ASSESSMENT OF POTENTIAL ECOLOGICAL EFFECTS OF THE PROPOSED NOVA ENERGY SOLAR FARM NEAR TWIZEL

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EXECUTIVE SUMMARY

Ecological surveys of vegetation, habitats, and plants, lizards, birds, and terrestrial invertebrates were undertaken in the summers of 2022-2024 across a proposed solar farm site on outwash plains between the Ohau River and Twizel River, south of Twizel in the Mackenzie Basin.

The site has largely been cultivated and mostly supports improved pasture or exotic vegetation, but small areas of uncultivated outwash plain support indigenous vegetation, which have been excluded from the proposed development area. Scarps run across the north and down each side of the site, and these are critical habitats for indigenous biodiversity values including populations of Threatened and At Risk plants, lizards, and invertebrates.

Important biodiversity values at the site include:

- Seven plant species classified as At Risk or Threatened.
- Eight Threatened and nine At Risk avifauna species may be present at the site.
- Three lizard species have been confirmed at the site, including two At Risk species and one Not Threatened species.
- Four notable terrestrial invertebrate species occur at the site.
- An ephemeral wetland is located in the north of the site, and other wetlands are located on an alluvial terrace on the eastern side of the site.

In general, these biodiversity values are located on the margins of the site. On-site options to address non-avoidable adverse effects are available.

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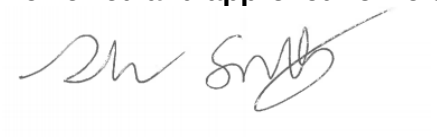

Des Smith
Director, Senior Principal Ecologist, South Island Regional Manager
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1. INTRODUCTION

Nova Energy is proposing to develop a solar energy farm east of Twizel township (Figure 1). Nova Energy commissioned Wildlands Consultants to assess the ecological features and values present at this site and identify potential ecological effects associated with the proposed solar farm, using a combination of both desktop and field-based methods. Measures have been developed by which to avoid, remedy or mitigate potentially adverse effects, as well as methods for monitoring ecological outcomes. Offsetting and compensation are not required as the residual effects after avoidance and other effects management are considered to be no more than minor.

2. METHODS

2.1 Desktop assessment

Vegetation and Habitats

Relevant existing information was collated and assessed.

Avifauna

A desktop assessment for avifauna was carried out using the online bird database eBird (maintained by Cornell University). All species with records within five kilometres of the proposed solar farm were reviewed (January 2021 and January 2023).

Herpetofauna

Department of Conservation BioWeb Herpetofauna Database records within 20 kilometres of the site were assessed.

Freshwater Fauna

A desktop assessment of freshwater fauna in the area was undertaken using the New Zealand Freshwater Fish Database (Stoffels 2022), which is hosted by NIWA and accessed online. Records from the Twizel and Ōhau rivers adjacent to the proposed site were assessed, along with any records from connected waterways within the surrounding area. The presence of dams and hydro-generation structures was taken into consideration, as these pose significant barriers to fish movement throughout the waterways in this area.

Terrestrial Invertebrates

A desktop assessment of terrestrial invertebrates was undertaken using the Global Biodiversity Information Facility GBIF[1]. GBIF data was filtered using a polygon covering the site of the proposed development as well as an area encompassing a five kilometre radius around the site. Insecta, Mollusca, Arachnida, and Chilopoda were

[1] https://www.gbif.org/

included as species filters. Freshwater species (primarily mayflies/Ephemeroptera) were deleted from the data set.

2.2 Field assessment

Vegetation, Habitats, and Flora

Field surveys were undertaken on 8 and 9 December 2022, 19 December 2023, and 23 and 24 January 2024. Vegetation and habitat types were identified and mapped (using aerial photography) and described following the structural classes of Atkinson (1985). Hard copy field mapping was digitised using ArcGis10.8.

Locations of Threatened and At Risk species were recorded using a hand-held GPS unit (refer Table 1). All vascular plant species observed are listed in Appendix 1.

Avifauna

A site visit was undertaken on 14 and 15 December 2022. Due to the large size of the site, four discrete continuous transects were evaluated to ensure that all habitat types were surveyed and to encompass as much of the area as possible. All bird species seen or heard while walking each transect were also recorded, and any additional species detected while travelling between the separate transects were recorded as incidental counts. The location of any Threatened or At Risk species within the site were recorded using a hand-held GPS unit. Bird species using the waterways adjacent to the site were also recorded (Table 3).

Lizards

Two lizard surveys of the site were undertaken.

Survey 1

An initial site visit that was undertaken on 16 December 2022, during which 74 artificial cover objects (ACOs) were placed along six transects in lizard habitat throughout the site. A habitat assessment was also undertaken during this first site visit. Incidental lizard encounters were recorded.

A survey of the ACOs was subsequently undertaken over four days (three nights) in warm conditions (*c.*23°C) between 27 February and 3 March 2023. ACOs were checked daily between 7:30 am and 1:00 pm, to avoid the hottest part of the day.

Additionally, limited manual and visual searching was undertaken. Manual searching consisted of lifting rocks or other debris (e.g. pieces of wood) to detect lizards within refuges. Visual searching consisted of slowly walking through talus slopes looking for basking skinks.

Survey 2

A site visit that was undertaken between 3-4 October 2023 to set up 120 ACOs at the site. ACOs were set up along the east-west fence line through the centre of the site.

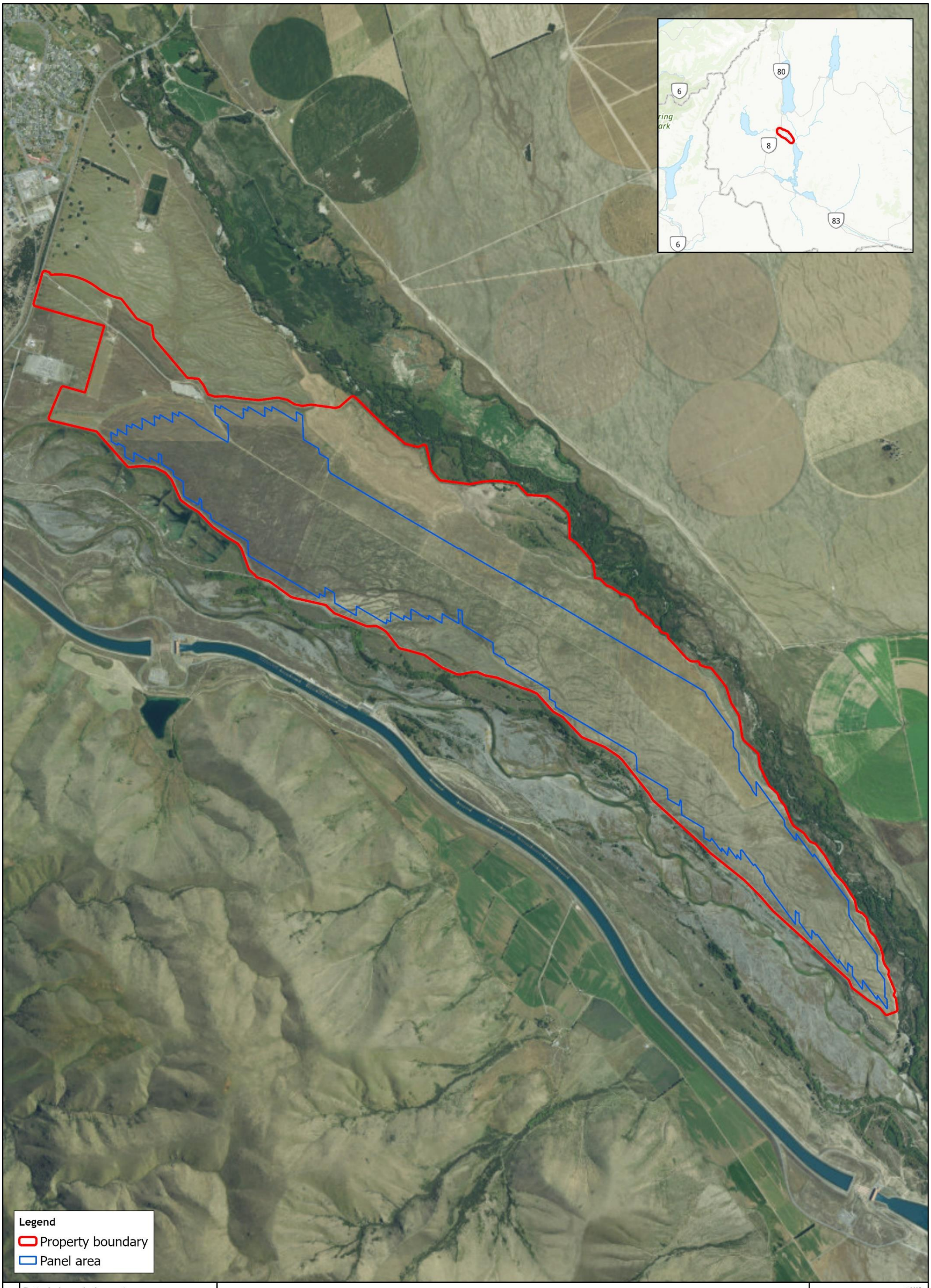

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Figure 1. Location of the proposed solar farm site

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A lizard survey was subsequently undertaken between 18-23 December 2023 using the ACOs, as well as Gee's minnow (funnel) traps and visual and manual searching. Twenty-five funnel traps were set up on 18 December, and an additional 25 traps were set up on 19 December.

Traps were set up in an area of old river terrace and talus, at the base of an area of scarp herbfield and grassland in the central southern part of the site. During the previous lizard survey of the site, lizards were detected in this area in high abundance (i.e. within complex rock piles at the base of the scarp), and it was considered possible that Lakes skink may be present in this habitat. Therefore, funnel traps were set up partially buried within rock piles, to increase the likelihood of capturing Lakes skink. All funnel traps were baited with Berry Bliss (The Natural Confectionery Co.) and grass was added to protect any lizards caught from predation and desiccation.

Funnel traps and ACOs were checked daily over five days in hot conditions (*c*. 25°C) between 19-23 December and removed on 23 December 2023. ACOs were checked between 8:00 am and 1:00 pm to avoid the hottest part of the day. Limited manual and visual searching was undertaken in areas of rock piles.

Terrestrial Invertebrates

Invertebrate survey methods are summarised in Figure 2.

General invertebrate survey

Initially, three field visits were undertaken for a general invertebrate field survey: 28 February and 1 and 3 March 2023. A total of approximately 16 hours was spent searching the site for any notable terrestrial invertebrates. The survey included searching for potential habitats for minute grasshopper (*Sigaus minutus*; Threatened-Nationally Vulnerable) and short-horned grasshopper (*Phaulacridium otagoense*; At Risk-Declining), which were both identified in the desktop survey as possibly being present. A sweep net was used to capture flying and jumping insects for identification.

Targeted grasshopper and wētā survey

Targeted grasshopper and Tekapo ground wētā surveys were conducted in summer 2023. The full methodology is described in the report (Wildland Consultants, 2024a). Methodology was based on the robust grasshopper population monitoring transect protocol developed by Schori *et al.* (2020), with guidance from T. Murray (pers. comm.), adapted for presence-only detection. Live-capture pitfall traps were used to detect presence of Tekapo ground wētā.

Fifteen transects were established on-site on the 19 and 20 December 2023. Transects were approximately 100 m long, estimated using the GPS receiver. Transects were distributed throughout potential grasshopper habitat.

Each transect was walked five times in weather conditions suitable for robust grasshopper activity (temperature exceeding 14°C, winds below gale-force, no precipitation; Schori *et al*. 2020). Any habitat patches encountered between transects were briefly searched.

Three sets of five live-capture pitfall traps were deployed to detect Tekapo ground wētā. Traps consisted of the typical standard lidded cup design used for invertebrates, with a hole drilled in the bottom of each cup and baited with a small piece of canned pear. Each trap was left out for two nights and checked every day.

If minute grasshoppers were found in any transect, or if Tekapo ground wētā were found in any line of pitfall traps, that transect or line of pitfall traps would be discontinued as presence of Threatened species had been determined.

Tekapo ground wētā tracking tunnel survey

After confirming the presence of Tekapo ground wētā on-site, a methodology was designed to use tracking tunnels to find out more about their distribution throughout the site. Methodology was based on previous studies where tracking tunnels have been used to detect and monitor wētā (primarily giant wētā; e.g. Watts et al. 2011). The full methodology is described in the report (Wildland Consultants, 2024b).

The tracking tunnel survey was carried out in April 2024 during fine, sunny weather with cold, clear nights. Black TrakkaTM tracking tunnels with ready-inked cards were used. Tinned pear was used as bait, as it has been used in live-capture pitfall traps for Tekapo ground wētā (T. Murray, pers. comm).

Six tracking tunnel transects were run across the whole property (Figure 2). Each transect consisted of ten tracking tunnels spaced 50 metres apart to give good coverage of the site while minimising the potential for double-counting the same individual Tekapo ground wētā. Tracking tunnels were left out for two nights.

Prints on tracking cards were analysed to identify which animals had used the tunnels. Prints made by insects were sorted into wētā prints, potential wētā prints, and other insect prints. Since wētā species cannot be reliably discerned from prints alone, and Tekapo ground wētā are the most likely ground wētā species of their size to be on the property, all large wētā prints were considered likely to be Tekapo ground wētā. Potential wētā prints were similar to wētā prints but smaller. They are likely to indicate insects with similar footprints, juvenile Tekapo ground wētā, or other, smaller wētā species.

Prints from mice and hedgehogs were also recorded for the interests of pest mammal monitoring and control (Section 10).

Unmanned aerial vehicle (UAV) survey

After minute and Otago short-horned grasshopper were both confirmed on-site, a UAV survey was commissioned to better understand the distribution of their habitat on-site. The survey took place in November 2024 and mapped as much of the habitat that had not been walked through as possible, where minute and Otago short-horned grasshopper habitat had been found or were suspected. Some areas could not be mapped due to legal constraints (proximity to aerodrome) and the logistics of mapping such a large area.

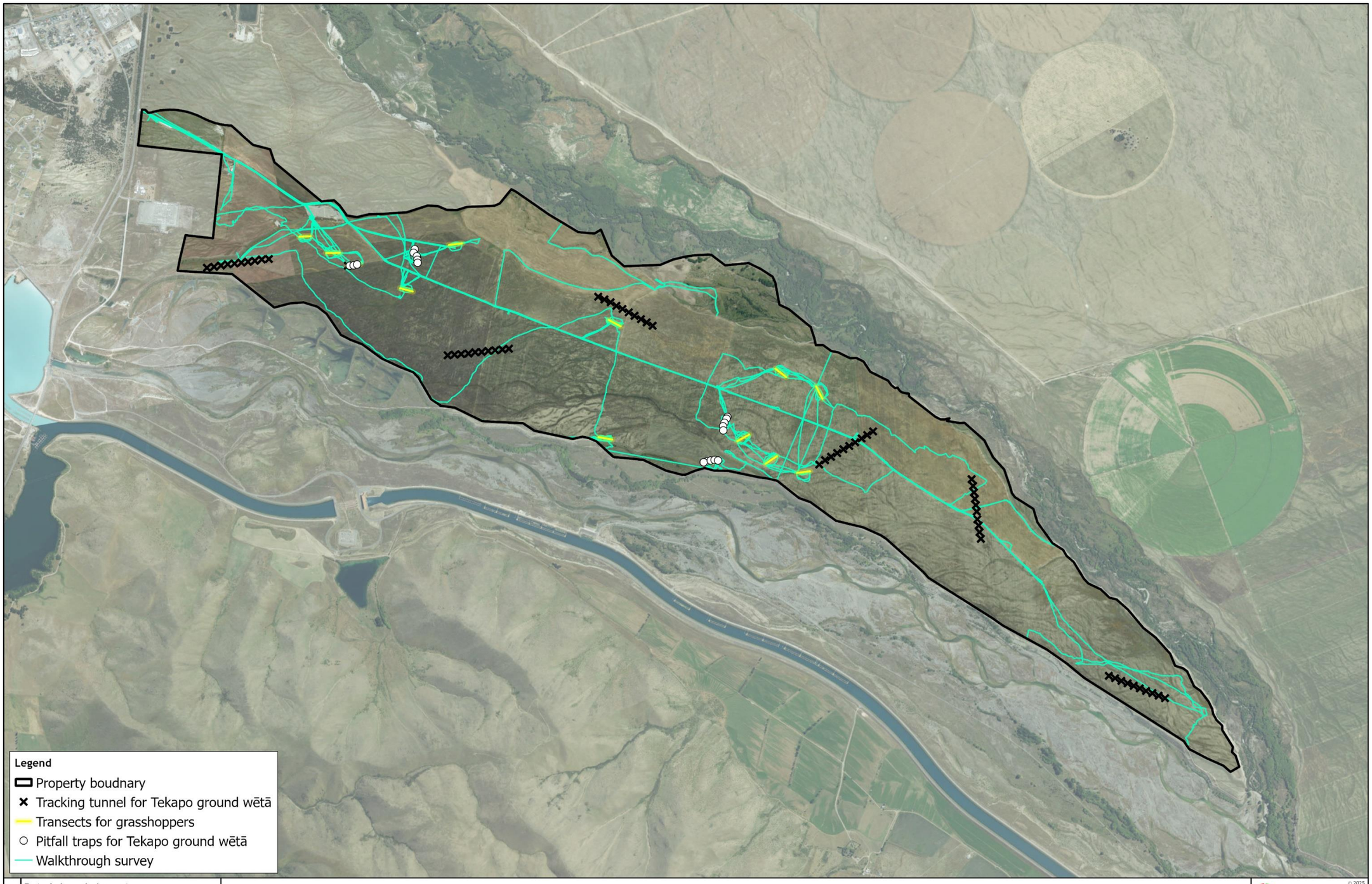

Figure 2. Terrestrial invertebrate surveys previously conducted at the proposed solar farm site in Twizel

The UAV photographs were examined for potential habitat, characterised by yellow to red patches (denoting dry plants) mottled with white or pale brown (denoting bare ground, rocks, or sparse plant cover). These areas were then mapped to assess the distribution of potential habitat for minute and Otago short-horned grasshoppers on-site.

The UAV survey is also described in the Terrestrial Invertebrate Management Plan (Wildland Consultants, 2025a).

2.3 Statutory context

2.3.1 Ecological significance

Ecological values at the site were assessed against the ecological significance criteria in the Canterbury Regional Policy Statement (CRPS; Appendix 2), and the Mackenzie District Plan.

