia nesophila</i> **	Pātōtara, dwarf mingimingi	Trees & Shrubs - Dicotyledons	Plant very sparingly. Low growing prickly sub-shrub ground cover species.

*Threat status is included where applicable.



Kānuka and mānuka, although historically part of the successional scrub communities in the Mackenzie Basin, have not been selected due to the high flammability of these species¹.

Tussock shrubland mosaic

Tussock shrubland mosaic is the main planting treatment that will be used. This is broad mosaic habitat that combines, shrubs, tussocks and grasses and a few herbs and trees (Tables 3, 4, and 5). Again, these plantings will combine species and 'vegetation type' clumping (e.g. swards of grasses/tussocks and clumps of shrubs planted together), with scattered intermixed planting. These planting should be established in areas with topsoil and abundant exotic grass cover – to help suppress these weeds.

Dryland herbfield (enrichment)

Dryland enrichment planting is intended as an experimental treatment to be implemented sparsely, in appropriate habitat, where it can be monitored and where necessary maintained. These species are generally low growing ground cover and mat forming species, that can easily be displaced by exotic weeds and grasses. Therefore, they should be established in dryland zones with skeletal soils, as this will limit the competition from exotic grasses and weeds. Within this planting treatment are several Threatened species, and species that can be difficult to establish, or not often used in restoration, which is why the treatment is experimental. The intention is to monitor the success of the species planted to learn what works and to focus future efforts on species that can be successfully established.

10.2 Restoration planting for lizards

Terrestrial skinks are more likely to occupy sites with increasing divaricating shrubs and vine cover (Wildland Consultants Ltd, 2024). In addition, geckos are likely to occupy sites with divaricating shrubs, and woody cover that provides additional refugia. Therefore, the plants chosen are those that provide a multitude of benefits to lizards (e.g. high levels of invertebrate biomass, nectar, and fruit as well refuge (Table 6). Enrichment planting can improve the functionality, habitat complexity, structural integrity, and sustainability of the ecosystem for lizards within The Point reserve through the addition of plants known to be beneficial to lizards that would naturally be present in this ecosystem. Suggested species consist of a mosaic of indigenous shrubs, grasses, and divaricating shrubs.

¹ Refer FENZ: <https://www.fireandemergency.nz/farms-rural-properties-and-rural-businesses/landscaping-with-low-flammability-plants/>

**Table 6–** Plant species recommended in Section 10.0 that are particularly beneficial for lizards, adapted from Herbert (2020).

Species	Recommended Habitat Type	Benefits to Lizards	Currently Present at Site (Y/N)	Beneficiaries	Growth Habit
Creeping pōhuehue (<i>Muehlenbeckia axillaris</i>)	Tussock shrubland mosaic	R, N, F, I	Y	Terrestrial skinks	Shrub
Tūmatakuru, Matagouri (<i>Discaria toumatou</i>)	Treeland and scrub, tussock shrubland mosaic	C, F	Y	Terrestrial skinks	Shrub
South Island toetoe (<i>Austroderia richardii</i> i)	Treeland and scrub, tussock shrubland mosaic	C, R, I	N	Terrestrial skinks	Tussock forming grass
Narrow-leaved snow tussock (<i>Chionochloa rigida</i> ssp. <i>rigida</i>)	Tussock shrubland mosaic	C, I,	N, but in ED description	Terrestrial skinks	Tussock grass
Mikimiki (<i>Coprosma dumosa</i>)	Treeland and scrub, tussock shrubland mosaic	C, F, N, I	N	Terrestrial skinks, geckos	Divaricating shrub
Mikimiki (<i>Coprosma propinqua</i> var. <i>propinqua</i>)	Treeland and scrub, tussock shrubland mosaic	C, F, N, I	Y	Terrestrial skinks, geckos	Divaricating shrub
Korokio (<i>Corokia cotoneaster</i>)	Treeland and scrub, tussock shrubland mosaic	C, F, N, I	N, but in ED description	Terrestrial skinks, geckos	Divaricating shrub
Fescue tussock, hard tussock (<i>Festuca novae-zelandiae</i>)	Tussock shrubland mosaic	C, R, I	Y	Terrestrial skinks	Tussock grass
Small-leaved pōhuehue, scrub pōhuehue, wire vine (<i>Muehlenbeckia complexa</i> var. <i>complexa</i>)	Treeland and scrub, tussock shrubland mosaic, dryland herbfield	R, N, F, I	N	Terrestrial skinks, geckos	Vine
Scented tree daisy (<i>Olearia odorata</i>)	Treeland and scrub, tussock shrubland mosaic	C, I	N	Terrestrial skinks, geckos	Divaricating shrub
Mountain tauhinu, Cottonwood (<i>Ozothamnus vauvilliersii</i>)	Treeland and scrub, tussock shrubland mosaic	C, I	N	Terrestrial skinks, geckos	Shrub
Silver Tussock (<i>Poa cita</i>)	Tussock shrubland mosaic	C, R, I	N	Terrestrial skinks	Tussock grass
Desert broom (<i>Carmichaelia petriei</i>)	Dryland herbfield	C, I, N	N, but recorded within 100m	Terrestrial skinks	Shrub
Coral broom (<i>Carmichaelia crassicaulis</i> subsp. <i>crassicaulis</i>)	Dryland herbfield	C, I, N	N	Terrestrial skinks	Shrub
Turfy coprosma (<i>Coprosma petriei</i>)	Dryland herbfield	I, N, C, F	N, but in ED description	Terrestrial skinks, geckos	Shrub/cushion/mat
Scab weed (<i>Raoulia australis</i>)	Dryland herbfield	R, C, N, I	Y	Terrestrial skinks, geckos	Cushion /Herb
Mat daisy (<i>Raoulia hookeri</i> var. <i>hookeri</i>)	Dryland herbfield	R, C, N, I	Y	Terrestrial skinks, geckos	Herb

Key to known benefits to lizards: C = Cover, R = retreats, N = nectar, F = fruit, I = invertebrates.