Areas of ecological significance in Canterbury are areas of vegetation or habitats that meet one or more of the criteria listed in Appendix 3 of the Canterbury Regional Policy Statement (CRPS). The CRPS criteria set can be used to assess significance of indigenous vegetation and habitat of indigenous fauna against 10 criteria within four categories:

- Representativeness
- Rarity or distinctive features
- Diversity and pattern
- Ecological context

2.3.2 Wildlife Act

All indigenous lizards, most indigenous birds, and some indigenous invertebrates, are protected under the Wildlife Act (1953). It is an offence to disturb or destroy protected wildlife without a Wildlife Act Authorisation (WAA; also known as a wildlife permit) from the Department of Conservation. A permit must be obtained from the Department before any protected wildlife (and/or their habitats) can be disturbed, handled, translocated or killed, including the lizards considered in this report. Because of these requirements, provisions for the management of indigenous fauna provided in this report need to be considered within the context of the Wildlife Act (1953).

2.3.3 Mackenzie District Plan

Relevant rules and definitions outlined in the operative Mackenzie District Plan relate to indigenous vegetation and vegetation clearance. It should be noted that these rules and definitions are currently under appeal as part of Plan Change 18 of the Mackenzie District Plan. Vegetation and habitat types present at the site were assessed against the operative definitions for indigenous vegetation and the definition of improved pasture, to assess whether they are subject to vegetation clearance rules.

The Mackenzie District Plan also stipulates limits on activities adjacent to wetlands.

The site was assessed in relation to these rules.

2.3.4 Natural wetlands

Natural wetlands are identified according to the Resource Management Act (RMA; 1991) and the National Policy Statement for Freshwater Management (NPS-FM; 2020). The RMA defines wetlands as "permanently or intermittently wet areas, shallow water, and land/water margins that support a natural ecosystem of plants and animals that are adapted to wet conditions".

A natural inland wetland is defined in the operative NPS-FM as a wetland (as defined in the Act) that is not:

(a) In the coastal marine area; or
(b) A deliberately constructed wetland, other than a wetland constructed to offset impacts on, or to restore, an existing or former natural inland wetland; or
(c) A wetland that has developed in or around a deliberately constructed water body, since the construction of the water body; or
(d) A geothermal wetland; or
(e) A wetland that:
    i. Is within an area of pasture used for grazing; and
    ii. Has vegetation cover comprising more than 50% exotic pasture species (as identified in the National List of Exotic Pasture Species using the Pasture Exclusion Assessment Methodology (see clause 1.8)); unless
    iii. The wetland is a location of a habitat of a threatened species identified under clause 3.8 of this National Policy Statement, in which case the exclusion in 9e) does not apply.

Development within 100 metres of areas classified as wetlands is restricted in some circumstances under the NES-FM. The vegetation and habitats on the site and within 100 metres of its boundaries were evaluated for wetland status. Our assessment did not formally delineate these areas, but noted where such areas may trigger this definition.

3. ECOLOGICAL CONTEXT

3.1 Pukaki Ecological District

The proposed solar farm site is located within the Pukaki Ecological District (McEwen 1987), which 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. Pasture now occupies much of this Ecological District, with some tussockland and areas of indigenous scrub (matagouri, coprosma, kōwhai, and corokia) remaining. Significant grazing impacts are due to the effects of sheep and rabbits. The braided riverbeds provide important habitat to a number of bird species, and there are also notable rare insect species in the area.

3.2 Nearby protected areas

The Lake Ruataniwha Conservation Area surrounds much of the proposed solar farm site, made up of several discrete areas of land. One area lies along most of the Twizel River side of the proposed solar farm property, with another area on the Ōhau River side nearest to Lake Ruataniwha. The Ben Ōhau Conservation Area is approximately five kilometres to the north and the Glenbrook Conservation Area is approximately 10 kilometres to the south (Figure 3).

3.3 Sites of natural significance

An area along the Ōhau River is identified as a Site of Natural Significance in the Mackenzie District Plan, primarily for its avifauna habitat values, as well as areas of wetland. It extends along the Ōhau river from Lake Benmore into, and including, parts of Lake Ruataniwha and its margins (Figure 4). There are two locations where this area overlaps with the boundary of the proposed solar farm property.

3.4 Threatened environment classification

The proposed solar farm development is within a land environment that is classified as >30% indigenous cover left with <10% protected (Figure 5). This means that it falls into the threatened environment classification of being 'poorly protected' but also not strongly threatened by historic loss.

3.5 Land cover database

Various land cover types have been mapped in the New Zealand Land Cover Database[1] for the potential solar farm site. Most of the area is described as depleted grassland with smaller areas of high-producing and low-producing grassland also present. Patches of exotic hardwood trees are present along river margins.

3.6 Inland outwash gravels

Inland outwash gravels (or outwash plains) are a historically rare ecosystem type and a critically endangered ecosystem (Williams *et al.* 2007, Holdaway *et al*. 2012). The majority of the site has been mapped as an outwash plain or terrace formed in the latest late Otiran glacial stage. Outwash plains are located in intermontane basins and are characterised by gravels which are well drained and result in low nutrients, supporting sparse vegetation (Manaaki Whenua 2023, Barrell *et al.* 2011).

3.7 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 New Zealand's braided rivers occur in Canterbury. The braided rivers of the Mackenzie Basin drain into the Waitaki river. The braided rivers and wetlands of the upper Waitaki Basin are subject to active restoration

[1] https://lris.scinfo.org.nz/layer/104400-lcdb-v50-land-cover-database-version-50-mainland-new-zealand/

under “Project River Recovery” This programme is run by the Department of Conservation and funded by Meridian Energy and Genesis Energy under a compensatory agreement that recognises the impacts of hydroelectric power development on these rivers and wetlands (DOC 2020).

3.8 Notable hydro scheme modifications

The proposed solar development site is in close proximity to several hydropower stations which are part of the larger Waitaki hydro scheme. This scheme comprises 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. Development of this hydro scheme has resulted in notable modifications to the surrounding environment due to the construction of dams, formation of lakes (e.g. Lake Benmore), and diversion of water through canals, drastically altering hydrological regimes of the rivers in the Mackenzie basin. Construction of dams has also hindered the movement of aquatic species through the river system.

The site lies alongside the Ōhau B and C canals, which connect Lake Ruataniwha and Lake Benmore, and are associated with two power stations (Ōhau B and Ōhau C).

3.9 Hydropower inundation areas

Parts of the proposed solar farm property fall within the hydroelectricity inundation hazard area identified in the Mackenzie District Plan This includes a large area along the northern side of the property, and a smaller area on the southern side. These areas are recognised as those at risk of inundation due to the unlikely event of a dam or canal breach only and do not reflect any natural hazards, for example flooding from rivers.

3.10 Current and recent land use

The site is currently operating under a farm lease arrangement, predominantly as cropping and sheep grazing. The area is subdivided into fenced paddocks and some have been used for hay/baleage production. Most of the site has been cultivated by direct-drilling, and this has led to a widespread distribution of improved pasture species across the site, Table 9 provides a breakdown of indigenous vegetation, exotic vegetation and improved pasture at the site.

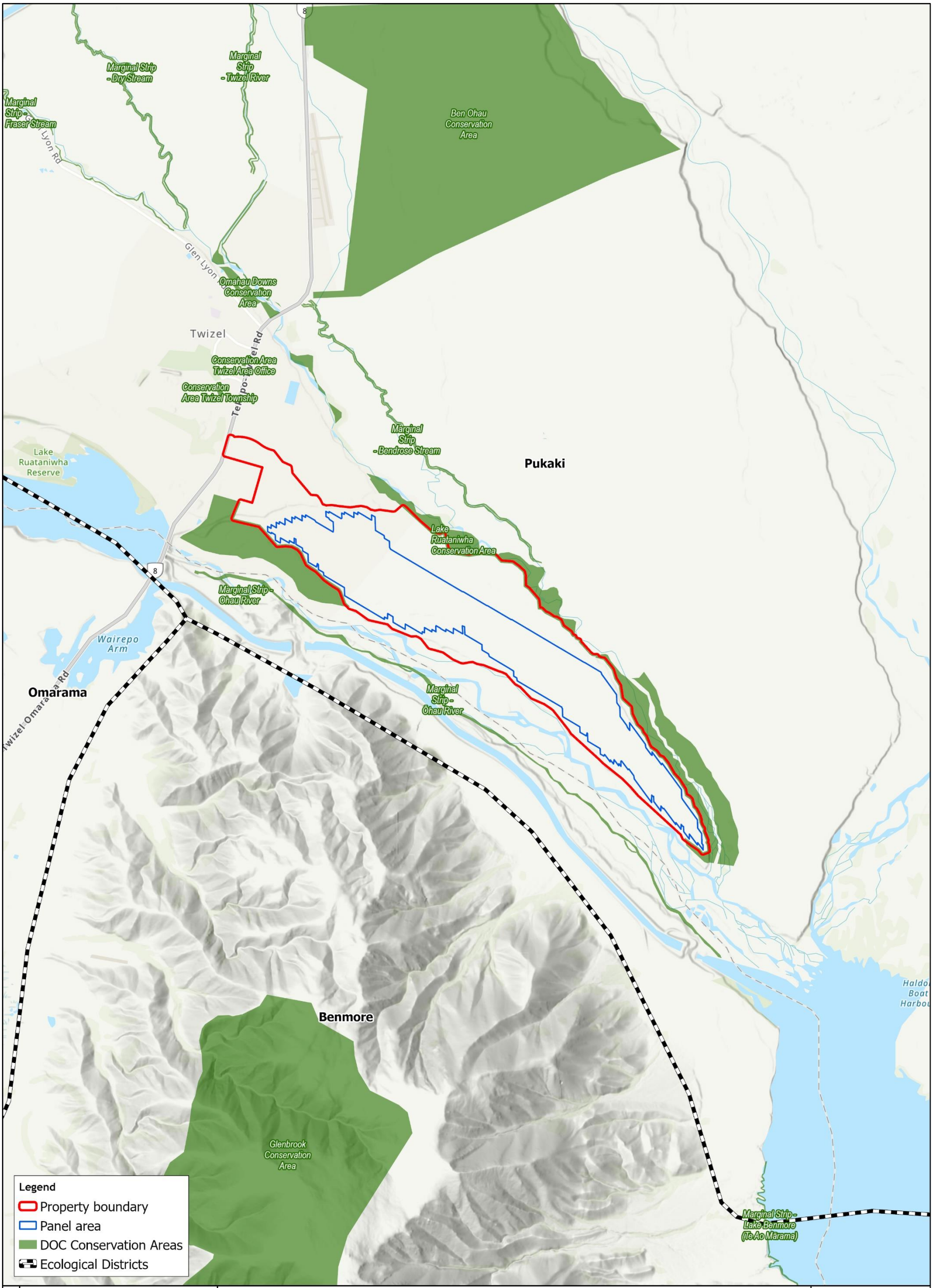

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Figure 3. Protected areas in the vicinity of the site

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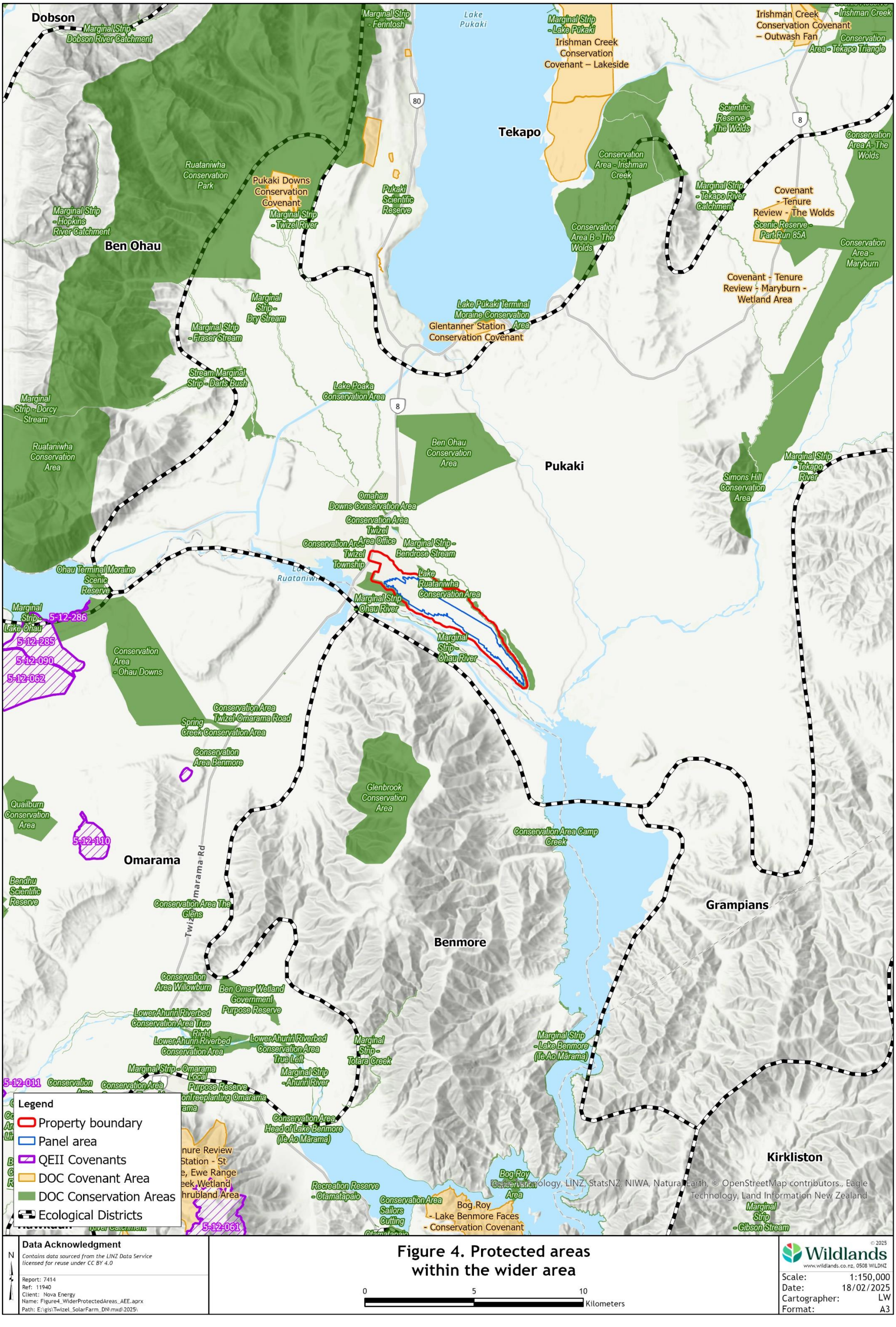

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Figure 4. Protected areas within the wider area

0 5 10 Kilometers

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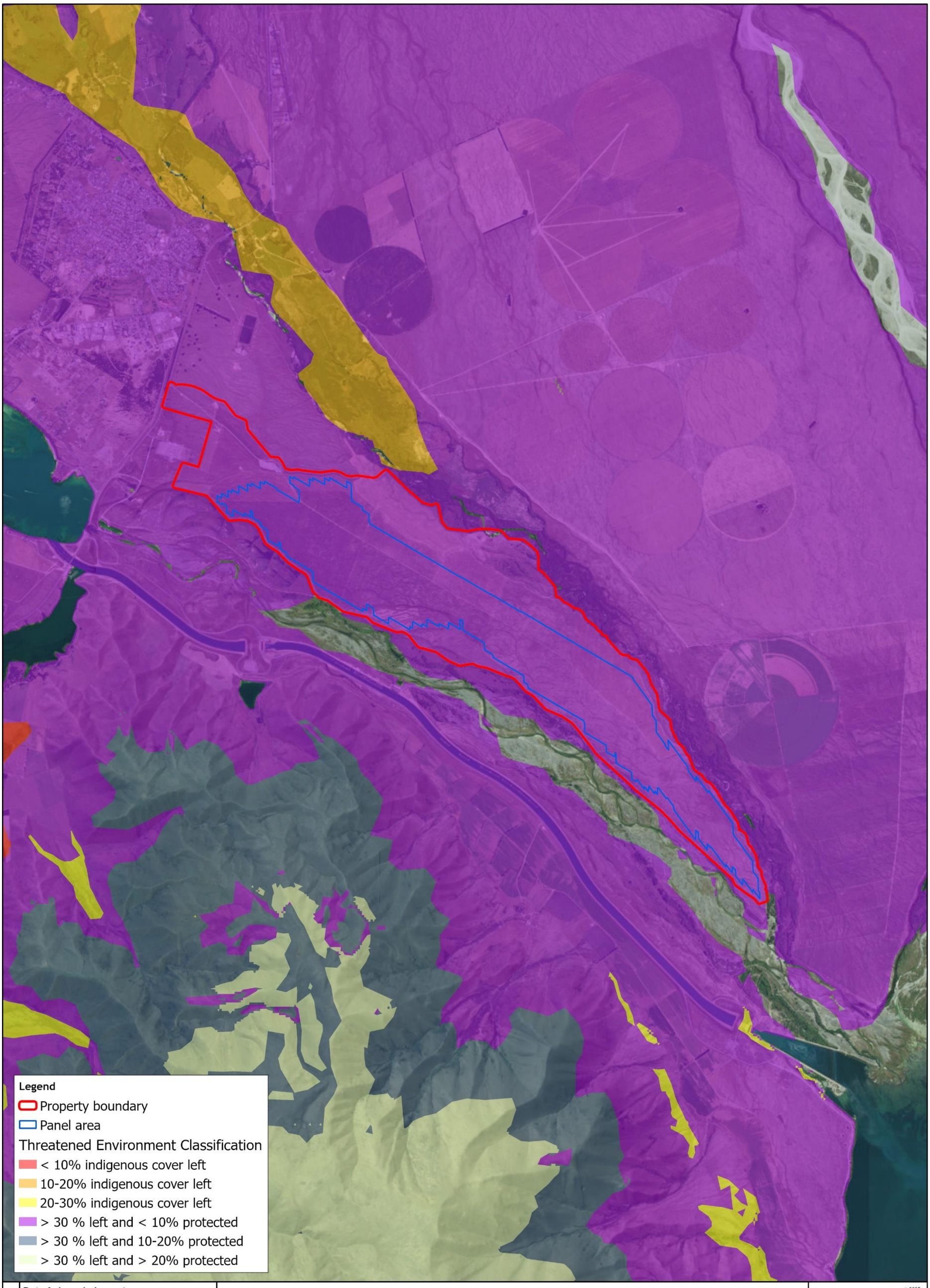

Figure 5. Threatened Environment Classification of the site

4. VEGETATION AND HABITATS

4.1 Overview

Fifteen vegetation and habitat types were identified at the site:

Terrestrial Habitats

1. Flood channel shrubland (1.2 hectares)
2. Sweet briar shrubland (22.4 hectares)
3. Browntop-sweet vernal-clover grassland (488.3 hectares)
4. Alluvial grassland (35.7 hectares)
5. Scarp herbfield and grassland (10.2 hectares)
6. [Wilding conifer]/scarp herbfield and grassland (4.2 hectares)
7. Sweet vernal-mouse-ear hawkweed herbfield and grassland (2.9 hectares)
8. Hares foot trefoil-sweet vernal- grassland (5.3 hectares)
9. Old river terrace (8.1 hectares)
10. Haresfoot trefoil herbfield (272.3 hectares)
11. Earthworks and quarrying (3.5 hectares)

Wetland Habitats

12. Ephemeral wetland (0.1 hectares)
13. Tall fescue- rautahi marsh (2.1 hectares)
14. Alder forest (1.9 hectares)
15. Crack willow forest (0.8 hectares)

These vegetation/habitat types are described below and mapped in Figure 6.