10.3 Restoration planting for invertebrates

The habitat values that are important for invertebrates within The Point reserve are described in Chinn (2024), and can be characterised into three main invertebrate microhabitats, summarised in Table 7.

Table 7 – Invertebrate microhabitats to restore at The Point reserve using the plant species recommended in Section 11.

Invertebrate Microhabitat	Invertebrates that Benefit Most	Vegetation Characteristics	Physical Characteristics that Benefit Invertebrates in this Habitat
Dryland herbfield	Grasshoppers and crickets (including wētā) that need open spaces to bask.	Short grasses and dryland herbs, mosses and lichens. Low plant density.	Open, sun-exposed areas with bare gravel, soil, and/or rock.
Tussock shrubland mosaic	Butterflies, moths, flies, grasshoppers, crickets (including wētā), beetles, and spiders.	Grasses and prostrate shrubs. Legumes and creeping pohuehue. Medium to high plant density.	A mixture of sun and shade, plants and bare rocks. Rock stacks to provide hides for predators such as beetles and spiders.
Treeland and scrub	Butterflies, moths, grasshoppers, crickets (including wētā), beetles, and spiders.	Taller grasses and shrubs, trees, legumes and creeping pohuehue. Medium to high density.	A mixture of sun and shade, plants and bare rocks. Rock stacks to provide hides for predators such as beetles and spiders.

The above invertebrate microhabitats should form patches throughout The Point reserve. Microhabitat characteristics such as vegetation species are flexible, aside from those specified in Table 7, and should vary. A suitably-qualified invertebrate ecologist should be consulted before the planting plan is finalised to ensure that sufficient and varied invertebrate habitat will be created.

11.0 Restoration planting schedule

11.1 Overview

This describes the methods that would generally be used for undertaking restoration plantings and covers the following:

- Plant sourcing:
 - Eco-sourcing of indigenous species.
 - Seed source lead time.
 - Plant size and quality.
- Planting.
 - General site preparation.
 - Plant layout and spacing.
 - Timing of planting.
 - Planting technique.
 - Plant protection.



11.2 Plant sourcing

Eco-sourcing of indigenous species

The use of 'eco-sourced' indigenous plants is best practice in ecological restoration planting. Eco-sourcing is the propagation of indigenous plants from seeds (or sometimes cuttings) that have been collected from naturally occurring indigenous vegetation that is both as near to the restoration site as possible, and as similar ecologically as possible, i.e. *Coprosma* planted in a dryland environment should be grown from seed collected from *Coprosma* found in a dryland. The aim is to maintain local genetic lineages for those species planted, and to increase the likelihood that the plants will be adapted to site conditions.

Plants will be eco-sourced from Arawhenua Native Nursery and Restoration, which is run by Ngā Tahu, and Wai-ora Nursery.

Seed source lead-in time

The majority of the species selected are readily available or easy to source through Arawhenua Native Nursery and Restoration, however, due to the quantity of species required, some species may require a year or more of lead-in time.

Several novel species are proposed for the enrichment planting, which will not be usually eco-sourced or stocked by plant suppliers. Seed or propagule locations for these species will need to be identified as early as possible, and sourced at least one year in advance. The use of local plant suppliers who have worked in the Mackenzie before, with existing concessions to collect seed from DOC land is recommended. If new concessions are needed, the lead time will be longer.

Plant size and quality

- RX90 (or similar) grade plants will be used.
- We will ensure that all nursery grown tree, shrub, and grass species used in the treeland and mosaic planting are a minimum of 20 centimetres tall and trees and shrubs have a root collar/basal stem diameter of at least three millimetres. All plants will have a well-developed root ball that fills the pot, without overfilling and being root-bound. This will make sure that the plants are sufficiently robust to survive the first growing season. Visual assessments of the suitability of ground cover and enrichment planting species should be undertaken by the contractor.
- All plants will be hardened off (exposed to sun, wind and temperatures that are similar to the climatic conditions at the site) by the plant nursery prior to planting.
- All plants will be free from pests and diseases.

Care of stock between the nursery and planting

Plants will 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 plants prior to planting will be built. This will also protect temporarily stored plants from browsing animals such as rabbits, possums, and livestock. Note that plants that undergo drought stress prior to planting, have a much higher chance of mortality within restoration sites.



11.3 Planting

General site preparation - treeland and scrub, tussock shrubland mosaic

Within the treeland and scrub, tussock shrubland mosaic planting areas – site-preparation spot-spraying will be undertaken to kill exotic ground-cover vegetation and create places for planting. Blanket spraying of the planting area must not be undertaken, as it risks the invasion of that area by pest plants (Porteous, 1993), overspray damaging adjacent indigenous drylands, and harm to invertebrates, particularly grasshoppers (T. Murray, pers. comm). Planting areas have been chosen where exotic plant species (mostly grasses) dominate, and indigenous plant species are largely absent. However, where indigenous species are found, they will be avoided. Site preparation and planting will take place no less than 1.5 metres from naturally occurring indigenous plants or communities. Sprays will not use spray additives (such as dyes, penetrants or surfactants), and will not be applied adjacent to bare stony ground patches, to minimise risk to Threatened and At Risk grasshopper species which are highly sensitive to agrichemical sprays.