4.2 Vegetation and habitat types

4.2.1 Terrestrial

1. Flood channel shrubland

Shrubland is present along a seasonally wet flood channel in the northeastern part of the site. The indigenous shrub tūmatakuru/matagouri (*Discaria toumatou*) is common along edges with occasional exotic woody species such as elder (*Sambucus nigra*), sweet briar (*Rosa rubiginosa*) and broom (*Cytisus scoparius*). A large crack willow is also present in this area. The ground cover is dominated by sweet vernal, browntop (*Agrostis capillaris*), and Yorkshire fog (*Holcus lanatus*), along with yarrow (*Achillea millefolium*), red fescue (*Festuca rubra*), white clover (*Trifolium repens*), creeping buttercup (*Ranunculus repens*), cleavers (*Galium aparine*), mouse ear chick weed (*Cerastium fontanum*), and bog stitchwort (*Stellaria alsine*). In areas that lack shrubs, small localised wetlands are present, containing pasture species (sweet vernal, browntop, Yorkshire fog, rautahi (*Carex coriacea*), oval sedge (*Carex leporina*), *Juncus conglomeratus,* and track rush (*Juncus tenuis*).

Plate 1: Flood channel shrubland with tumatakuru and sweet briar.

2. Sweet briar shrubland

Sweet briar forms patches of shrubland in the southern part of the site, with a ground cover dominated by occasional spring speedwell (*Veronica verna*), haresfoot trefoil (*Trifolium arvense*), browntop, sweet vernal, vipers bugloss, yarrow, sheeps sorrel (*Rumex acetosella*), *Bromus tectorum*, and white clover.

3. Browntop-sweet vernal-clover grassland

Exotic-dominated improved pasture grassland in the northern part of the site comprises patches of browntop and sweet vernal, red fescue, and *Bromus* sp. This area also contains a high abundance of yarrow and red clover (*Trifolium pratense*) probably due to the presence of more productive soils. This grassy vegetation also contains patches of herbfield dominated by white clover, mouse-ear hawkweed and red clover with haresfoot trefoil, sheep's sorrel and occasional sweet vernal and woolly mullein (*Verbascum thapsus*).

Plate 2: Browntop-sweet vernal-clover grassland, towards the interior of the site.

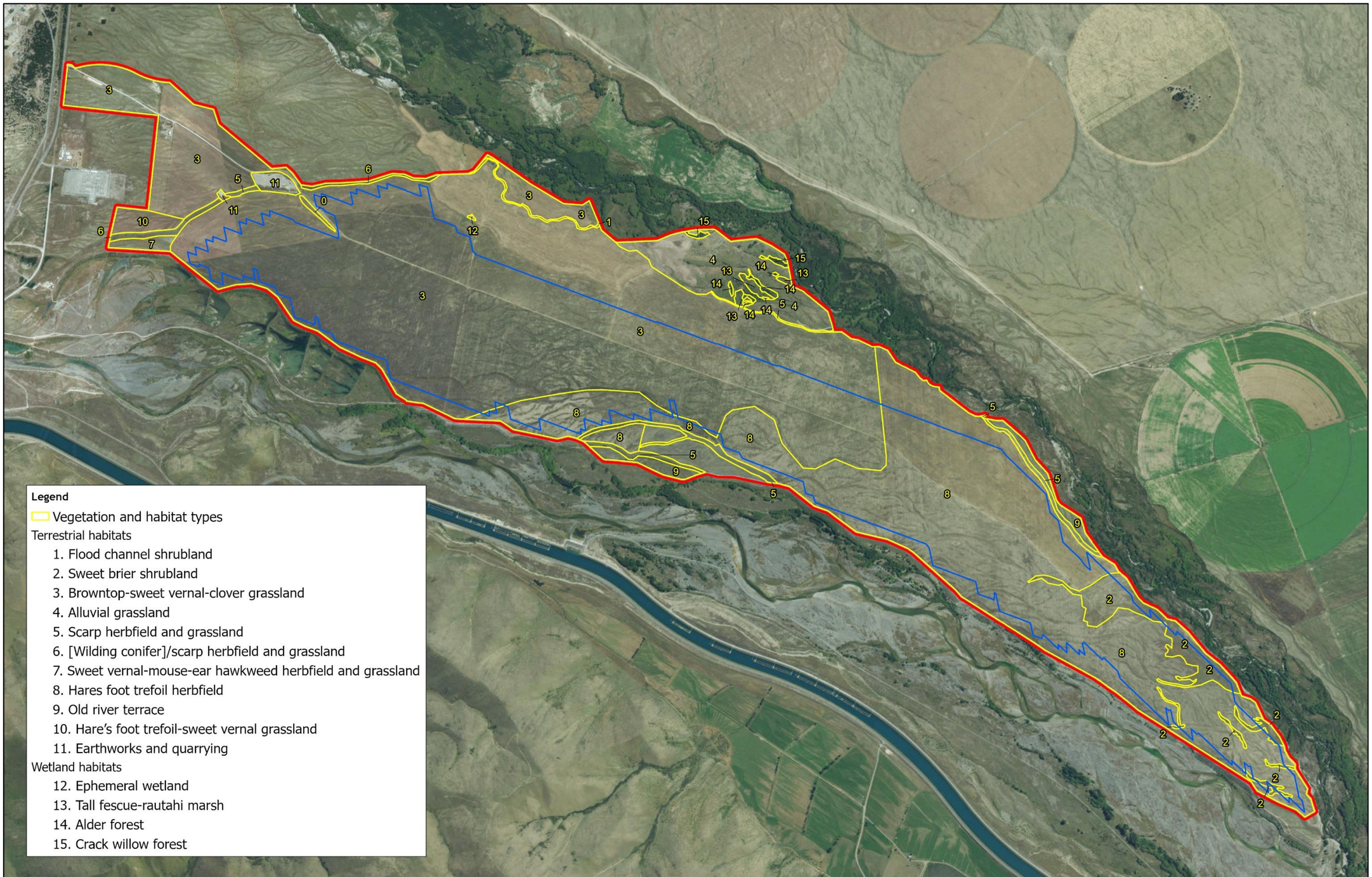

Figure 6. Vegetation and habitats at the site

4. Alluvial grassland

A small stream runs through alluvial grassland in the eastern part of the site. Vegetation is taller in stature and comprises exotic grasses and herbs with occasional indigenous species. Pasture species – including sweet vernal, browntop, Yorkshire fog and white clover – are abundant, as well as *Juncus conglomeratus*, jointed rush, red fescue, bog stitchwort, water forget-me-not (*Myosotis laxa*), and lotus (*Lotus pedunculatus*) in marshy areas. Indigenous sedges rautahi, pūkio (*Carex secta*), and bog rush (*Schoenus pauciflorus*) are occasional present along stream margins with the indigenous herb *Bulbinella angustifolia* also present in some areas. Woody species – including common alder (*Alnus glutinosa*), sweet briar and tumatakuru – are also present occasionally on stream banks.

5. Scarp herbfield and grassland

Stony scarps on the eastern and western margins of the site support low stature vegetation dominated by exotic herbs and grasses, haresfoot trefoil, mouse-ear hawkweed (*Pilosella officinarum*), red fescue, and occasional sweet briar. Creeping pohuehue (*Muehlenbeckia axillaris*), māikaika/onion orchid (*Microtis unifolia*), white clover, purging flax (*Linum catharticum*), vulpia hair grass (*Vulpia myuros*), sheep's sorrel, yarrow and *Bromus tectorum* are also common. The indigenous herb *Convolvulus verecundus* f. *verecundus* is also present on these scarps, as is occasional New Zealand harebell (*Wahlenbergia albomarginata*) and golden spaniard (*Aciphylla aurea*).

Plate 3: Example of scarp herbfield and grassland in the western part of the site.

6. [Wilding conifer]/scarp herbfield and grassland

In the northwestern part of the site, the scarp dividing the outwash plain has scattered Corsican pine (*Pinus nigra*) and ponderosa pine (*P. ponderosa*) above grassland dominated by red fescue, sweet vernal, browntop, and hard tussock (*Festuca* novae-*zelandiae*). Numerous sub-shrubs, herbs, and smaller grasses are present including purging flax, mouse-ear hawkweed, red clover, New Zealand harebell, *Plantago novae-zelandiae*, *Celmisia gracilenta*, *Raoulia australis*, white sun orchid (*Thelymitra longifolia*), desert broom (*Carmichaelia petriei*), *Pimelea prostrata*, *Coprosma petriei*, *Luzula rufa*, hooked sedge (*Carex breviculmis*), blue tussock (*Poa colensoi*), and dwarf broom (*Carmichaelia vexillata*).

7. Sweet vernal-mouse-ear hawkweed herbfield and grassland

Scattered sweet briar and porcupine shrubs above abundant sweet vernal and mouse-ear hawkweed are present on the lower uncultivated outwash plain in the northwestern part of the site. Onion orchid, white sun orchid, *Prasophyllum colensoi*, *Thelymitra colensoi*, New Zealand harebell, Australian sheep's burr (*Acaena agnipila*), sheep's sorrel, hares foot trefoil, creeping pohuehue, *Geranium brevicaule*, red clover, red fescue, and vipers bugloss are also present.

8. Haresfoot trefoil herbfield

Herbfield dominated by haresfoot trefoil, mouse-ear hawkweed with occasional *Bromus* sp., white clover, sheep's sorrel, sweet vernal and vipers bugloss. Briar rose is present occasionally. Some areas are more exclusively dominated by mouse-ear hawkweed with occasional sweet vernal, sheeps sorrel and haresfoot trefoil. Briar, vipers bugloss, king devil (*Pilosella praealta*) and silvery hair grass (*Aira caryophyllea*) are more abundant in rocky areas.

9. Old river terrace

Two examples of old river terrace are present in both the eastern and western margins of the site with vegetation mostly comprising of mouse-ear hawkweed, sweet vernal, māikaika/onion orchid and red fescue. Indigenous species including hooked sedge, creeping pohuehue, common mat daisy, *Convolvulus verecundus f. verecundus* and māikaika/white sun orchid (*Thelymitra longifolia*) are common as well as exotic herbs, catsear (*Hypochaeris radicata*), haresfoot trefoil, and spring speedwell. Woody species are occasionally present, including broom and *Melicytus alpinus* and wilding lodgepole pine (*Pinus contorta*).

10. Haresfoot trefoil-sweet vernal-grassland

Uncultivated upper outwash plain in the northwestern part of the site supports a grassland dominated by sweet vernal and haresfoot trefoil, with occasional browntop, sheep's sorrel, white clover, red clover and St John's wort (*Hypericum perforatum*). Occasional taller sweet briar and vipers bugloss are scattered within this grassland.

11. Earthworks and quarrying

These areas comprise a consented operational quarry site.

4.2.2 Wetlands

12. Ephemeral wetland

An ephemeral wetland is present in the northern part of the site. Vegetation within this habitat is comprised of abundant celery-leaved buttercup (*Ranunculus sceleratus*) and curled dock (*Rumex crispus*). Exotic rushes toad rush (*Juncus bufonius*) and jointed rush (*Juncus articulatus*) and the exotic herb Shepherd's purse *Capsella bursa-pastoris* are common. Other exotic species present include spring speedwell, storksbill (*Erodium cicutarium*), water forget-me-not, oval sedge, prickly puha (*Sonchus asper*), tall willowherb (*Epilobium ciliatum*) and kneed foxtail (*Alopecurus geniculatus*). Two indigenous herbs which are often associated with ephemeral wetlands are present, mudwort (*Limosella lineata*) and *Glossostigma diandrum.*

Plate 4: Ephemeral wetland habitat.

13. Tall fescue- rautahi marsh

Marsh wetland is present in the northeastern of the site on the alluvial terrace. Vegetation in this area is dominated by tall fescue (*Lolium arundinaceum*) and rautahi with lotus, sweet vernal, *Bulbinella angustifolia,* oval sedge, Yorkshire fog, *Juncus conglomeratus*, and yarrow. An indigenous sedge, *Carex kaloides*, is also present in this area.

14. Alder forest

Alder trees about six metres tall in an old river channel have formed a closed canopy, with no other woody species present in the canopy or sub-canopy. Groundcover is either densely vegetated with exotic grasses such as sweet vernal and tall fescue and herbs (bog stitchwort, Californian thistle, dock and hawkbit) or very sparse with celery leaved buttercup and water forget-me-not amongst extensive pugging by stock.

15. Crack willow forest

Small patches of forest dominated by crack willow (*Salix ×fragilis*) are present in wet old river channels in the east of the alluvial grassland at the eastern margin of the site. These were not inspected closely.

5. FLORA

5.1 Overview

Twenty-seven indigenous vascular plants and 68 exotic vascular plants were recorded during the site visit (Appendix 1).

5.2 Rare, Threatened and At-Risk taxa

Seven of the indigenous species observed at the site are classified as At Risk- Declining and an additional species, *Convolvulus verecundus f. verecundus* is classified at At Risk – Declining (Table 1; Plate 5).

Convolvulus verecundus f. verecundus is cryptic when not flowering and was recorded widely on the margins of the site during the 2022 field survey (Figure 7). In only one of these locations was *Convolvulus verecundus f. verecundus* flowering. An additional survey for *Convolvulus verecundus f. verecundus* was undertaken in summer 2023-2024 with more populations detected across the site.

Of the species classified as At Risk-Declining, desert broom, dwarf broom, and common mat daisy were only observed on scarp and terrace riser habitats. *Rytidosperma exiguum* and *Pimelea sericeovillosa* subsp. *pulvinaris* (Threatened – Nationally Vulnerable) were also detected on scarp and terrace riser habitats at low abundance (Figure 6).

In 2024, during the course of field surveys at this site, the threat classification for vascular plants was revised, this resulted in the status of *Convolvulus verecundus f. verecundus* changing from Threatened-Nationally Vulnerable (de Lang *et al.* 2017) to At Risk – Declining (de Lang *et al.* 2024). *Pimelea sericeovillosa* subsp. *pulvinaris* maintained its classification of Threatened – Nationally Vulnerable (de Lang *et al*. 2024). *Rytidosperma exiguum, Carmichaelia petriei, Carex kaloides Carmichaelia vexillata* and *Raoulia australis* are still listed as At Risk – Declining and matagouri/tūmatakuru (*Discaria toumatou*) is no longer At Risk (de Lang *et al*. 2024).

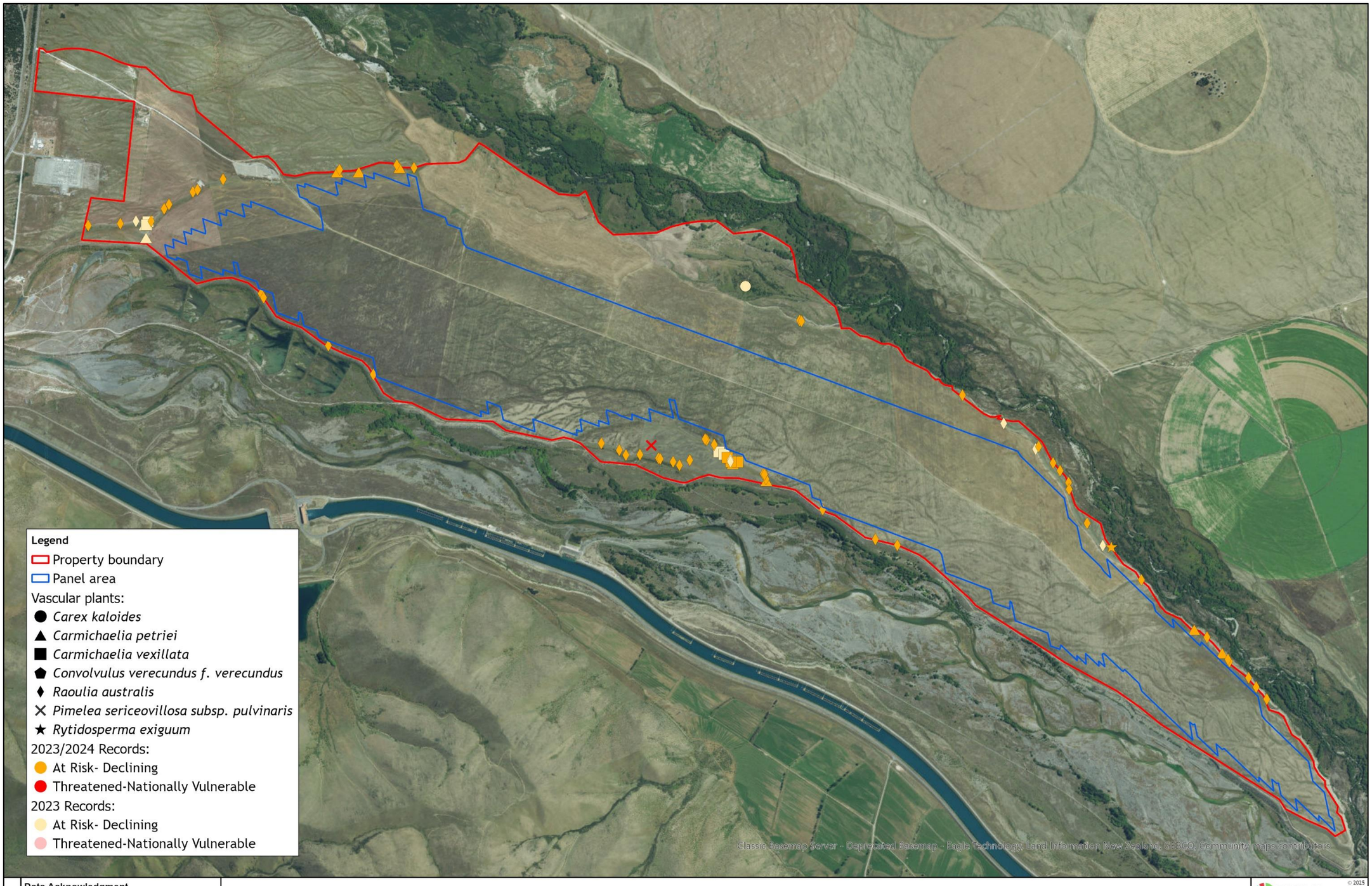

Figure 7. Locations of Threatened and At Risk plants at the site

Table 6: Rare, Threatened, and At Risk vascular plant species observed at the site.

Species	Common Name	Plant Type	Threat Ranking
Carex kaloides	-	Sedge	At Risk – Declining
Carmichaelia petriei	Desert broom	Shrub	At Risk – Declining
Carmichaelia vexillata	Dwarf broom	Shrub	At Risk – Declining
Convolvulus verecundus f. verecundus	-	Herb	At Risk – Declining
Pimelia sericeovillosa subsp. *pulvinaris*		Herb	Threatened – Nationally Vulnerable
Raoulia australis	Common mat daisy	Herb	At Risk – Declining
Rytudisperma exiguum		Grass	At Risk - Declining

Plate 5: *Convolvulus verecundus f. verecundus* in flower at the site.

Plate 6: *Raoulia australis* in flower at the site

5.3 Pest plants and ecological weeds

Six plant species recorded in the site are listed as either 'pest' or 'Organisms of Interest' (OoI) in Environment Canterbury's Regional Pest Management Plan (CRPMP; 2018-2038; Table 2). An additional six plants have been identified as ecological weeds.

Table 2: Pest plants and Organisms of Interest (PEST, OOL, respectively), listed in the CRPMP that were recorded at the site.

Scientific Name	Common Name(s)	Growth Form	Pest Status
Cytisus scoparius	Broom	Shrub	PEST
Echium vulgare	Vipers' bugloss	Herb	OOI
Hypericum perforatum	St John's wort	Herb	OOI
Lolium arundinaceum	Tall fescue	Grass	Ecological weed
Lupinus polyphyllus	Russell lupin	Herb	PEST
Pilosella officinarum	Mouse-ear hawkweed	Herb	OOI
Pinus contorta *Pseudotsuga menziesii*	Wilding conifers	Tree	PEST
Rosa rubiginosa	-	Shrub	Ecological weed
Salix fragilis	Crack willow	Tree	Ecological weed
Sambucus nigra	Elder	Shrub	Ecological weed
Sedum acre	Stonecrop	Herb	Ecological weed
Solanum dulcamara	Bittersweet	Herb	Ecological weed

6. AVIFAUNA

6.1 Desktop assessment

The desktop assessment recorded 54 species and two hybrid taxa within five kilometres of the site (Table 3). Of these, 40 are indigenous and 16 exotic.

Eight Threatened species have been recorded in the vicinity of the site:

- Nationally Critical: kakī/black stilt (*Himantopus novaezelandiae*) and kotuku/white heron (*Ardea alba modesta*).
- Nationally Endangered: tarapirohe/black-fronted tern (*Chlidonias albostriatus*).
- Nationally Vulnerable: taranui/Caspian tern (*Hydroprogne caspia*), kārearea/ eastern falcon (*Falco novaeseelandiae novaeseelandiae*), pūteketeke/Australasian crested grebe (*Podiceps cristatus australis*), and pārera/grey duck (*Anas superciliosa*).
- Nationally Increasing: ngutu pare/wrybill (*Anarhynchus frontalis*).

Nine At Risk species have been recorded in the vicinity of the site:

- Declining: pohowera/banded dotterel (*Charadrius bicinctus bicinctus*), tarāpuka/ black-billed gull (*Chroicocephalus bulleri*), kotoreke/marsh crake (*Zapornia pusilla affinis*), pīhoihoi/New Zealand pipit (*Anthus novaeseelandiae novaeseelandiae*) and tōrea/South Island pied oystercatcher (*Haematopus finschi*).
- Relict: māpunga/black shag (*Phalacrocorax carbo novaehollandiae*) and kawaupaka/little shag (*Microcarbo melanoleucos brevirostris*).
- Naturally Uncommon: Australian coot (*Fulica atra australis*) and kawau tūī/little black shag (*Phalacrocorax sulcirostris*).

6.2 Field survey findings

Of the 38 taxa recorded during the site visit (Table 3), 21 were indigenous species, 16 were exotic, and one *Anas* sp. was not identified to species level. Two Threatened species were observed: tarapirohe/black-fronted tern and pārera/grey duck. Five At Risk species were observed: pohowera/banded dotterel, tarāpuka/black-billed gull, tōrea/South Island pied oystercatcher, māpunga/black shag, and kawaupaka/little shag.

Introduced passerines were the most common species group throughout the site, with skylark (*Alauda arvensis*) being particularly abundant. All species detected during the site visit were also recorded in the desktop assessment.

Tōrea/South Island pied oystercatcher were observed feeding and roosting in the browntop-sweet vernal-cover grassland on the site (Figure 8). One bird was observed sitting on what looked like a nest, although this could not be confirmed. The short grassland did provide habitat suitable for tōrea/South Island pied oystercatcher to breed. Tarapirohe/black-fronted terns were observed flying over the site and foraging in the river along the site's southern border (Figure 8).

Adjacent Important Sites

Several areas are important to avifauna on the southern margins of the site and these are shown collectively in Figure 8 as an "important avifauna area". Large numbers of waterfowl and waders, including the Threatened pārera/grey duck and At Risk pohowera/banded dotterel and tōrea/South Island pied oystercatcher, were present in wetlands between the Ōhau River and the southern margin of the site (opposite the Ōhau B Power Station, as shown in Figure 8). The Department of Conservation kakī/black stilt captive breeding centre is adjacent to the proposed solar farm. The Ōhau River and its delta on Lake Benmore provide important habitat for various Threatened and At Risk species, including māpunga/black shag and kawaupaka/little shag, which were observed feeding in the river during the site visit. Wetland patches in the Ōhau River are known habitat for the At Risk kotoreke/marsh crake.

7. LIZARDS

7.1 Desktop assessment

Six species have been found within the wider vicinity of the site including four species of skink and two species of gecko (Table 4). The following have been recorded within 20 kilometres of the site: McCann's skink (*O. maccanni*; Not Threatened), southern grass skink (*Oligosoma* aff. *polychroma* Clade 5; At Risk – Declining), Lakes skink (*O.* aff. *chloronoton* "West Otago"*;* Threatened – Nationally Vulnerable), scree skink (*O. waimatense*; Threatened – Nationally Vulnerable), Southern Alps gecko (*Woodworthia* "Southern Alps"; At Risk – Declining) and jewelled gecko (*Naultinus gemmeus*; At Risk – Declining).

Table 3: Bird species detected during the desktop assessment and site visit for the proposed Nova Energy solar farm near Twizel. Common names, scientific names, and threat classification are from Robertson *et al*. 2021.

Common Name(s)	Scientific Name	Threat Classification 2021	Likelihood of Presence at Site
Indigenous			
Black stilt/kakī	*Himantopus novaezelandiae*	Threatened-Nationally Critical	Highly likely
White heron/kōtuku	*Ardea alba modesta*	Threatened-Nationally Critical	Possible
Black-fronted tern/tarapirohe	*Chlidonias albostriatus*	Threatened-Nationally Endangered	Seen during visit
Caspian tern/taranui	*Hydroprogne caspia*	Threatened-Nationally Vulnerable	Highly likely
Australasian crested grebe/pūteketeke	*Podiceps cristatus australis*	Threatened-Nationally Vulnerable	Unlikely
Eastern falcon/kārearea	*Falco novaeseelandiae novaeseelandiae*	Threatened-Nationally Vulnerable	Possible
Grey Duck/pārera	*Anas superciliosa*	Threatened-Nationally Vulnerable	Seen during visit
Wrybill/ngutu pare	*Anarhynchus frontalis*	Threatened-Nationally Increasing	Likely
Banded dotterel/pohowera	*Charadrius bicinctus bicinctus*	At Risk-Declining	Seen during visit
Black-billed gull/tarāpuka	*Chroicocephalus bulleri*	At Risk-Declining	Seen during visit
Marsh crake/kotoreke	*Zapornia pusilla affinis*	At Risk-Declining	Highly likely
New Zealand pipit/pīhoihoi	*Anthus novaeseelandiae novaeseelandiae*	At Risk-Declining	Possible
South Island pied oystercatcher/tōrea	*Haematopus finschi*	At Risk-Declining	Seen during visit
Black shag/māpunga	*Phalacrocorax carbo novaehollandiae*	At Risk-Relict	Seen during visit
Little shag/kawaupaka	*Microcarbo melanoleucos brevirostris*	At Risk-Relict	Seen during visit
Australian coot	*Fulica atra australis*	At Risk-Naturally Uncommon	Unlikely
Little black shag/kawau tūī	*Phalacrocorax sulcirostris*	At Risk-Naturally Uncommon	Highly unlikely
Australasian shoveler/kuruwhengi	*Spatula rhynchotis*	Not Threatened	Seen during visit
Bellbird/korimako	*Anthornis melanura melanura*	Not Threatened	Possible
Black swan/kakīānau	*Cygnus atratus*	Not Threatened	Seen during visit
Grey duck – mallard hybrid	*Anas superciliosa* × *platyrhynchos*	Not Threatened	Seen during visit
Grey teal/tētē-moroiti	*Anas gracilis*	Not Threatened	Seen during visit
Grey warbler/riroriro	*Gerygone igata*	Not Threatened	Seen during visit
New Zealand kingfisher/kōtare	*Todiramphus sanctus vagans*	Not Threatened	Possible
New Zealand scaup//pāpango	*Aythya novaeseelandiae*	Not Threatened	Seen during visit
Paradise shelduck/pūtangitangi	*Tadorna variegata*	Not Threatened	Seen during visit
Pied stilt/poaka	*Himantopus himantopus leucocephalus*	Not Threatened	Seen during visit
Pied stilt - black stilt hybrid	*Himantopus himantopus* ×*novaezelandiae*	Not Threatened	Highly likely
Pukeko/pūkeko	*Porphyrio melanotus melanotus*	Not Threatened	Unlikely
Shining cuckoo/pīpīwharauroa	*Chrysococcyx lucidus lucidus*	Not Threatened	Possible
Silvereye/tauhou	*Zosterops lateralis lateralis*	Not Threatened	Seen during visit
South Island fantail/pīwakawaka	*Rhipidura fuliginosa fuliginosa*	Not Threatened	Likely
South Island tomtit/ngirungiru	*Petroica macrocephala macrocephala*	Not Threatened	Highly unlikely
Southern black-backed gull/karoro	*Larus dominicanus dominicanus*	Not Threatened	Seen during visit
Spur-winged plover	*Vanellus miles novaehollandiae*	Not Threatened	Seen during visit
Swamp harrier/kāhu	*Circus approximans*	Not Threatened	Seen during visit
Tui/tūī	*Prosthemadera novaeseelandiae novaeseelandiae*	Not Threatened	Highly unlikely
Welcome swallow/warou	*Hirundo neoxena neoxena*	Not Threatened	Seen during visit
White-faced heron/matuku moana	*Egretta novaehollandiae*	Not Threatened	Seen during visit
White-winged black tern	*Chlidonias leucopterus*	Non-resident Native – Migrant	Highly unlikely

Common Name(s)	Scientific Name	Threat Classification 2021	Likelihood of Presence at Site
Exotic Species			
Anas sp.	*Anas* sp.	-	Seen during visit
Australian magpie	*Gymnorhina tibicen*	Introduced and Naturalised	Seen during visit
California quail	*Callipepla californica*	Introduced and Naturalised	Likely
Canada goose	*Branta canadensis*	Introduced and Naturalised	Seen during visit
Chaffinch	*Fringilla coelebs*	Introduced and Naturalised	Seen during visit
Common redpoll	*Acanthis flammea*	Introduced and Naturalised	Seen during visit
Dunnock	*Prunella modularis*	Introduced and Naturalised	Seen during visit
Eurasian blackbird	*Turdus merula*	Introduced and Naturalised	Seen during visit
Greenfinch	*Chloris chloris*	Introduced and Naturalised	Seen during visit
Goldfinch	*Carduelis carduelis*	Introduced and Naturalised	Seen during visit
House sparrow	*Passer domesticus*	Introduced and Naturalised	Seen during visit
Mallard	*Anas platyrhynchos*	Introduced and Naturalised	Seen during visit
Passerine sp.	*Passeriformes* sp.	Introduced and Naturalised	Seen during visit
Rock pigeon	*Columba livia*	Introduced and Naturalised	Seen during visit
Song thrush	*Turdus philomelos*	Introduced and Naturalised	Seen during visit
Skylark	*Alauda arvensis*	Introduced and Naturalised	Seen during visit
Starling	*Sturnus vulgaris*	Introduced and Naturalised	Seen during visit
Yellowhammer	*Emberiza citrinella*	Introduced and Naturalised	Seen during visit

Table 4: Lizard records from a Department of Conservation Bioweb herpetofauna database search within a 20-kilometre radius of the site and an assessment of the likelihood of the presence of these species at the site. Conservation status is from Hitchmough *et al*. 2021. The likelihood of occurrence for each species is based on their known habitat preferences and distribution in the wider area.

Species	Common Name	Conservation Status	Nearest Record (km)	Preferred Habitats	Likelihood of Occurrence
Oligosoma maccanni	McCann's skink	Not Threatened	< 0.1	Open habitats – dry rocky environments such as rock outcrops, and montane grassland.	**Presence confirmed** (through site survey).
***Oligosoma* aff. *polychroma* Clade 5**	Southern grass skink	At Risk – Declining	<0.1	Prefers damp or well vegetated habitats such as rank grasslands, wetlands, stream/river edges, and gullies.	**Presence confirmed** (through site survey).
***Oligosoma* aff. *chloronoton* "West Otago"**	Lakes skink	Threatened – Nationally Vulnerable	10.1	Rocky scrubland, river terraces, scree, talus, boulderfield and braid plains.	**Unlikely** (increasingly rare therefore unlikely to be present at this site, some habitat present on site, but not detected during multiple surveys).
Oligosoma waimatense	Scree skink	Threatened – Nationally Vulnerable	4	Creviced rock outcrops, river terraces, scree, talus, boulderfield and braid plains.	**Highly unlikely** (increasingly rare therefore unlikely to be present at this site. Some habitat present on site, but not detected during multiple surveys).
***Woodworthia* "Southern Alps"**	Southern Alps gecko	At Risk – Declining	0.5	Scrubland, forest, creviced rock outcrops, rocky scrubland, boulder beaches, river terraces, scree, talus, boulderfield and braid plains.	**Presence confirmed** (through site survey).
Naultinus gemmeus	Jewelled gecko	At Risk – Declining	5	Scrubland, forest and tussockland.	**Unlikely** (some suitable dense scrub habitats, but regenerating since 1980s with no natural contiguous forest associations).

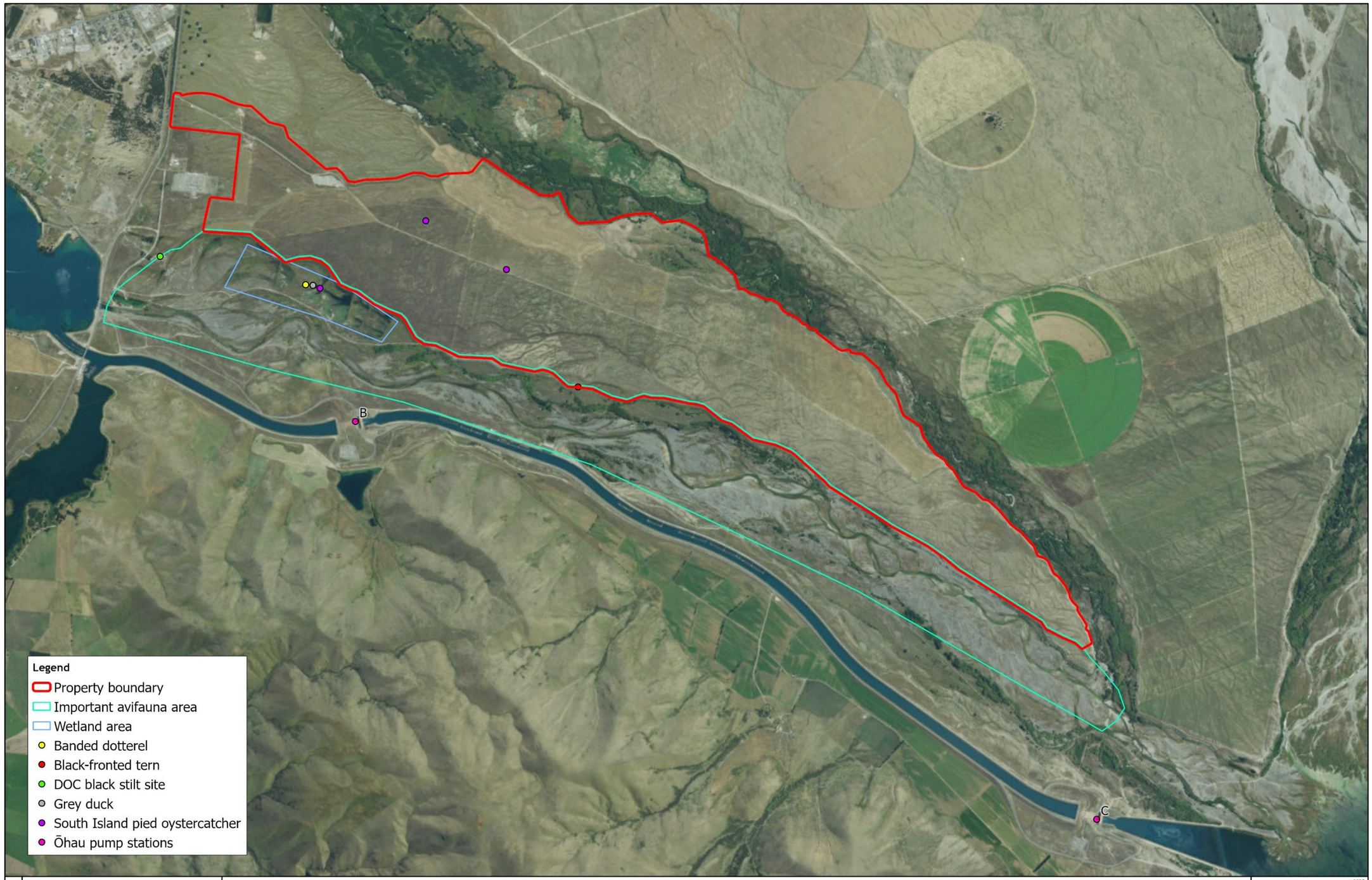

Figure 8. Avifauna and important habitats for avifauna in the vicinity of the site

Southern grass skink and McCann's skink are widespread throughout the Mackenzie District, and often persist in areas of grassland habitat comprising rank grass and scrub similar to that found at the proposed site. Southern Alps gecko are commonly found in rocky areas with shrubland, talus slopes, and braid plains.