11.4 Plant layout and spacing

Sedge, grass and shrub species will be planted at 1.0 metre spacings. Tree species will be planted at 1.5 metre spacings. Planting at these spacings will help ensure that a dense canopy quickly forms, thereby reducing competition with exotic grasses and pest plants.

11.5 Timing of planting

The planting windows in the Mackenzie Basin are shorter than other areas. Planting will need to take place in early autumn (March–April), once summer-dry conditions have passed and ideally six weeks before the very cold winter temperatures arrive. Or, in mid spring (generally October) after the most of the hard frosts have finished, but there is still adequate soil moisture to allow the plants to establish before dry summer conditions return. The region is prone to drought and other weather extremes and assessment of planting suitability will be made prior to undertaking any planting.

11.6 Planting technique

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

- Ideally all planting will be undertaken by experienced workers in accordance with recognised industry best practice. If volunteers would like to contribute, they will be briefed and thoroughly supervised to ensure correct planting techniques are used.
- Care will be taken to ensure that the root ball is not excessively disturbed during container removal or planting.
- The planting hole will 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.
- The root ball will be covered by a thin layer of soil. This will prevent it being exposed to the air and drying out.
- If the root ball looks dry it will be immersed in a bucket of water until all air bubbles are gone. Then, it will be lifted out and allowed to drain before planting.
- If plants start to show signs of water stress (e.g. wilting leaves), watering will be carried out to reduce plant losses.



11.7 Plant protection

Newly-planted trees and shrubs can be decimated by browsing by rabbits, possums, or feral browsing animals (e.g. deer, goat, wallaby), so protection against browsing is critical.

- Individual plant guards will 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 will be removed once the plants are large enough to outcompete surrounding exotic vegetation.
- Weed mats will be used to retain moisture, reduce soil temperature fluctuations, and suppress pest plant growth (Dollery *et al.*, 2018).
- We recommended using cardboard plant guards. The cardboard plant guard is robust, biodegradable and resilient, but are more expensive. Due to the wind exposure on the site, cheap and light weight plastic guards should be avoided.
- Suggested weed mats are Eco-wool Mulch Mats (250 millimetre).

11.8 Planting maintenance

For the first two years following planting, the plantings will be maintained 1-3 times per year, with maintenance needs assessed during the first maintenance trip. Annual maintenance trips should be scheduled for the following three years. During these visits, plants will be released (weeding around plantings) from exotic vegetation by the spraying of herbicide in a 30cm radius ring around each guard to ensure they are not outcompeted by surrounding exotic vegetation. 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 significantly.

Watering

The planting window in the Mackenzie Basin is very limited and rainfall can be fickle. Therefore, watering maybe required initially (first two years) why plants are establishing, to avoid high mortality rates.

The need for watering should considered prior to any planned maintenance, with climatic conditions monitored. Water will need to shipped on site with a tanker. Watering can be done by hand (knapsack), or broom spraying from a truck, but this needs to be well directed so as to not inadvertently water weeds.

11.9 Infill planting

Infill planting to replace plants that have died may be required and should be undertaken in years two and three 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.

Supplementary plantings of indigenous climbing species, especially those in the genera *Rubus*, *Clematis*, and *Muehlenbeckia*, should be considered once the initial restoration plantings form a canopy (3-5 years after initial planting). These species should be planted at a density of 15-20 plants per hectare.



12.0 Pest plant control methods

The proposed reserve is currently relatively free of significant weed and pest plant infestations. However, there are still a few wilding pines, as well as broom and sweet briar. Areas where these larger woody weeds are present will be targeted for treeland and scrub planting. Where woody weeds are controlled, they should be left to die *in situ*, or cut stacked (i.e. do not remove), as they will provide shelter to surrounding plantings that are establishing. Broom, gorse, and other weeds that propagate vegetatively will not be left *in situ* unless they have been killed by herbicide, as otherwise they will regrow.

Pest plant control methods will include:

- Herbicide control (e.g. drill and fill, foliar spray, cut and paint). Penetrant or surfactant is **not to be used** with any herbicide application.
- Manual removal (hand-pulling small seedlings).
- Combination methods (e.g. manual and herbicide to avoid damage to indigenous biodiversity).

Pest plants will be controlled using the most effective and appropriate control methods, ensuring that any control causes minimal damage to indigenous plants (and fauna), especially Threatened and At Risk species. It is essential that pest plant control staff are suitably trained and experienced, to ensure that pest plants are accurately identified and indigenous species are not accidentally targeted or damaged during control work.

Each pest plant infestation should be assessed for the best control option, which depends on the size and maturity of the infestation, the situation it is growing in, and any information/advice received from Council and/or the Department of Conservation (see Appendix 1 for different types of control methods). Pest plant control will only be carried out during the appropriate seasons when pest plants can be more easily identified and targeted for control, and control is likely to be most effective (i.e. during the growing season for deciduous species). All control will follow manufacturers' guidelines, current best practice procedures, and NZ Standards of agrichemical management (NZS8409:2021). Signs will need to be erected to notify the public during pest plant control works.

13.0 Proposed experimental restoration methods

The aim of the experimental restoration is to use adaptive management to inform future decisions and develop ecological restoration strategies that are less expensive and self-sustaining, and can be used across the wider Mackenzie Basin landscape, to improve the quality and integrity of the indigenous dryland habitats.

The dryland grassland and herbfield habitats are representative of remnant outwash plain habitats found across the Mackenzie Basin and are among the most degraded habitats in this unique environment. However, the level of pest control and restoration planting currently proposed will not be sufficient to cover and restore the whole remnant outwash plain in the reserve. Therefore, it is suggested that within unplanted areas, with very low ecological values (as determined by the detailed mapping), that two experimental restoration actions are implemented.

13.1.1 Grazing

Indigenous shrubland and grassland require different management techniques. For example, grazing by sheep may be beneficial to indigenous dryland grasslands and herbfields, keeping vegetation short, which also benefits fauna such as Threatened and At Risk grasshoppers. In contrast, year-round grazing



adversely affects shrubs while grazing in spring and summer may benefit some shrubs by controlling rank grass.

Some unplanted areas are recommended to be periodically grazed (spring and summer), to suppress the exotic grass. These grazed areas should be monitored to identify the impacts and benefits of grazing, and the learnings from this monitoring used to inform grazing management within the reserve. Monitoring should be undertaken by a suitably qualified ecologist.

13.1.2 Soil disturbance scarification

Disturbance is also a natural and important feature of dryland environments (Rogers *et al.*, 2005) and there is evidence that mechanical, or artificial disturbance can be used to facilitate indigenous regeneration process, in these environments (Hutchison *et al.*, 2020).

Once the detailed mapping has been completed, small areas with low ecological value (e.g. swards of exotic grass) should be selected for scarification. Ideally these would be close or even next to areas of indigenous dryland habitat, or planting, that could provide a seed source for regeneration.

It is suggested that initially ten scrape sites are implemented, five shallow (just top soil removed) and five deep (topsoil and subsoil removed to create hollows). Both scrape techniques will result in some soil mounding on the ends (or edges); this should be left in place as a feature and wind break.

It is essential that a ground survey is undertaken by a suitably qualified ecologist before implementing any scarification treatments in the reserve.

14.0 Vegetation Monitoring

Regular monitoring of The Point reserve will be undertaken by a suitably qualified ecologist so that:

- Management can be adapted 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 weeds or pest plants can be identified and managed.
- Pest mammal control can be adapted as required.

After the initial five years, long-term monitoring of vegetation changes at the site would be useful 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.

Monitoring should be conducted using a range of methods including:

- UAV orthomosaic photo monitoring (Section 14.1.1).
- Walk-through surveys to monitor:
 - Plant health (e.g. die back and disease).
 - Location of weeds and pest plants (GPS waypoints).
 - Pest mammal sign (browsing damage, scat, paw prints etc.).



14.1.1 UAV orthomosaic photo monitoring

Monitoring the success of restoration management actions and establishment of indigenous planting within The Point reserve is important, as this will be informative not only for this site but also other restoration projects in the Mackenzie Basin.

Traditional photopoint monitoring (i.e. using markers and a hand-held camera) has high potential for human error and bias associated with it. The use of Unmanned Aerial Vehicles (UAVs) to monitor vegetation offers significant improvements over traditional photopoint assessment methods. UAVs use calibrated high-resolution sensors, pre-programmed flight paths for consistent framing, and high-precision GPS for accurate location tracking. Additionally, UAVs can efficiently assess plant health over large areas, identifying issues such as stress or disease.

UAV photopoint monitoring methods

Different drone pilots use different methods, but the following methods have been used successfully by Wildlands and would be appropriate for The Point reserve.

Using a DJI Mavic 2 Pro with a Hasselblad L1D-20c camera, systematic aerial surveys with pre-programmed flight paths are developed in the DroneDeploy software. High-resolution orthomosaic maps of the site are then created by stitching together multiple high-resolution aerial images taken by the UAV, with the drone's camera calibrated to ensure minimal distortion in the captured images.

Using photogrammetry algorithms to align and stitch the individual images together, common points (features) are recognised among images and matched. The GPS data from the drone's onboard system is then used to georeference each image. Orthorectification is also applied, which corrects image distortions caused by terrain variation or camera angle, ensuring all objects in the map appear in their true, top-down position, as if they were viewed from directly above (an orthogonal view). The resulting map is geographically and geometrically accurate. The corrected images are then blended together seamlessly into a single, large, high-resolution map, an orthomosaic, which can be imported into GIS software. Since these maps are orthorectified, they can be used for precise measurements (e.g. distances, areas, etc.).

14.1.2 Weed and pest plant surveillance

Pest plant monitoring and surveillance should be carried out across the entire site by an ecologist (or a suitably trained/experienced person) annually and this should be ongoing until all restoration goals are achieved. This is necessary to determine if novel pest plants are establishing, or previously controlled pest plants (e.g. pine trees), are re-establishing. Finding and controlling pest plant infestations before they become established is the most cost-effective control method. Therefore, surveillance needs to feedback into the ongoing management and inform restoration work as and when it is undertaken.

Ongoing monitoring will also be required to assess the effectiveness of any pest plant control undertaken. Some species, particularly long-lived, woody plants (e.g. pine, gorse, broom), can resprout after control and may require several applications of herbicide (over several growing seasons) to kill them. Weed infestations should be monitored for at least every 1-2 years following the initial control work, as follow-up treatment may be required.