Potential habitat (complex rock piles) for Lakes skink is present in an area of old river terrace along the central southern edge of the site. This species has become increasingly rare and is sparsely spread across the Mackenzie District, and is therefore considered unlikely to be present. While this area also provides appropriate habitat for scree skink, this species is particularly rare at lower elevations and is highly unlikely to be present. Multiple intensive surveys have failed to detect either species on site.

It is unlikely that jewelled gecko are present at the site. All available shrubland is restricted to a narrow strip of talus slope and as a result of this habitat fragmentation, it is highly unlikely that any populations or remnant individuals remain within the project area.

7.2 Field survey findings

Figure 9 and Table 5 show the combined lizard survey results from Survey 1 and Survey 2.

Survey 1

Total survey effort for Survey 1 included 296 ACO checks and 10 person hours of visual and manual searches. Lizards detected during Survey 1 included:

- 7 Southern Alps geckos
- 50 McCann's skinks (including 5 recaptures)
- 4 southern grass skinks
- 13 unidentified skinks

Unidentified skinks were seen either basking or under ACOs, but were too quick to catch, due to the hot conditions. It is highly likely these were McCann's skinks, based on their size and the abundance of this species on site.

Survey 2

Total survey effort for Survey 2 included 600 ACO checks, 225 funnel trap nights and three person hours of visual and manual searches. Lizards detected during Survey 2 included:

- 19 Southern Alps geckos (including 1 recapture)
- 179 McCann's skinks (including 17 recaptures)

Table 5: Summary of lizard survey effort and weather conditions at the site. 'ph' refers to 'person hours'.

Date	Weather	Activity and Effort	Species detected
12 December 2022	Sunny, warm (no temperatures recorded)	Opportunistic observations	3 unidentified skinks
16 December 2022	Sunny, warm (no temperatures recorded)	74 ACOs installed	6 McCann's skink 4 Southern Alps gecko 4 unidentified skinks
28 February 2023	High cloud, calm 18.2 °C, 68.5% RH-24 °C,44.7% RH	74 ACOs checked, 4 ph visual and manual searches	15 McCann's skink 4 southern grass skink 1 Southern Alps gecko 5 unidentified skinks
1 March 2023	Overcast/low cloud clearing 15.2°C, 76.9% RH – 24.9°C, 46% RH	74 ACOs checked, 3 ph visual and manual searches	13 McCann's skink (1 recapture) 2 Southern Alps gecko 1 unidentified skink
2 March 2023	Sunny, slight breeze 18.2°C, 70.7% RH.-28.8°C, 34.9% RH	74 ACOs checked, 3 ph visual and manual searches	13 McCann's skink (3 recaptures)
3 March 2023	Sunny, turning cloud, slight breeze, SW front approaching 12.1°C,65.9% RH – 21°C, 54% RH	74 ACOs checked and removed	8 McCann's skink (1 recapture)
3-4 October 2023	Not recorded	120 ACOs installed	N/A
18 December 2023	Sunny, hot, light breeze, 24.8-24.5°C, 36.3-38% RH	25 Gee's minnow traps installed, 0.5 ph visual and manual searches	N/A
19 December 2023	Sunny, hot, calm, 22.9-28.1°C, 48.1-24.3% RH	25 Gee's minnow traps checked and an additional 25 Gee's minnow traps installed, 120 ACOs checked, 0.5 ph visual and manual searches	30 McCann's skink 2 Southern Alps gecko
20 December 2023	Sunny, hot, calm, 27.2-30.7°C, 30.5-34% RH	50 Gee's minnow traps checked, 120 ACOs checked, 0.5 ph visual and manual searches	45 McCann's skink (1 recapture) 1 Southern Alps gecko
21 December 2023	Sunny, hot, calm, 26.3-26.8°C, 37.5-36.2% RH	50 Gee's minnow traps checked, 120 ACOs checked, 0.5 ph visual and manual searches	36 McCann's skink (4 recaptures) 10 Southern Alps gecko 1 mouse (dead)
22 December 2023	Overcast turning sunny in afternoon, warm-hot, light breeze, 15.1-28.1°C, 64-33.1% RH	50 Gee's minnow traps checked, 120 ACOs checked, 0.5 ph visual and manual searches	33 McCann's skink (6 recaptures) 3 Southern Alps gecko (1 recapture)
23 December 2023	Sunny with intermittent cloudy periods, warm-hot, light breeze, 19-24°C, 53.8-48.2% RH	50 Gee's minnow traps checked and removed, 120 ACOs checked and removed, 0.5 ph visual and manual searches	35 McCann's skink (6 recaptures) 3 Southern Alps gecko
Total	**Temperature range 12.1 – 30.7°C**	**225 Gee's minnow trap nights 896 ACO checks 13 ph manual searches**	**229 McCann's skink 4 southern grass skink 13 unidentified skinks 26 Southern Alps gecko 1 mouse (dead)**

No other lizard species were detected on site during the surveys.

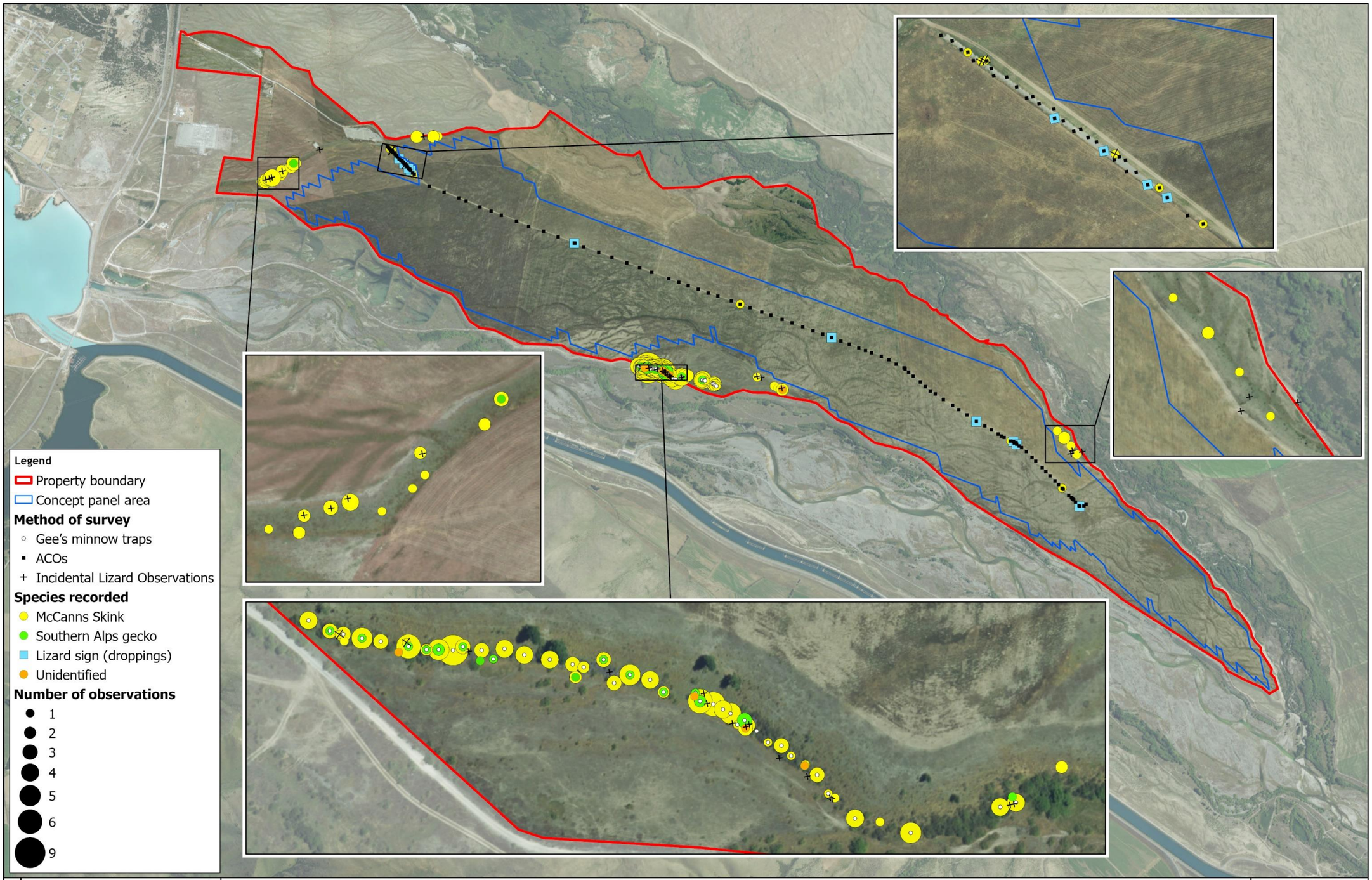

Figure 9. Combined results from the February-March and December 2023 lizard surveys at the proposed solar farm site, Twizel

Indigenous lizard species present within the site are part of wider populations associated with remnant habitats throughout the basin. Indigenous lizard populations in the Mackenzie District are in decline as a result of intensive farming practices and due to pressure from habitat loss, climate change, and predation.

Lizards were captured in various vegetation and habitat types and are likely to be found within the following vegetation types:

- Flood channel shrubland.
- Sweet briar shrubland.
- Browntop-sweet vernal-clover grassland.
- Alluvial grassland.
- Scarp herbfield and grassland.
- [Wilding conifer]/scarp herbfield and grassland.
- Sweet vernal-mouse-ear hawkweed herbfield and grassland.
- Haresfoot trefoil herbfield.
- Old river terrace.
- Earthworks and quarrying.

Both McCann's skinks and sign (scat) were detected under ACOs in areas with minimal ground cover along the central fence line, such as around small amounts of dense vegetation or small groupings of loose rocks, indicating that McCann's skink are likely present across the site in low densities (even in low-quality habitat). McCann's skink is considered to be the only species present along the central fence line and in other areas of low-quality habitat, due to the dry, exposed habitat, and shallow retreat site availability in these areas.

Lizard survey methods sometimes have poor detection rates because of typically low population densities, cryptic colouration of some species, difficulty in surveying preferred habitats and behaviour/activity patterns of lizards. As such, even intensive lizard surveys are unlikely to detect all individuals in the population or, possibly, all species present. However, following the intensive survey effort undertaken, no additional lizard species are considered likely to be present on site.

8. TERRESTRIAL INVERTEBRATES

8.1 Desktop assessment

The desktop survey revealed three notable invertebrate species recorded within a five-kilometre radius of the site (Table 6).

Tekapo ground wētā (*Hemiandrus furoviarius*; Threatened-Nationally Endangered (Trewick *et al*. 2022) and New Zealand blue butterfly (*Zizina oxleyi*; Not Threatened but declining[1]) are other notable species that were found on the site (see below) but did not appear in the GBIF records.

[1] Patrick B. and Patrick H. 2012: Butterflies of the South Pacific. Otago University Press and Otago Museum.

Table 6: Invertebrate species of interest found in the desktop survey within a five-kilometre radius of the site.

Species	Common Name	Threat Status	Habitat	Reason for Designation as a Species of Interest	Likelihood of Occurrence on Site
Brachaspis robustus	Robust grasshopper	Threatened-Nationally Endangered (Trewick *et al*. 2022)	Open rocky areas on braided river beds.	Protected under the Wildlife Act (1953). Threatened by introduced predators and habitat loss.	Unlikely – habitat not present.
Sigaus minutus	Minute grasshopper	Threatened-Nationally Vulnerable (Trewick *et al*. 2022)	Open rocky areas.	Threatened by introduced predators and habitat loss.	Possible – potential habitat present on site.
Phaulacridium otagoense	Short-horned grasshopper	At Risk-Declining (Trewick *et al*. 2022)	Open rocky areas and herbfields	Threatened by genetic incursion by *P. marginale*.	Possible – potential habitat present on site.

8.2 Field survey

Results from all invertebrate surveys are summarised in Figure 10.

8.2.1 General invertebrate field survey

The general invertebrate field survey was carried out during a range of weather conditions, from rainy and cool to sunny and hot. Warm, sunny weather was most common, when most invertebrates are likely to be active.

Table 7 lists invertebrate species found during the field survey. In general, habitat was either lacking or low-quality for indigenous invertebrates, although higher quality minute and short-horned grasshopper habitat was present towards the southwestern end in the hare's foot trefoil herbfield. The invertebrate fauna was generally found to be lacking in diversity, as expected for a highly modified site with high sun exposure and low rainfall.

Table 7: Invertebrate species found in the field survey of the proposed solar farm site in February-March 2023.

Species	Common Name	Threat Status	Habitat	Species of interest?
Sigaus minutus	Minute grasshopper	Threatened-Nationally Vulnerable (Trewick *et al*. 2022)	Open habitat with bare or rocky ground, with lichen and moss for food plants.	Yes – threatened species.
Orocrambus vitellus	Grass moth	Not assessed (Hoare *et al*. 2015)	Indigenous and exotic grassland.	No.
Orocrambus sp.	Grass moth	Not assessed (Hoare *et al*. 2015)	Indigenous and exotic grassland.	No.
Bombus spp.	Bumblebee	Introduced and naturalised (Ward *et al*. 2017)	Meadow with exotic flowers.	No.
Pieris rapae	Cabbage white butterfly	Introduced pest	Open fields with brassica plants for larval food.	No.
Formicidae	Ant	Not assessed (Ward *et al*. 2017)	Nests found in loose sandy soil.	No.

Species	Common Name	Threat Status	Habitat	Species of interest?
Eudonia catexesta	Stone moth	Not assessed (Hoare *et al*. 2015)	Larvae associated with mosses; adults have been seen feeding on the indigenous daisy *Helichrysum intermedium*.	No.
Anoteropsis urquharti	Wolf spider	Not threatened (Sirvid *et al*. 2021)	Mountain scree and stony ground.	No.
Socca pustulosa	Orb weaver spider	Not threatened (Sirvid *et al*. 2021)	Ubiquitous throughout New Zealand.	No.
Phaulacridium marginale	Short-horned grasshopper	Not threatened (Trewick *et al*. 2022)	Open lowland habitat.	No.
Phaulacridium otagoense	Otago shot-horned grasshopper	At Risk – Declining (Trewick *et al.* 2022)	Open, very dry habitat with sparse plant cover.	Yes – At Risk.
Zizina oxleyi	New Zealand blue butterfly	Not threatened (Hoare *et al*. 2015)	Open, sunny areas with nearby shelter, leguminous plants for larval food, and flowers for adult food.	Yes – thought by experts to be declining. Has disappeared throughout much of its historical range.
Vespula sp.	Wasp	Introduced pest	Any habitat associated with humans.	No.
Diptera (families Tachinidae, Acalyptratae, Calliphoridae, Syrphidae, Muscidae)	Flies	Not Assessed, Not Threatened, or introduced (Andrew *et al*. 2012)	Ubiquitous	No.
Philaenus spumarius	Meadow spittlebug	Introduced pest	Grasslands	No.
Boldenaria boldenarum	Boulder copper	Not assessed (Hoare *et al*. 2015)	Pohuehue and open, stony areas.	No.
*Hemiandrus "*furoviarius"	Tekapo ground wētā	Threatened – Nationally Endangered (Trewick *et al*. 2022)	Braided river terraces.	Yes – Threatened.

Despite the lateness of the season (March 2023), three minute-grasshopper individuals (one mating pair plus one female) were observed in one location on site (Plate 7; Figure 10). Habitat patches for minute grasshopper and short-horned grasshopper were observed throughout the site.

New Zealand blue butterfly was found on-site, along with plenty of suitable habitat.

Robust grasshopper habitat was not found at the site.

Plate 7: Female minute grasshopper basking on a small patch of bare ground.

8.2.2 Targeted grasshopper and wētā survey

Results from the targeted grasshopper and wētā survey are also discussed in the report (Wildland Consultants, 2024a).

Weather conditions throughout the targeted surveys were generally close to optimal for grasshopper detection. Only five out of six grasshopper transect runs were completed due to weather constraints, which was considered adequate, as the purpose was to detect presence of grasshoppers throughout the site rather than to monitor numbers.

Tekapo ground wētā were detected in two out of the three sets of pitfall traps (within the concept panel area, near the western edge; Plate 10). Two individuals were caught. The hardness of the ground prevented more than 15 live-capture pitfall traps from being set. Running the traps for 2-3 nights increased the sample size, and succeeded in detecting Tekapo ground wētā presence on-site, but does not provide much information concerning their distribution.

Minute grasshoppers were found on the old river terrace at the central-southern edge of the property (outside the concept panel area), in approximately the same location as they were found previously (Figure 10). They were not found elsewhere despite available habitat. The area of river terrace in the southern-central part of the site, where minute grasshoppers were found, is the best quality grasshopper habitat on-site, with the highest abundance and diversity of grasshoppers present.

The western third of the property has patches of grasshopper habitat that are highly degraded with exotic grass, but Otago short-horned grasshopper was frequently detected there and on the same terrace on the southern edge as the minute grasshoppers (Figure 10). Within these areas, Otago short-horned grasshopper appears to be relatively abundant.

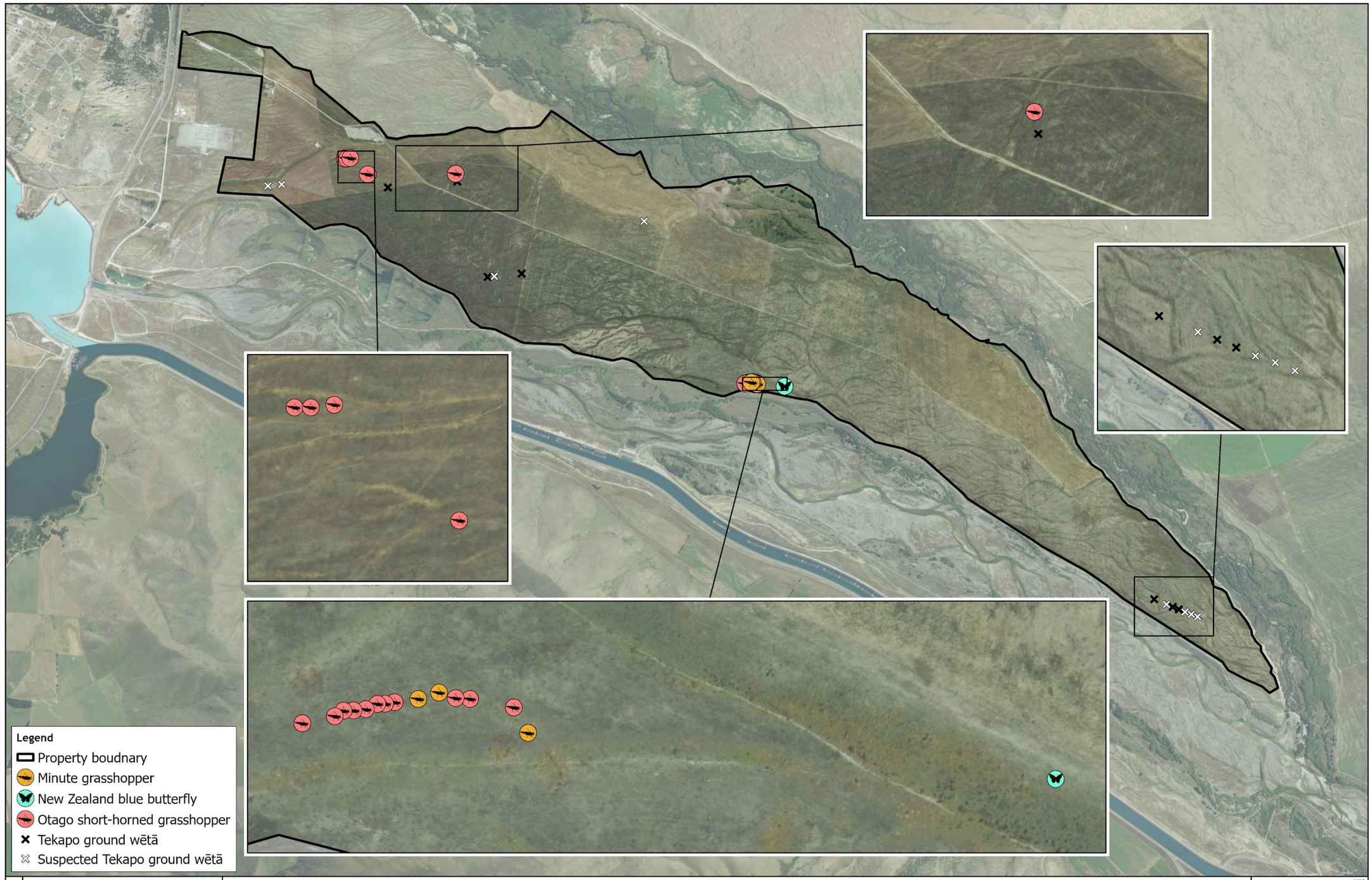

Figure 10. Results from previous general and targeted invertebrate surveys at the proposed solar farm site in Twizel

Some areas of the property have been ploughed and are therefore not suitable habitat. In the central portion of the property, particularly south of the road, there are patches of potential habitat for grasshoppers. Neither Otago short-horned nor minute grasshoppers were found in this part of the property despite numerous transects and searching between transects. This may be due to farming practises such as ploughing or spraying, or the presence of a predator or competitor such as tiger beetles, which were seen on-site. There may be other factors involved, as the habitat requirements of these species are not fully understood.

The western end of the site where Otago short-horned grasshoppers and Tekapo ground wētā were found appears to be of high value for grasshoppers and wētā. Minute and Otago short-horned grasshopper are unlikely to be present in the central or eastern terrace portions of the site, though their possible presence in undetectable numbers cannot be ruled out in suitable habitat.

At the very eastern tip of the site is a field planted with barley. Due to the shading effect from the barley, there is no habitat in the field that would support the grasshopper species of interest.

Tekapo ground wētā were detected in two out of the three sets of pitfall traps (within the concept panel area, near the western edge; Plate 8). Two individuals were caught. The hardness of the ground prevented more than 15 live-capture pitfall traps from being set. Running the traps for 2-3 nights increased the sample size, and succeeded in detecting Tekapo ground wētā presence on-site, but did not provide much information concerning their distribution.

Plate 8: Tekapo ground wētā caught in a live-capture pitfall trap on-site.

8.2.1 Tekapo ground wētā tracking tunnel survey

Results from the Tekapo ground wētā tracking tunnel survey are also discussed in the report (Wildland Consultants, 2024b).

Out of 60 tracking cards, 33 showed signs of animal activity. Four tracking cards showed large wētā tracks likely to be Tekapo ground wētā. These were located within the western third of the site, and at the eastern tip. Potential wētā tracks were also found in the western half and eastern tip, though it was difficult to tell whether or not they were Tekapo ground wētā.

8.2.2 Unmanned aerial vehicle survey

Results from the UAV survey are also discussed in the Terrestrial Invertebrate Management Plan (Wildland Consultants, 2025a).

This project represents the first-time aerial photography has been used to identify potential minute and Otago short-horned grasshopper habitat. Large, open patches that are likely to be suitable habitat for minute and Otago short-horned grasshopper were obvious in the photographs. However, results should be interpreted with the understanding that some habitat aspects that may affect minute and Otago short-horned grasshopper distribution may not be apparent in the photographs. Aerial imagery is not expected to detect all aspects relative to ecology, especially for invertebrates.

Out of 107 hectares mapped by UAV, 48 hectares were identified as potential minute or Otago short-horned grasshopper habitat, characterised by short-stature vegetation mixed with bare ground and/or stones (Figure 11). Habitat was mostly found in large patches south and east of the central fence line, with small patches of low-quality habitat north of the fence line and to the west. A large part of the property north of the fence line appears to have been cultivated, and some areas are wetlands, both of which are unlikely to provide habitat for minute and Otago short-horned grasshopper.

The UAV and walkthrough surveys combined have given detailed mapping of potential minute and Otago short-horned grasshopper habitat distribution. The areas of habitat shown in Figure 11 include patches identified during the walkthrough and UAV surveys, but the extent to which habitat patches spread outside the UAV polygons is unknown.

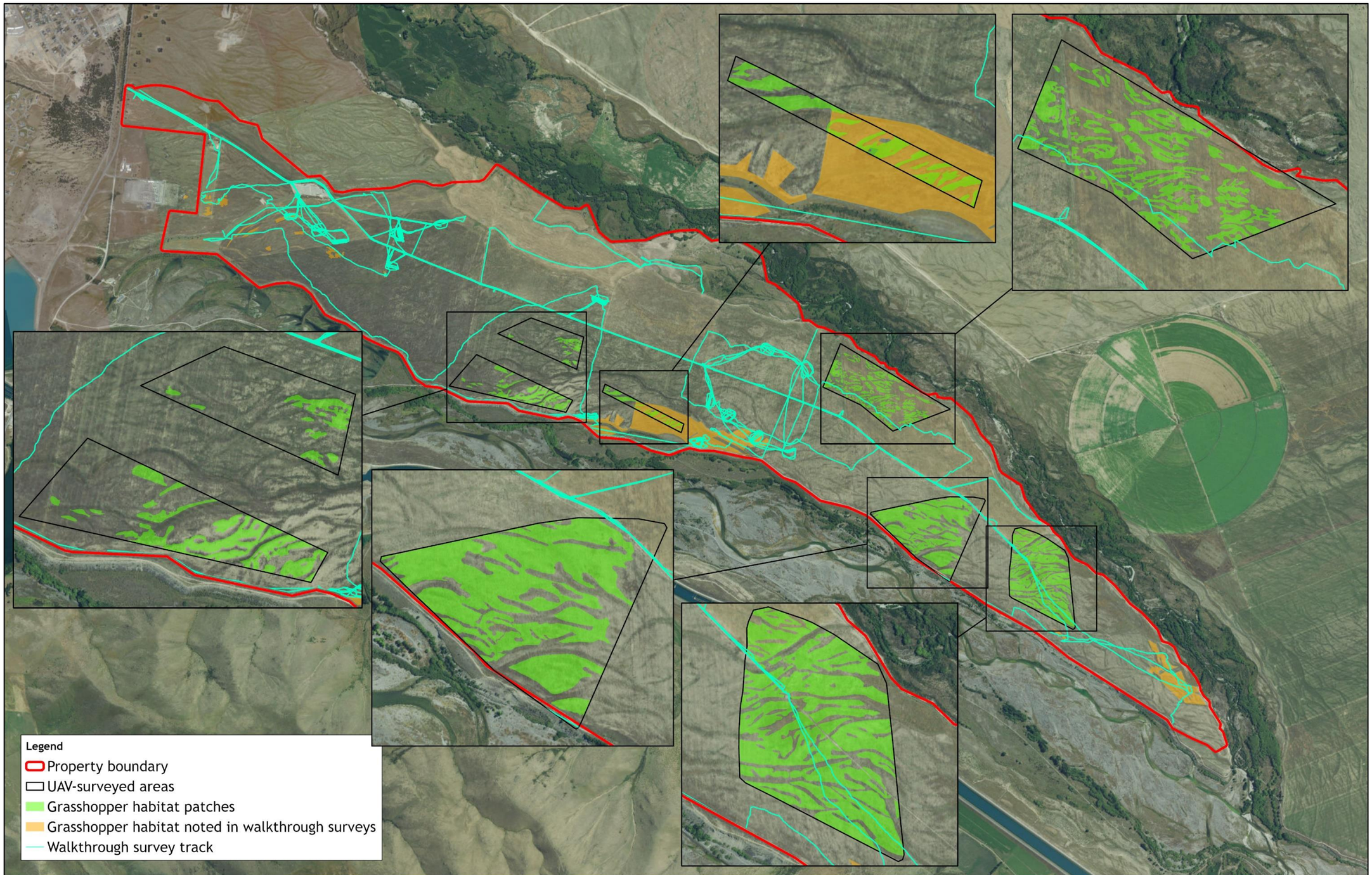

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Figure 11. Grasshopper habitat patches at the proposed solar farm site in Twizel

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Scale: 1:25,000
Date: 18/02/2025
Cartographer: LW
Format: A3R

9. FRESHWATER FAUNA

9.1 Desktop assessment

Within the waterways immediately adjacent to the proposed solar farm site, including the Twizel and Ōhau Rivers, there are 117 records of the presence of 11 fish species (Table 8).

Table 8: New Zealand Freshwater Fish Database records from waterways immediately adjacent to the proposed solar farm development. Threat status as listed in Dunn *et al*. 2018.

Scientific Name	Common Name	Number of NZFFD Records	Threat Status
Anguilla dieffenbachii	Longfin eel	5	At Risk - Declining
Galaxias brevipinnis	Koaro	20	At Risk - Declining
Galaxias cobitinis	Lowland longjaw galaxias	13	Threatened - Nationally Critical
Galaxias macronasus	Bignose galaxias	17	Threatened - Nationally Vulnerable
Galaxias paucispondylus	Alpine galaxias	1	At Risk - Naturally Uncommon
Galaxias vulgaris	Canterbury galaxias	21	At Risk - Declining
Gobiomorphus breviceps	Upland bully	59	Not Threatened
Gobiomorphus cotidianus	Common bully	10	Not Threatened
Oncorhynchus mykiss	Rainbow trout	20	Introduced and naturalised
Oncorhynchus nerka	Sockeye salmon	2	Introduced and naturalised
Salmo trutta	Brown trout	63	Introduced and Naturalised

Of these species, six are classified as At Risk or Threatened. Within the wider area the NZ Freshwater Fish Database records two additional species not found in the waterways immediately adjacent to the site. The additional species include a single record of kākahi/freshwater mussels (*Echyridella menziesii;* At Risk - Declining) in an upper tributary of Wairepo Creek, and a single record of chinook salmon (*Oncorhynchus tshawytscha*; Introduced and Naturalised) at the Ōhau A tailrace.

A significant proportion of the indigenous species found in the waterways adjacent to this proposed solar farm site are subject to some level of conservation concern. The nature of the Waitaki hydro system poses major challenges to many indigenous fish species. A large proportion of New Zealand's fish assemblage is migratory, requiring access to the sea to complete their lifecycle. Of the species identified in this area, only longfin eels are obligate migrants, to maintain populations of longfins within this system, there is a trap and transfer programme operation to shift juvenile elvers upstream, and migrant adults downstream. Two other indigenous species, kōaro, and common bullies, are typically considered as migratory species, but have been known to form successful landlocked populations. All other indigenous fishes present are non-migratory.

One of the most significant threats facing the non-migratory species is competition and predation pressure from introduced salmonid species. In this area, the abundance of salmonids is particularly high due to the number of salmon farms within the Upper Waitaki, increasing the predatory pressure of these species.

10. TERRESTRIAL INTRODUCED FAUNA

Targeted surveys for terrestrial introduced fauna were not undertaken as part of the site visit, however, lagomorph (European rabbit *Oryctolagus cuniculus cuniculus* and brown hare *Lepus europaeus occidentalis*) sign and browse was common throughout the site. Other introduced mammals are either confirmed or likely to be present permanently or periodically at the site, including feral cat (*Felis catus*), hedgehogs (*Erinaceus europaeus*), rodents (*Rattus rattus*) and mustelids (*Mustela* spp).

Mouse tracks were detected throughout the site in tracking tunnels set for Tekapo ground wētā (Section 8.2.3) and hedgehog tracks were found in the central third area of the site. A feral cat was spotted during tracking tunnel checks at the western end of the site.

11. STATUTORY ASSESSMENT

11.1 Ecological significance

Each vegetation and habitat type within the site was assessed against the ecological significance criteria in the Canterbury Regional Policy Statement (Appendix 2). All vegetation habitat types except 'Sweet briar shrubland' contained ecologically significant values, mostly because of habitat value for Threatened and At Risk indigenous fauna. This includes improved pasture vegetation types which provide habitat for minute grass hopper, McCanns skink and Tōrea/South Island pied oystercatcher potentially breed in these habitats at the site.

Thirteen of the 15 vegetation/habitat types met the criteria for rarity and distinctiveness as Threatened or At Risk vascular plant or indigenous fauna species are present in these habitats. The ephemeral wetland habitat also meets the criteria for rarity. Ephemeral wetlands are considered to be rare ecosystem types, and all wetland habitats are ecologically-significant due to widespread reduction and modification throughout Canterbury. Thus alder- and willow-dominant wetlands were also assessed as significant. Indigenous vegetation and habitats - including, flood channel shrubland, tall fescue marsh, scarp herbfield and grassland, (wildling conifer)/scarp herbfield and grassland, old river terrace and sweet vernal-mouse-ear hawkweed - met the significance criteria for ecological context, as they provide important habitat for indigenous fauna and/or connectivity across the site.

11.2 Mackenzie District Plan

Most of the vegetation within the site meets the definition of improved pasture (Table 9, Figure 12) and does not meet the definition of indigenous vegetation (although the two are not mutually exclusive) and therefore are not subject to indigenous vegetation clearance rules.

Seven vegetation habitat types present at the site met the definition of indigenous vegetation as defined in the Mackenzie District Plan (Table 9), and are therefore subject to rules relating to the clearance of indigenous vegetation. These areas are mostly on

the margins of the site, comprising uncultivated outwash plain, alluvial and scarp habitats (Figure 13).

Four natural wetlands are present on the site (Figure 13), Rule 8 of the Mackenzie District Plan vegetation clearance rules specifies that clearance may not occur within 50 metres of any wetland. All of the identified wetland habitat types meet the ecological significance criteria.

The quarry area was not assessed against District Plan provisions, as this is a consented activity, operated by a third party.

Table 9: Vegetation and habitat types evaluated against definitions for 'improved pasture' and natural wetland in the Mackenzie District Plan.

Vegetation Habitat Type	Status	Improved Pasture	Natural Wetland
1. Flood channel shrubland	Indigenous	No	**Yes**
2. Sweet briar shrubland	Exotic	No	No
3. Browntop-sweet vernal-clover grassland	Exotic	**Yes**	No
4. Alluvial grassland	Exotic	**Yes**	No
5. Scarp herbfield and grassland	Indigenous	No	No
6. [Wilding conifer]/scarp herbfield and grassland	Indigenous	No	No
7. Sweet vernal-mouse-ear hawkweed herbfield and grassland	Indigenous	No	No
8. Hares foot trefoil-sweet vernal grassland	Exotic	**Yes**	No
9. Old river terrace	Indigenous	No	No
10. Hares foot trefoil herbfield	Exotic	No	No
12. Ephemeral wetland	Indigenous	No	**Yes**
13. Tall fescue-rautahi marsh	Indigenous	No	**Yes**
14. Alder forest	Exotic	No	**Yes**
15. Crack willow forest	Exotic	No	**Yes**

12. ASSESSMENT OF POTENTIAL ADVERSE EFFECTS

12.1 Overview of potential effects

The proposed design for consenting has been influenced by ecological survey information provided by Wildland Consultants Ltd and includes solar panels located in exotic grassland at the site. The design includes minimum setbacks which will be applied post-consenting during the detailed design phase. A setback of 10 metres will be applied to Sites of Natural Significance and ecologically significant vegetation and habitat, whilst a 50-meter setback will be applied for wetlands. Depending on the final design, the proposed works may affect the ecology of the site due to requirements for the following activities:

- Earthworks – scale will depend on installation process and design.
- Shading –the impacts of shading has been reduced through use of tracking panel designs. However, some shading effects will remain.
- Long-term weed control –this effect will be determined by how much weed control is necessary and the methods by which it is undertaken.

- Introduction of new surfaces – the scale of impacts associated with this activity on Mackenzie basin fauna are largely unknown. The scale of this impact may also depend on design.
- Machinery movement around site – both during construction and ongoing. Protocols around the use of machinery will determine the scale of this effect.
- Auxiliary construction, such as buildings, poles, service roads or fences required for solar farm functioning.
- Indigenous plantings or other mitigation on-site.
- Rabbit and hare control– if applicable. The extent will be determined by how much weed control is necessary and the methods by which it is undertaken.