15.0 Pest mammal control

Pest mammals, along with habitat loss, are the largest cause of biodiversity loss within Aotearoa New Zealand. On braided rivers in Canterbury, pest mammals threaten vegetation, lizards, terrestrial invertebrates, and birds. To protect lizards and invertebrates, controlling mice in particular is important.

The Point reserve presents a distinct opportunity to control pest mammals for the benefit of local ecology, without the general public or domestic pets being a concern.

15.1 Overview

Pest mammal management at The Point will utilise control, using a combination of traps and poison to reduce pest mammal activity, and monitoring by suitably qualified ecologists, to gauge the success of the control methods and identify points of weakness for improvement. Pest management will cover the entire site, but focus on The Point reserve. A rabbit proof fence will be installed around the perimeter of the The Point site.

After surveying to assess which pest mammals are present at the site, a more detailed pest mammal management plan will need to be prepared by a suitably-qualified ecologist prior to control and monitoring being undertaken.

15.2 On-site hazards

The main hazards present on-site are livestock, non-target wildlife captures, and the Tekapo and Twizel rivers. All methods of pest mammal control must consider these hazards at all stages, from planning to implementation. Some considerations are listed here, but these are not exhaustive and common sense must prevail.

Livestock

Sheep are likely to graze under the solar panels, and may be periodically grazed within parts of The Point reserve to manage exotic grass within dryland habitat. Traps and poisons in bait stations are unlikely to affect sheep, but some of the larger traps may injure curious lambs. Any scattered poison may be ingested, preventing the sheep from being slaughtered for human consumption until a withholding period has been observed. Bait stations will therefore be empty while stock are grazing in the same enclosure.

Non-target wildlife

Birds will be discouraged from using The Point reserve, but they should still be considered as potential non-target bycatch in traps. Birds may place their heads in traps if they are curious or suspect food is there. Bird excluders will therefore be applied where necessary, and traps placed above 70 cm off the ground where possible. Kārearea may be attracted to poisoned mammals that are still alive and have taken a sublethal dose. Kahu may be attracted to feed upon poisoned carcasses. Therefore, poison selection should ensure rapid biodegradation and minimal risk of secondary poisoning. The risk of a sublethal dose should be minimised by prefeeding and selecting appropriate poisons for the target species.

Rivers

The Tekapo and Twizel rivers must not be contaminated by carcasses or poison. Local and national legislation must be followed with regards to pest mammal control near water. All traps and bait



stations should be placed at least 20 metres from the edge of the river, so that dead animals and poison cannot fall into it even if the river is high. Animal carcasses should be collected and burned every time the traps and bait stations are checked to avoid them building up and attracting scavenger birds such as kahu.

15.3 Pest mammal control goals

The following goals are oriented towards improving ecological values at The Point and should be applied using a robust and enduring pest management plan:

- Reduce pest mammal numbers: reduce the abundance of pest mammals within The Point reserve, and maintain them at low levels. Monitoring of pest mammal relative abundance and activity will inform this.
- Enhance indigenous biodiversity: protect and support the regeneration of indigenous plant species to provide a habitat with more refugia for indigenous lizards and insects. This will be reflected in monitoring results for indigenous flora and fauna.

15.4 Pest mammal control extent

The Point reserve is a long, thin strip with a small area to perimeter ratio, making it unsuitable for pest mammal control without a predator proof fence. If pest mammal control were restricted to The Point reserve, reinvasion by pests would be continuous, meaning reaching pest control goals would be highly unlikely. Therefore, the pest mammal control methods suggested here encompass the entire site, to provide buffering control to The Point reserve.

15.5 Pest mammal species present

Currently, no pest mammal control or monitoring is taking place on-site. However, Table 8 shows species of pest mammals that are typical of the location and habitat on-site, and their likely impacts. Impacts on birds are not described, as restoration of habitats Threatened and At Risk indigenous avifauna is not a focus within The Point reserve. However, pest mammal control at The Point may benefit surrounding avifauna populations, by lowering predator numbers in the immediate vicinity.

Ungulates, such as deer and pigs, are sometimes seen in surrounding areas but are unlikely to be permanently present on-site.

15.6 Pest mammal survey and monitoring

Before a pest mammal control plan can be more specifically designed, a survey must be undertaken to assess which pest mammals (Table 8) need to be managed. This should include tracking tunnels, wax tags, and visual observations. A suggested layout of monitoring devices is provided in Figure 3.

Methods and device layout used in the survey will be replicated for monitoring pest mammals. Monitoring should be undertaken by a suitably qualified ecologist.

The most important indication of successful control of brushtail possums, rabbits and hares will be a reduction in browse damage to existing indigenous plants, and restoration plantings. Therefore, browse damage should be recorded as a part of walkthrough vegetation surveys (see Section 14.1.2).

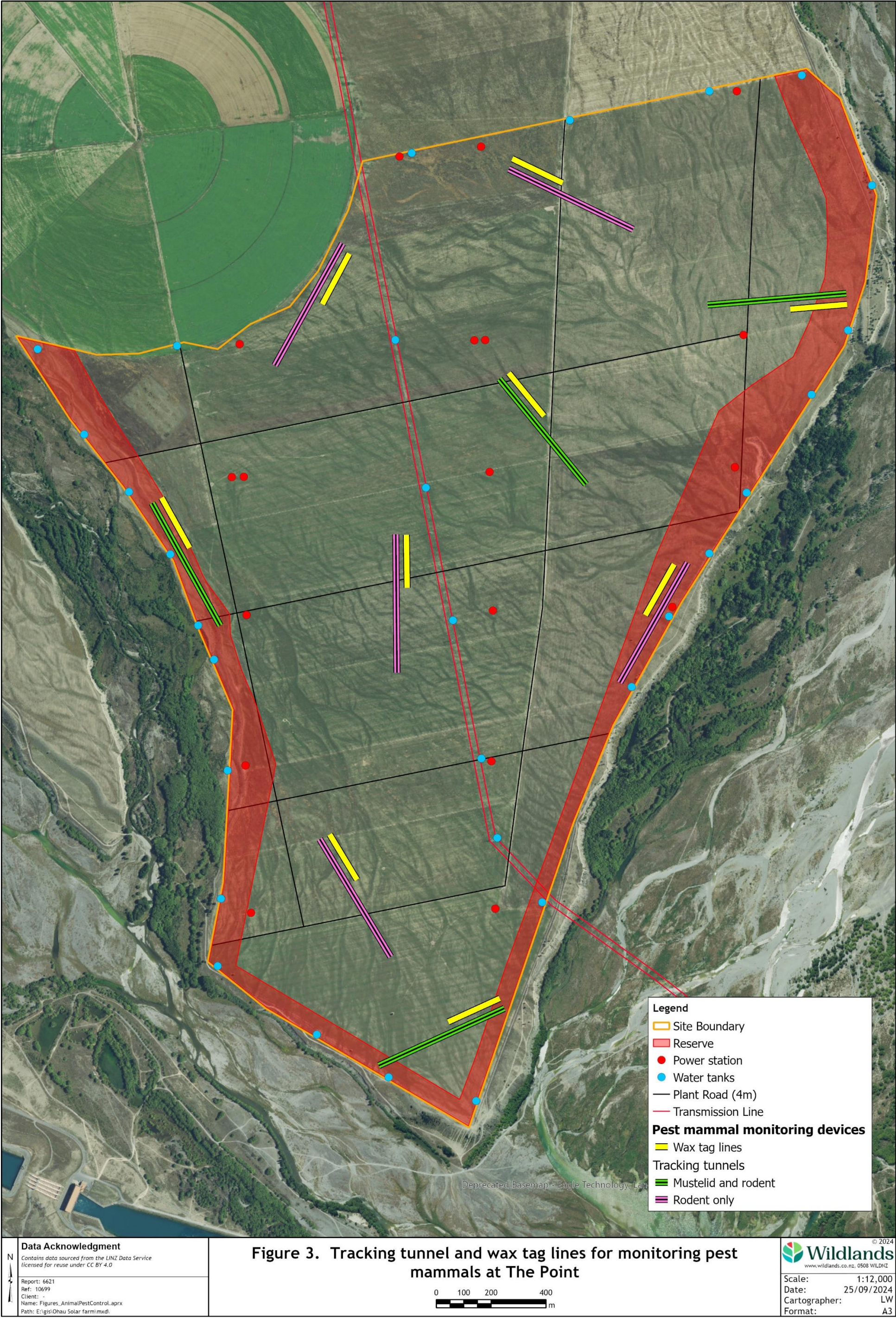
In addition to this, pest mammal activity should be monitored annually, following the start of control, using the same wax tag and tracking tunnels lines, twice a year (in spring and autumn). The results will



show the progress of the pest mammal programme over time and allow adjustments to be made if needed based on activity levels and species detected.

**Table 8 – Pest mammals that may be present at The Point.**

Common Name	Scientific Name	Likelihood of Presence	Impacts
Norway rat	<i>Rattus norvegicus</i>	Almost certain	Norway rats eat seeds, lizards, and invertebrates.
Ship rat	<i>Rattus rattus</i>	Almost certain	Like Norway rats, ship rats eat seeds, invertebrates, and lizards. They are adept climbers, so can easily access arboreal species.
Mouse	<i>Mus musculus</i>	Almost certain	Mice eat seeds, invertebrates, and lizards. They can be extremely hard to control, and if their populations increase as a result of controlling cats, weasels and other predators, mice can have devastating impacts on lizards and invertebrates.
Least weasel	<i>Mustela nivalis vulgaris</i>	Likely	Weasels mainly eat mice, but will often kill invertebrates and lizards.
Ferret	<i>Mustela furo</i>	Almost certain	Ferrets primarily eat rabbits, but will often eat lizards.
Stoat	<i>Mustela erminea</i>	Almost certain	Stoats prey upon lizards and invertebrates, and will take prey much larger than themselves.
Hedgehog	<i>Erinaceus europaeus</i>	Almost certain	Hedgehogs primarily prey upon invertebrates and lizards.
Feral cat	<i>Felis cattus</i>	Almost certain	Feral cats prey upon invertebrates and lizards. They also eat rodents, rabbits, and mustelids. They are highly mobile with large home ranges, and they can climb trees to access arboreal species.
Brushtail possum	<i>Trichosurus vulpecula</i>	Almost certain	Possums destroy indigenous foliage as they are primarily herbivorous, but they also eat eggs, chicks, and invertebrates. They are highly mobile and can target bird nests in trees.
European rabbit	<i>Oryctolagus cuniculus</i>	Almost certain	Rabbits destroy habitat by digging through the ground and eating indigenous plants.
European hare	<i>Lepus europaeus</i>	Almost certain	Hares damage indigenous vegetation by chewing it.
Red-necked wallaby	<i>Macropus rufogriseus rufogriseus</i>	Likely	Wallabies damage indigenous vegetation, particularly growing shoots, by feeding.