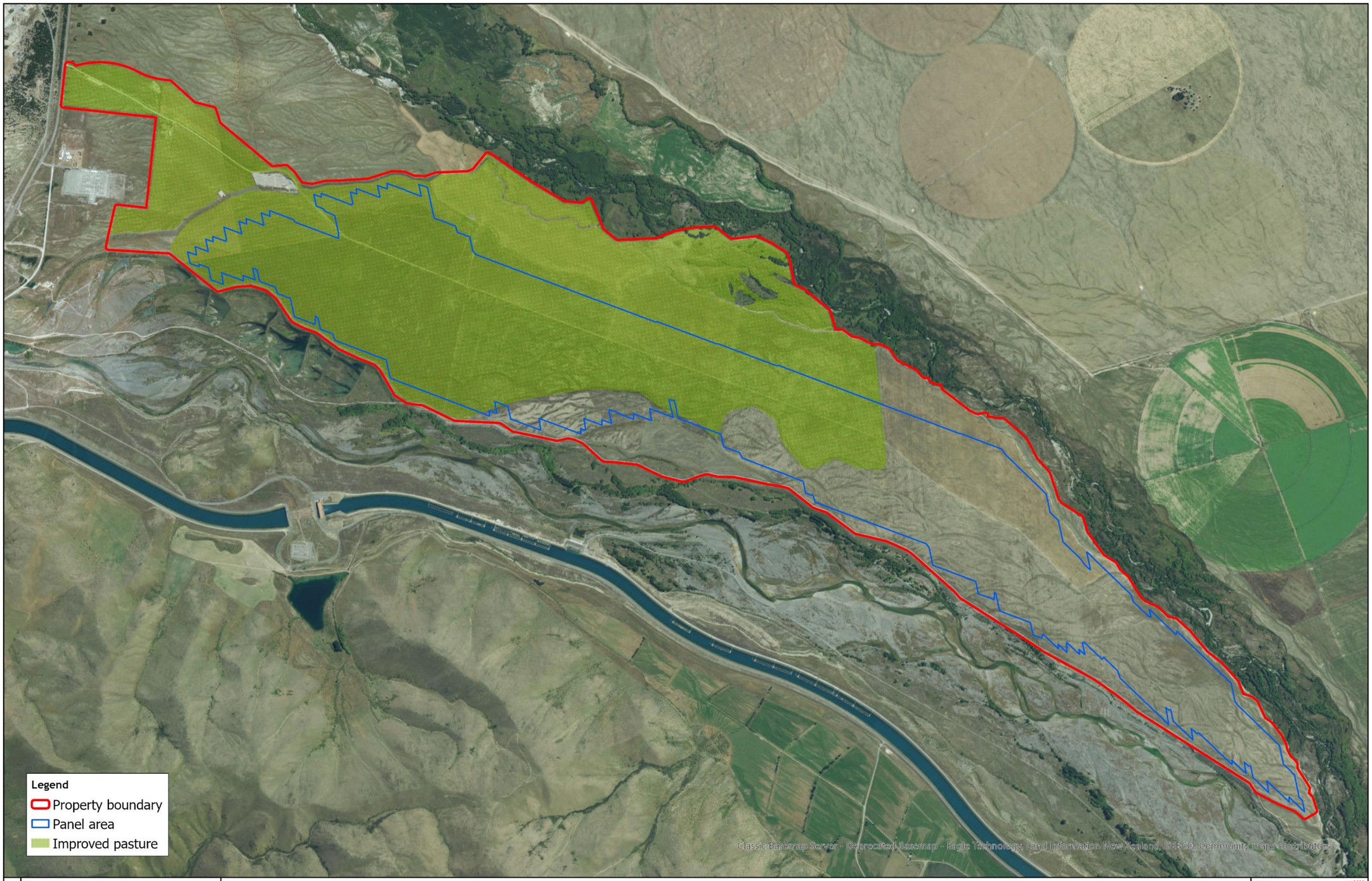
The site is currently subject to grazing and localised quarrying. Potential ecological effects resulting from the change in land use and establishment of the solar farm could include:

- Vegetation and flora:
  - Clearance of indigenous vegetation.
  - Microclimatic changes beneath solar panels, resulting in changes to vegetation.
  - Loss of At Risk or Threatened plants.
  - Modifications of wetland habitat.
  - Potential introduction of pest plants.

- Avifauna:
  - Loss of avifauna habitat.
  - Disturbance to indigenous breeding avifauna during construction.
  - Death or injury to indigenous breeding avifauna during construction.
  - Operational disturbance to avifauna.
  - Risk of bird strike with panel arrays.

- Lizards:
  - Disturbance (including death and injury) to lizards.
  - Loss of lizard habitat.
  - Fragmentation of lizard habitat.
  - Reduction of lizard habitat quality due to shading from panels.
  - Operational disturbance to lizards.
  - Disturbance to lizards during earthworks.
  - Breeding failure/displacement of lizards.

- Invertebrates:
  - Reduction in invertebrate habitat.
  - Mortality and disturbance of invertebrates.
  -
  - Reduction in invertebrate habitat quality due to shading.



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0 500 1,000 m

Figure 12. The distribution of improved pasture at the site

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Date: 12/06/2023
Cartographer: LW
Format: A3R

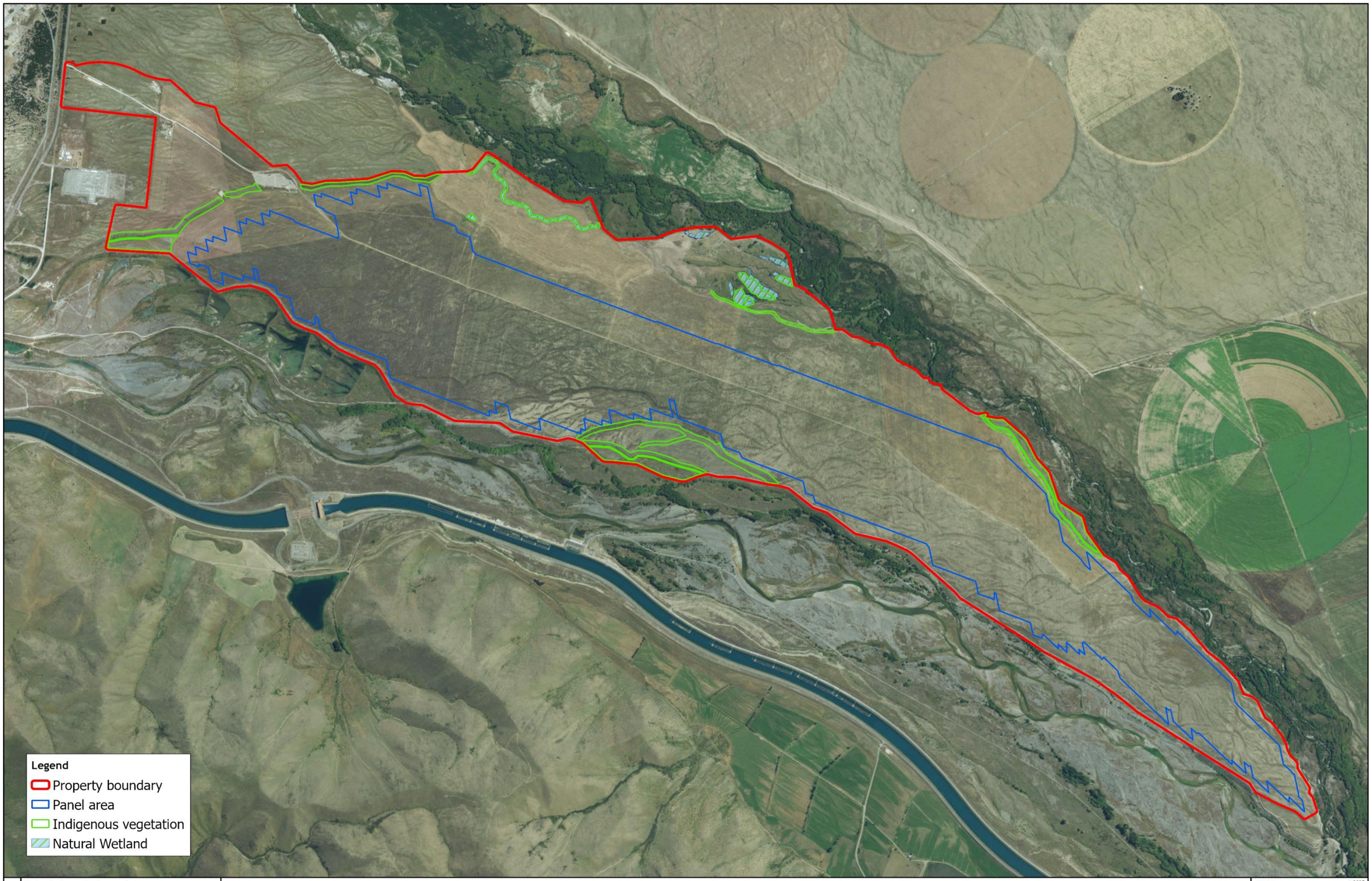

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Figure 13. The distribution of indigenous vegetation and natural wetlands at the site

0 500 1,000 m

Scale: 1:22,000
Date: 18/02/2025
Cartographer: LW
Format: A3R

It is considered likely that ongoing solar generation will require the control of vegetation within the development footprint to ensure that panels are not shaded. Specifically, it is likely that woody weeds such as wilding conifers may become established as a result of changes to land use. If wilding pines do become established, they will require control. However, insufficient information is available to assess this potential effect at present. The magnitude of effects associated with vegetation control around the development will depend on many factors, including how often vegetation is managed, how vegetation responds to altered microclimatic conditions, which species thrive at the site over time, and which weed management techniques are employed. Weeds could be managed mechanically, chemically, or through the use of grazing animals. These techniques will vary in the degree to which they affect indigenous biodiversity. Some of these techniques could potentially affect all elements of indigenous biodiversity outlined in this report. However, the most recent proposed panel area excludes indigenous vegetation. This means that control of weeds for operational reasons will only occur within exotic vegetation. However, management of ecological weeds is outlined in the Biodiversity Management Plan.

12.2 Vegetation and flora

Clearance of Significant Vegetation

Most of the vegetation present within the site is classified as exotic vegetation, with indigenous vegetation generally restricted to the margins of the site. All indigenous vegetation types present on the site are ecologically significant, due to the relatively small proportion of indigenous vegetation remaining, and depending on its scale and location, indigenous vegetation clearance may have more than minor adverse effects. However, based on the layout design provided to Wildland Consultants in November 2024, indigenous vegetation is excluded from the panel area, which would likely result in **less than minor adverse effects.**

Microclimate Changes Beneath Solar Panels, Resulting in Changes to Vegetation

Changes in the microclimate beneath the tracking solar panels may affect the floristic composition of the site. The proposed development area comprises exotic grassland, and species native to the Mackenzie Basin, which typically thrive in full sun. Therefore, species that thrive in shade, slightly lower temperatures, and increased soil moisture will likely colonise the spaces underneath the solar panels. These species are likely to be non-indigenous. This effect on the floristic composition of the site will be more than minor if notable plant species or habitats are affected. The current layout design includes a 10 meter setback from areas of significant indigenous vegetation, depending on the height of the panels and therefore sun angles, it is likely that this will be sufficient to reduce the level of effect to **minor**.

Modification of Wetland Habitat

Wetland habitats could be affected by potential earthworks (roading and construction) which could cause sediment to flow into these systems or impact the hydrology. All wetlands are in the northwestern part of the site and outside of the proposed panel area. The 2024 panel design concept is 94 m from an ephemeral wetland. Earthworks outside of a natural inland wetland, but within a 100 m setback from a natural wetland are a

non-complying activity and requires consent under some circumstances. It is unlikely that any earthworks will occur within 100 m of the ephemeral wetland. Ephemeral wetlands are rain fed only and therefore the proposed activities are not expected to impact the hydrology of the wetland. The impacts of the current design on wetlands are likely to be **less than minor**.

Loss of At Risk, Threatened, and Rare Plants

Seven Threatened or At Risk species were identified at the site during the site visit. These are largely located within indigenous vegetation habitat types on the margins of the site with only common mat daisy (*Raoulia australis)* and dwarf broom (*Carmichaelia vexillata)* located within the panel area. These species could be disturbed during construction, affected by weed control, or shaded out due to the presence of the solar panels. Depending on their height, the solar panels may limit the height of larger At Risk shrub species.

Field surveys undertaken in December 2022 focused on areas with indigenous vegetation and habitats, and further surveys for At Risk, Threatened and rare plants were undertaken over summer 2023 and 2024. The current layout has been designed and modified to avoid areas where threatened and at risk plants were detected. No Threatened or At Risk species have been observed within the currently proposed design. However, due to the size of the site it is possible that some species were not detected and therefore further surveys may be required once the final solar farm layout has been determined. In the interm, the present design is considered to potentially have a **minor adverse** effect.

Potential Introduction of Pest Plants

If proposed works require transport of roading aggregate, soil or fill for construction, there is the potential that these materials will be contaminated with seeds of pest plants and ecological weeds which are not already present at the site, particularly if roading materials are brought in from outside the area. This, combined with clearance of existing vegetation, would accelerate the estblishment of undesired species at the site, which could have **a minor to more than minor adverse effect**, depending on the species introduced.

12.3 Avifauna

There are five potential effects on avifauna: permanent habitat modification/loss (e.g. South Island pied oystercatcher breeding on farmland), displacement resulting from construction disturbance, especially along the Ōhau and Twizel Rivers and within the Department of Conservation black-stilt breeding centre; impacts on breeding birds (e.g. death or injury if breeding onsite), ongoing disturbance to birds during operation, and impact trauma (bird strike) with panel arrays.

Habitat Modification or Loss

The development of the solar farm may affect various indigenous species including tōrea/South Island pied oystercatcher which may lose foraging (and potentially breeding) habitat within the open grassland areas. Tarapirohe/black-fronted tern will

potentially lose foraging habitat for large insects, including grasshoppers and lizards, if the site becomes less suitable for these species. Similarly, although not observed during the site survey, pīhoihoi/New Zealand pipit (*Anthus novaeseelandiae novaeseelandiae*) and pohowera/ banded dotterel (*Charadrius bicinctus bicinctus*) may also breed and forage within open grassland. Without mitigation, this effect is likely to be **more than minor**.

Displacement of Breeding Avifauna

Disturbance from construction activities includes noise, vibration, machinery and human activity. This disturbance is likely to cause birds the change their behaviour and abandon or temporarily avoid the site (and surrounding area) during the breeding season. This leads to behavioural and physiological responses which are presumed to be costly, and can lead to changes in habitat use, parental care, reproductive failure and may have long-lasting effects on populations (Weston *et al*. 2012). There is a risk that the disturbance for construction activities will displace a number of Threatened and At Risk species in the Ōhau river, as well as affect the Department of Conservation kakī/black stilt captive breeding centre and nearby wetlands. Without mitigation, this effect is likely to be **more than minor**.

Death or Injury During Construction

If birds are breeding within the construction site, these birds will not only be subject to construction disturbance but also adults, chicks or eggs maybe injured or killed by ground clearance and machinery. Without mitigation, this effect is likely to be **more than minor**.

Ongoing Disturbance

The main access road will be unsealed and will run central of the solar farm with road networks. With the main vehicle movements being central of the solar farm, this will reduce the risk of ongoing disturbance of birds in the Ōhau or Twizel riverbeds due to the majority of vehicle movements being well away from the rivers. Vehicle movements and maintenance work will provide some ongoing disturbance in areas where an activity is being undertaken close to a river or for bird utilising the site. However, this will be generally be short term. If birds are breeding onsite, then activity will lead to disturbance. Vehicles movements through the solar farm can lead to disturbance, mortality or bird strike with vehicles due to birds breeding within gravel areas and can potentially use the vehicle tracks as breeding sites. This effect is likely to be **more than minor** without mitigation.

Risk of Bird Strike

The proposed solar array layout incorporates ground mounted solar panels in a tracking arrangement which allows the panels to follow the progression of the sun. Each tracking arrangement contains around 29 panels connected together. Each tracking arrangement is separated between each row of panels, by a service road that is five metres wide and unpaved, or by the central arterial road which is six metres wide and unpaved. The panels also incorporate an anti-reflective design which will minimise the potential of bird strike with the panels.

The roads between the panel tracking arrangements, breaks up the potential 'Lake Effect' and allow birds using the solar farm site, the ability to navigate the access corridors avoiding bird strikes. It also allows them to land or depart from the site given the access roads and corridors between blocks of panels are well-spaced. However, glare off solar panels may still look like water to overflying birds, attracting them to the site. Birds may either try to dive into or land on the panels or if the water is perceived as shallow. For this reason, the solar panels being used have been designed to absorb and not reflect light, greatly reducing any attraction to overflying birds. Therefore this effect is likely to be less than **minor**.

12.4 Lizards

Injury/Death/Displacement

The proposed solar farm may result in the permanent displacement, injury and death of individual lizards within the proposed solar farm development area. Without mitigation, this effect is likely to be **more than minor**.

Habitat Loss

Lizard habitat is present throughout the impact area and loss of habitats at this site may not be avoided. The size and extent of the proposed solar farm development area means the impact to lizard habitats could be **more than minor** without mitigation.

Habitat Fragmentation

Although the site is an active farm, lizard habitat is connected throughout the site and is comprised of areas of low to high quality habitats, all of which are connected across the site via fence lines, or unmaintained areas. The proposed solar farm will result in the fragmentation of habitats across a large site. These habitats will have varying levels of population density of at least one Not Threatened lizard (McCann's skink). Without mitigation, this effect is likely to be **minor**.

Reduction of Lizard Habitats Due to Shading

Lizard habitats within the site could be shaded due to the installation of solar panels, resulting in the gradual shift in vegetation and species composition. This could reduce population abundance of lizards on site. Without mitigation, this effect is likely to be **minor**, due to the likely low densities of lizard populations over most of the site.

Operational Disturbance

Vehicle strikes, noise and dust may affect lizard populations along newly-formed roads and vehicle accessways in areas adjacent to lizard habitat (e.g. where rock piles or ground cover vegetation is present along fence lines). While there is limited published literature about the impacts of dust on lizards, it is likely that lizards would avoid habitat if there was heavy dust deposition. Dust build up may also contribute to the deposition and increased growth of weedy vegetation within areas of rock piles on site, reducing

interstitial spaces for lizards and therefore reducing habitat quality. Without mitigation, this effect is likely to be **minor**.

Disturbance During Earthworks

Disturbance during construction to lizards includes dust, vibration, and noise. This disturbance is likely to disrupt normal behaviour, including social dynamics in lizard populations adjacent to the site footprint as a result of earthworks. Without mitigation, across the site, this effect is likely to be **minor**.

Breeding Failure/Avoidance

The proposed solar farm and associated earthworks may affect the behaviour of lizards, potentially altering social interactions and increasing stress, leading to reduced population functionality, poor breeding and low population recruitment. Without mitigation, this effect is likely to be **less than minor**, due to the likely low densities of lizard populations over most of the site.