Corrected trap catch (catch per 100 trap nights, or C/100TN) from the deployed kill traps, and bait take from bait stations will also be useful methods for monitoring pest mammal abundance (Cross *et al.*, 1998; Hubert & Fabrizio, 2007).

15.6.1 Tracking tunnels

A tracking tunnel survey should be conducted in either spring or autumn. Tracking tunnels detect rodents, mustelids, hedgehogs, and sometimes other species. They also often detect lizard and wētā presence. Nine tracking tunnel lines should be placed around the site (Figure 3). Each line consists of ten tracking tunnels spaced 50 m apart. After they have been *in situ* for three weeks, they will be loaded with ink cards and baited with peanut butter for rodents and left for one fine night. The next day all cards should be retrieved and replaced. Every other tunnel along the mustelid and rodent lines (four lines coloured green in Figure 4) should be baited with fresh rabbit and left for three fine nights for mustelids.

Tracking tunnel cards should be analysed and tracking data entered into a spreadsheet. The tracking tunnel index (TTI) will be calculated for every species as a percentage tracking, averaged over the whole site (Gillies & William, 2013).

15.6.2 Wax tags

A wax tag survey should be run at the same time as the tracking tunnel survey. Ten unflavoured wax tags should be placed 20 metres apart as shown on Figure 4, attached to wooden stakes where no other upright attachment point is available. The wax tags should be left out for seven fine nights before checking them for possum chews and calculating the Wax Tag Index (WTI) to assess possum activity (National Pest Control Agencies, 2015).

15.6.3 Observations

Whenever any person is working or travelling around the site, they should make a note of any observations of feral cats or other pest mammals and their locations. Over time, an approximation of pest mammal activity levels, and any hot spots of activity can be made. When the pest control programme is implemented, it will consider all observations of pest mammal activity.

15.7 Pest mammal control options

15.7.1 Overview

The device types and control methods implemented at The Point will depend on the species detected during the pest mammal survey and ongoing observations. The devices in Table 9 are suggested based on the landscape, hazards, and suspected species present, but the devices and their layout in the final plan should be decided in consultation with a suitably-qualified ecologist. Where funding constraints restrict the number of devices available, priority must be given to controlling pest mammals in the reserve. Rat and mouse baiting is only necessary within the reserve, but mouse control is essential to protect lizards and invertebrates (Samaniego *et al.*, 2024; Watts *et al.*, 2022).

15.7.2 Rabbit-proof fencing (if funds become available)

Rabbit-proof fences are known to be able to exclude unwanted mammal pests from areas, which include rabbits, hares and hedgehogs. The latter are significant predators of lizards, especially in dryland sites. While best practice hedgehog control is currently being developed, there is no current standard for best practice control. Constructing rabbit-proof fences may therefore provide protection for lizards, increasing their abundance, as well as increasing invertebrate abundance and flora recovery (food and cover).

**Table 9** – Recommended pest mammal control devices and their implementation at The Point reserve.

Pest Mammal Control Device	Target Pest	Recommended Bait	Spacing Along Lines	Distance Between Lines in Intense Control Zone	Estimated Check Frequency
Trapinator	Possum	Possum dough ¹	Wherever trees or fence posts are available, at least 50 metres apart	Wherever trees or fence posts are available, at least 100 metres apart	Once per month.
Timms	Possum	Apple half	50 metres	100 metres	Once per month.
Romark bait station	Possum	Encapsulated cyanide ² in prefeed matrix	50 metres	50-100 metres	Once per night for three fine nights, no more than once every three years, when no stock is present.
Run-through bait station	Rat, mouse	Diphacinone blocks	50 metres	50 metres	Only necessary in the reserve. Focus on mouse habitat and rock stacks for lizards and invertebrates. Requires pulsing, four four-week pulses per year in August, November, February and April (approximately).
DOC-series traps	Mustelid	Fresh rabbit or hen eggs	200 metres	400 metres	Once per fortnight September-March; once per month March-September.
SA2 Kat Trap	Feral cat	Fresh rabbit	400 metres	500 metres	Once per fortnight September-March; once per month March-September.
Rabbit-proof fence (Section 15.7.2)	Rabbits, hares, hedgehogs	N/A	N/A	N/A	N/A
Rabbit and hare shoots	Rabbits, hares	N/A	N/A	N/A	As needed when rabbit numbers are high.
Magtoxin	Rabbits	N/A	N/A	N/A	As needed when burrows are discovered.

¹ Sourced from Traps.co.nz² Controlled substances licence (CSL) required.



16.0 Research opportunities

The Point reserve presents a unique opportunity to study the effects of cost-effective restoration practices and minimal ongoing maintenance over a large area of land. In particular, BACI studies of lizard and invertebrate enhancement initiatives would be useful. The potential presence of At Risk and Threatened plant, lizard and invertebrate species also presents research opportunities into effects management and conservation for these species. Conservation for many species may require translocations, and The Point reserve may be a good location for studying translocation methods and effects. Its position in an exposed dryland environment makes it a good candidate for research into restoring threatened landscapes, and the effects of climate change on these highly valuable places.

17.0 Discussion and recommendations

The Point reserve has the potential to be an exemplar of cost-effective, large-scale high-country restoration, presenting opportunities for habitat creation, species conservation, and research. After surveying habitat types and undertaking lizard and invertebrate surveys, restoration of plant communities and habitats can begin. This EEP presents a synergy of best practice methods backed up by research, with some recommended experimentation, where best practice is lacking or could be developed further.

Next steps for Stage 2: Implementation of habitat enhancement are:

1. Map all habitats within The Point reserve using a UAV.
2. Conduct baseline surveys for lizards and invertebrates.
3. Identify lizard and invertebrate populations off-site to use as controls.
4. Monitor on-site and off-site lizard and invertebrate populations.
5. Survey for pest mammals.
6. Control pest mammals.
7. Create a robust grasshopper reserve.
8. Create and maintain lizard habitats.
9. Plant suitable plant species in a mosaic throughout The Point reserve.
10. Manage pest plants.
11. Monitor plant growth and lizard and invertebrate populations.

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Appendix 1

Pest plant control methods

The use of herbicide needs to be restricted to avoid any potential grass hopper habitat (e.g. open bare ground and low herbfield vegetation). Penetrant or surfactant is **not to be used** with any herbicide application.

Pest plant control should be carried out during appropriate seasons when pest plants can be more easily identified and targeted for control. Different pest plant control methods are described below, but the exact method to be used on each plant will depend on the species, and its growth stage and location when the control is carried out (refer Weedbusters¹ for more information). Where necessary, e.g. if seeds are present or as directed, pest plants or seed heads could be bagged and left in secure areas on-site to rot inside the bags, to ensure seeds are not spread. These could be removed from sites, as required, subject to permit requirements for pest plants designated as Unwanted Organisms under the Biosecurity Act 1993.

Manufacturers' guidelines, current best practice procedures, and NZ Standards of agrichemical management (NZS 8409:2021) will need to be followed. All mixing of chemicals, and cleaning and refuelling of equipment must be carried out greater than 20 metres from surface water bodies, and care will be taken to minimise the risk of spillage. The amount of herbicide used should be minimised by favouring more direct and manual methods over foliar spraying.

Cut Stump and Treat

This method is used to control woody pest plants and larger climbers that have woody stems, e.g. pines, gorse, broom, sweet briar, trunks/stems of the plant are cut close to the ground and herbicide immediately applied to the stump. Herbicide used is either gel-based, in an applicator bottle, or a liquid in a small handheld spray bottle. This is generally recommended for woody pest plants between 0.5 metres and 3.0 metres high. For old man's beard all cut sections need to be left off the ground (e.g. by hanging in adjacent vegetation), with large plants having a one metre section of trunk removed to prevent aerial roots from taking root in the soil.

Drill and Fill

This method is used on trees and large woody pest plants, e.g. large pines. The method is particularly good for large specimens, and involves drilling holes around the trunks and lower stems of the plants, at regular intervals, and immediately injecting herbicide into the holes. The dead trees can remain standing for quite some time (can be years) and this can help to reduce new pest plants establishing beneath them, and can be valuable where tree habitat is needed for indigenous fauna in areas where the indigenous trees have not yet established.

Frilling

This method is used on trees and woody pest plants, e.g. large pines. A chainsaw is used to make a deep cut into the sapwood at regular intervals around the base of the tree, taking care not to ring-bark the plant. Herbicide is then immediately applied to the cuts.

Foliar Spray

This method is used on various pest plants, e.g. cocksfoot (*Dactylis glomerata*), or small tree and shrub saplings. This is effective for large patches of a pest plant, particularly seedlings, and isolated plants, where there are no

¹ Weedbusters: <https://www.weedbusters.org.nz/>



immediately adjacent indigenous species. Foliar spray would be applied evenly to the plants, ensuring good cover is achieved. This method cannot be carried out when rain is imminent and/or during windy periods.

Hand Pulling (Non-Herbicide Manual Control)

This method is effective to use on seedlings and small plants of any of the pest plant species, provided that the entire plant and root system can be removed to ensure that re-sprouting does not occur. If plants are heavily laden with seeds (e.g. Russel lupin, *Lupinus polyphyllus*), then seedheads should be cut off and bagged as described above, before hand-pulling.

Monitoring and Data Records

All staff should carry handheld GPS units to track their movements during pest plant control works, and record points of interest including pest plant locations or infestations. This will ensure that all necessary areas are covered and pest plants encountered. In some areas control work should be carried out in a grid formation (e.g. willow forest) to ensure all areas accurately covered.

Selected data can be collected during pest plant control works, such as staff persons present, general weather conditions, ground covered during the work (via GPS tracking), pest plant species controlled and control method, new pest plant infestations located, new hazards encountered and health and safety incidences. This information will help track work that is occurring and identify possible areas for improvements, and could be collated into a spreadsheet for analysis, or (if required), regular reporting. Follow-up control, monitoring of works carried out, and surveillance for new pest plant infestations needs to be undertaken on an ongoing basis.

Call Free 0508 WILDNZ
Ph +64 7 343 9017
Fax +64 7 349018
ecology@wildlands.co.nz

99 Sala Street
PO Box 7137, Te Ngae
Rotorua 3042, New Zealand

Regional Offices located in Auckland; Christchurch;
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