12.5 Invertebrates

Reduction in Invertebrate Habitat

Habitat for notable invertebrates has been identified within the proposed development footprint. The proposed development will remove a small amount of habitat that may support notable invertebrates at this site. Without mitigation this effect would potentially be **significant** if it occurred in the area of high minute and Otago short-horned grasshopper activity, on the central southern river terrace. Over the rest of the site, the effect is likely to be **minor**.

Mortality and Disturbance of Invertebrates

All earthworks, including for the placement of trenching wires and the cut-fill earthworks for establishing contours, will cause the removal and destruction of any notable invertebrates present on the surface of the ground during works. This is likely to affect the Tekapo ground wētā particularly, if any burrows are unearthed during works. Vehicle strikes will also cause the death of invertebrates. Dust and vibrations associated with earthworks are likely to disturb insects and affect their behaviour. Little has been published on the effects of dust on invertebrates, but dust settling on insect bodies may cause injury from abrasion and/or blocking of external breathing apparatus.

Vehicle strikes, vibration, and dust from ongoing maintenance works may affect invertebrate populations near newly-formed roads and vehicle accessways, particularly if they approach the river bed.

Without mitigation, this effect is likely to be **minor**.

Reduction of Habitat Quality Due to Shading

High quality habitats within the site could be shaded out due to the solar panels. Shading has the double-edged effect of both reducing habitat quality through a gradual shift in vegetation composition and structure, and reducing sunlight availability for basking species such as robust and minute grasshoppers. The creation of shaded areas is likely to benefit the New Zealand blue butterfly, but overall, this effect is likely to have adverse effects that are **significant**[1]**.** The tracking array technology reduces the amount of permanent shading, but rotating solar panels have been found to alter soil, temperature, and moisture microclimates underneath them due to the effects of dynamic shading patterns. This may impact plant and invertebrate communities (Grodsky & Hernandez, 2020; Li et al., 2025; Liu et al., 2019). Some effects will therefore remain due to the solar panels blocking the sunlight's path to the ground. As a result, vegetation is likely to grow taller underneath the solar panels, due to the increased moisture and shading from the sun (Li et al., 2025).

12.6 Freshwater

While there are no waterways within the area of the proposed site, consideration of the surrounding waterways remains important. Works will result in the disturbance of sediment, the quantity of which will depend on the method of construction. Sediment has the potential to enter waterways through overland flows, this can have a number of negative effects on freshwater fauna species. Small galaxiids and bullies, as well as many macroinvertebrate species utilise hard surfaces and interstitial spaces for foraging, spawning and shelter, an increase in fine sediment within the waterways they inhabit would result in loss of this habitat (Ryan 1991; Jowett and Boustead 2001).

Sedimentation of a waterway can result in a decrease in the survival rate of fish eggs as it can reduce both space and oxygen availability within the interstitial spaces of the substrate (Ryan 1991), impacting the recruitment rates of fish that spawn in the area. Sedimentation can also lead to an increase in invertebrate drift as habitat becomes less suitable, this can result in a change in the community composition, diversity and abundance (Mathers *et al*. 2022; Davis *et al*. 2022). Changes in macroinvertebrate community would cause follow on effects on the fish species that feed on them. Finally, sedimentation can also reduce the availability of refuges within the substrate for small indigenous fish species, which can increase the likelihood of negative interactions with introduced salmonids (Coughlan 2022; Sowersby *et al*. 2015).

Without mitigation, the impact of sediment in surrounding waterways could be **more than minor**.

[1] This effect level has been upgraded to **significant** from **more than minor** due to the results from the targeted grasshopper and wētā surveys, and the Tekapo ground wētā tracking tunnel survey, which revealed populations of At Risk and Threatened invertebrates over large portions of the site that will be covered with solar panels.

13. EFFECTS MANAGEMENT

13.1 Vegetation

Avoidance of Notable Plant Species and Habitats

The current solar panel area mostly comprises improved pasture and exotic vegetation. The proposed design for consenting avoids areas with indigenous vegetation and ecologically-significant vegetation and wetlands and known locations of Threatened and At Risk plants.

Earthworks should not be undertaken within the vicinity of any wetlands (as specified in the Mackenzie District Plan Vegetation Clearance rules) to avoid adverse effects on wetland hydrology and through sedimentation.

The proposed design for consenting avoids all known areas of threatened and at risk species. When the final solar farm layout has been determined, it should be assessed by an experienced vegetation ecologist to ensure that no Threatened or At Risk plants are present in areas of proposed works. If the solar farm activities during construction and ongoing activity avoid wetlands, indigenous vegetation and Threatened and At Risk plants, then the effects on indigenous vegetation and habitats will be **less than minor.**

Adherence to the Biosecurity Management Plan

Risk of introduction of pest plants can be mitigated by utilising the existing access road as much as possible and avoiding indigenous vegetation habitats. Any gravel, soil or fill bought into the site should be sourced locally where practical. Surveillance and follow up control of pest plants and ecological weeds should be undertaken to ensure further spread of these species does not occur. If the above actions are implemented and the steps outlined in the Biosecurity Management Plan (Wildlands 2025d) are followed then effects of weed spread will be **less than minor**.

13.2 Avifauna

Avoidance of Breeding Season or Breeding Individuals

The proposed solar farm footprint is to be developed mostly in grassland of various types, and although readily available in the surrounding areas, the habitat loss will affect breeding and foraging birds if construction work occurs during the breeding season. Construction activities during the breeding season (July – March) are likely to injure or kill breeding birds, eggs, and chicks. Ideally, as much construction work as possible should occur outside the bird breeding season. However, given the size of the project, it is inevitable that some of the construction will occur during the breeding season, and therefore the Avifauna Management Plan (Wildlands 2025c) will need to be implemented.

Disturbance During Construction

Proposed works must avoid disturbing birds in the rivers and wetland areas adjacent to the site. To avoid this disturbance, a buffer area of 50 metres from wetlands, 75 metres

of the Ōhau River and river delta and 100 metres from the Twizel River and delta, should be maintained between the near edge of rivers/wetlands and any area where machinery and power tools are being used. In particular, the river delta near the southeastern corner of the site and the area of wetland and river bed on the southwestern side of the site should be left undisturbed. It is noted however that a public gravel road is located adjacent to the property's southern boundary, along the Ōhau River. The area of wetland in the southwestern side of the site is part of the Department of Conservation kakī/black stilt captive breeding centre. The Department of Conservation should be consulted before any works proceed.

13.3 Lizards

Avoid High and Moderate-Quality Lizard Habitats

Where high and moderate-quality lizard habitats are present, effects from solar farm development should avoid these habitats as far as possible. This includes in particular areas of scarp herbfield and grassland and old river terrace. Avoidance of high and moderate-quality habitats should be the most important measure considered for the mitigation of effects on lizards at the site.

High and moderate-quality habitat areas could provide the basis for protected areas and ongoing enhancement.

Project Design that Includes Corridors

Corridors could also be created – whereby additional areas of land are avoided – within the site to provide connectivity for species across the wider site, and to link habitats, both of high and low quality. Some habitat enhancement within lizard corridors could also be undertaken.

Lizard Management Plan (LMP)

A LMP has been prepared for the project (Wildlands 2025b), in order to address potential adverse effects on lizards from the proposed solar farm development. Details of lizard management are included in detail in the LMP, and include avoidance of high and moderate-quality lizard habitats and the creation of lizard corridors, which include areas of habitat enhancement.

Site development with the implementation of the measures detailed in the LMP would result in a **less than minor** adverse effect on lizards.

13.4 Invertebrates

Habitat Avoidance

Destruction of indigenous legumes (such as indigenous broom) and indigenous flowering plants should be avoided where possible to ensure continued access to these for breeding and feeding for New Zealand blue butterfly. Loss of areas of bare ground and rock should be avoided where possible, to minimise loss of basking areas for New Zealand blue butterfly. These areas appear to be excluded from the current panel layout

(Figure 1). The most important habitats are around the perimeter of the site, which is being avoided.

Short-stature herbs, even invasive species such as hawkweed, should not be controlled unless they are going to be replaced with indigenous herbfield vegetation (see Habitat Restoration below). Short-stature herbs can provide important habitat for minute and Otago short-horned grasshoppers.

Use Grasshopper-Friendly Weed Control Techniques

Pesticide or herbicide sprays must not be used within or near short-stature herbs, areas of bare ground, or any areas identified so far as being potential or confirmed minute or short-horned grasshopper habitat. They must also be avoided anywhere Tekapo ground wētā have been found or are suspected (Figure 10). Weed control should instead be mechanical, hand-weeding, or use cut and paste herbicide.

Dust Management

Managing dust will avoid its impact on indigenous invertebrates. Management measures should include:

- Using water trucks to dampen dusty tracks before and during use.
- Implementing and enforcing speed limits. The speed limits should be decided based on dust levels caused by vehicles moving at different speeds.
- Avoiding work during particularly dry weather if work sites cannot manage dust using other methods.

Invertebrate Management Plan

A Terrestrial Invertebrate Management Plan (TIMP) has been developed (Wildlands 2025a). The TIMP outlines habitat protection and enhancement, and salvage and translocation protocols.

Habitat Restoration

A large area of suitable habitat may need to be enhanced and protected in order to balance the loss of important invertebrate habitat present on site. The site contains several patches of dry, open habitat that could be enhanced or restored for indigenous invertebrates such as short-horned grasshopper and minute grasshopper.

Grazing

Grazing should be encouraged throughout the panel area to keep the exotic grasses short. This will minimise the habitat modification effects for Tekapo ground wētā and potentially also minute and Otago short-horned grasshoppers. It will also minimise exotic grasses smothering herbfield vegetation.

Predator Control

Predator control throughout the site, through implementation of a pest mammal management plan designed by a suitably-qualified ecologist, would provide benefits for terrestrial invertebrates. A pest mammal management plan has been prepared by Wildlands (2024). Changes to predator control that deviate from the plan should be discussed with a suitably-qualified ecologist prior to implementation.

Salvage and Translocation

Populations of Tekapo ground wētā and minute and short-horned grasshoppers that are within the area to be covered with solar panels, roads, or other infrastructure (Figure 1) should be salvaged and translocated using the protocols specified in the TIMP (Wildlands 2025).

Incidental Discovery Protocol

The protocol outlined in the TIMP (2025) should be followed during construction, particularly in areas that have been identified as potential minute or Otago short-horned grasshopper habitat.

If these measures are implemented, it is likely that the effects of the development would be reduced to **minor**. However, compensation may be considered if monitoring shows that salvage and translocation efforts are not successful.

13.5 Freshwater fauna

A sediment management plan is required to ensure that there are no accidental discharges of disturbed sediment into the surrounding waterways. This should include consideration of the timing of works timing to avoid periods when high rainfall events are predicted.

A setback from the surrounding waterways would also reduce the risk of sediment or incidental chemical pollution occurring.

13.6 Wildlife management

13.6.1 Overview

A Wildlife Act permit is required to carry out activities that have adverse impacts on some indigenous fauna (Department of Conservation 2018). Measures are set out below for avifauna, lizards, and terrestrial invertebrates.

13.6.2 Avifauna

If vegetation clearance is to be undertaken during the avifauna breeding season, the Avifauna Management Plan (Wildlands 2025c) should be implemented to avoid and mitigate adverse effects. A pre-construction survey of braided river bird nesting activity should be undertaken, and any active nests near the site provided with a buffer to protect them from disturbance.

13.6.3 Lizards

As legally protected species of lizards have been confirmed present within the site, and at least some adverse effects on lizards are likely to be unavoidable, a LMP has been prepared for the project (Wildlands 2025b). LMPs are often required as a resource consent condition, as are continuing to meet all other legal obligations when carrying out consented activities.

The Department of Conservation will need to be confident that, on balance, lizard populations will not be worse off than prior to development of the site. The LMP provides a comprehensive plan that clearly addresses the potential losses of lizard populations and their habitats. Management actions detailed in the LMP include avoidance of high and moderate-quality habitats, habitat enhancement and lizard population monitoring at specific sites.

13.6.4 Invertebrates

Due to the presence on-site of minute grasshopper, Tekapo ground wētā, and Otago short-horned grasshopper the TIMP (Wildlands 2025) should be implemented to minimise impacts on these species.

13.7 Ecological enhancement

Ecological enhancement could result in habitat improvement through the removal of pest plants and the planting of ecologically-appropriate species. Ecological enhancement should also include predator control to improve habitat for lizards, invertebrates, and breeding birds. To ensure the protection of indigenous vegetation, these areas may need to be fenced to exclude lagomorphs (rabbits and hares).

Any area that is enhanced or protected should be legally protected to ensure that biodiversity loss does not occur over the lifetime of the project. A QEII covenant is an option for legal protection. Consent conditions could include legal protection, such as a QEII covenant, to ensure that biodiversity loss does not occur over the lifetime of the project.

13.8 Overall assessment of ecological effects

The types and levels of ecological effects on indigenous biodiversity if the mitigation measures provided in this report are implemented is presented in Table 10. Accurate prediction of the level of effects with mitigation in place is somewhat difficult but the assessment in Table 10 gives an indication of how effects can be reduced significantly with appropriate and effective mitigation.

Table 10: Ecological effects following implementation of appropriate and effective mitigation.

Effect	Level of Adverse Effect Without Mitigation	Level of Adverse Effect With Mitigation
Clearance of significant vegetation	Less than minor	Less than minor
Microclimatic changes beneath solar panels, resulting in changes to vegetation.	Minor	Less than minor
Modifications to wetland habitat	Less than minor	Less than minor
Loss of At Risk, Threatened, and rare plants	More than minor	Less than minor
Risk of introduction of pest plants	Minor to more than minor	Less than minor
Avifauna habitat modification or loss	More than minor	Less than minor
Displacement of breeding fauna	More than minor	Less than minor
Death or injury to avifauna during construction	More than minor	Less than minor
Death or injury of avifauna during construction	More than minor	Less than minor
Ongoing disturbance of avifauna	More than minor	Minor
Risk of bird strike	Less than minor	Less than minor
Injury/death/displacement of lizards	More than minor	Less than minor
Loss of lizard habitat	More than minor	Less than minor
Fragmentation of lizard habitat	Minor	Less than minor
Reduction of lizard habitat quality (shading from panels)	Minor	Less than minor
Operational disturbance to lizards	Minor	Less than minor
Disturbance to lizards during earthworks	Minor	Less than minor
Breeding failure/displacement of lizards	Less than minor	Less than minor
Reduction in invertebrate habitat	Minor	Less than minor
Mortality and disturbance to invertebrates	Minor	Negligible
Reduction in invertebrate habitat quality due to shading	Significant	Minor
Sedimentation of nearby rivers	More than minor	Less than minor
Ongoing weed management impacts on all biodiversity types	Not assessed	Not assessed

Overall, there are numerous ways through which biodiversity could be affected, including some effects that could be more than minor. The ecological impact of this development could be substantial if the project is not designed appropriately to address the significant ecological features and values known to be present at this site.

Notably, most of these impacts can be reduced greatly if the project is implemented in an ecologically-sensitive manner. Designing the project to avoid areas that are important to biodiversity will be extremely important for the maintenance of indigenous biodiversity at this site. The management plans which have been produced by suitably qualified and experienced ecologists (Wildland Consultants 2025a-d) are necessary to ensure that potential adverse effects are adequately addressed in this project.

14. CONCLUSIONS

This report provides an assessment of potential ecological effects of a proposed solar energy development in the Mackenzie Basin. Various desktop and field surveys underpin the findings presented in this report. Despite being relatively degraded by cultivation, the site includes significant indigenous biodiversity values, mostly distributed around the margins of the site. Significant biodiversity values were not detected across most of the proposed panel area, but undetected values may be present.

Important biodiversity at the site includes:

- Wetland habitats.
- Seven plant species classified as At Risk or Threatened.
- Eight Threatened and nine At Risk avifauna species may be present at the site.
- Three lizard species have been confirmed at the site, with two species being At Risk and one species Not Threatened.
- Two Threatened and one At Risk (Declining) terrestrial invertebrate species.

Nearby braided rivers comprise a naturally rare and threatened ecosystem type, and provide habitat for diverse significant biodiversity, including four At Risk and two Threatened fish species.

Various potentially adverse ecological effects have been identified in this report. Many of the potential adverse effects can be managed effectively through avoidance, some avoidance has already been proposed in the updated concept design. However, additional effects management, such as habitat restoration and the implementation of management plans, is required to manage other potential adverse ecological effects.

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VASCULAR PLANT SPECIES RECORDED AT THE SITE

Species	Common Name	Plant Type	Status
Achillea millefolium	Yarrow	Forb	Exotic
Aciphylla aurea	Golden spaniard	Forb	Indigenous Endemic
Agrostis capillaris	Browntop	Graminoid	Exotic
Aira caryophyllea	Silvery hair grass	Graminoid	Exotic
Alnus glutinosa	Common alder	Tree	Exotic
Alopecurus geniculatus	Kneed foxtail	Graminoid	Exotic
Anthoxanthum odoratum	Sweet vernal	Graminoid	Exotic
Bromus species		Graminoid	Indigenous Non-Endemic
Bromus tectorum	Cheatgrass	Graminoid	Exotic
Bulbinella angustifolia		Graminoid	Indigenous Endemic
Capsella bursa-pastoris	Shepherds purse	Forb	Exotic
Carex breviculmis	Hooked sedge	Graminoid	Indigenous Non-Endemic
Carex coriacea	Rautahi	Graminoid	Indigenous Endemic
Carex kaloides		Graminoid	Indigenous Endemic
Carex leporina	Oval sedge	Graminoid	Exotic
Carex secta	Pūkio	Graminoid	Indigenous Endemic
Centipeda minima	Sneezeweed	Forb	Indigenous Non-Endemic
Cerastium fontanum	Mouse-ear chickweed	Forb	Exotic
Cirsium arvense	Californian thistle	Forb	Exotic
Cirsium vulgare	Scotch thistle	Forb	Exotic
Convolvulus verecundus f. verecundus		Forb	Indigenous Endemic
Coprosma propinqua	Mikimiki	Tree	Indigenous Endemic
Cytisus scoparius	Broom	Shrub	Exotic
Dactylis glomerata	Cocksfoot	Graminoid	Exotic
Discaria toumatou	Tūmatakuru, matagouri	Tree	Indigenous Endemic
Echium vulgare	Vipers bugloss	Forb	Exotic
Eleocharis acuta	Spike sedge	Graminoid	Indigenous Non-Endemic
Epilobium ciliatum	Tall willowherb	Forb	Exotic
Erodium cicutarium	Storksbill	Forb	Exotic
Erythranthe guttata	Monkey musk	Forb	Exotic
Festuca novae-zelandiae	Hard tussock	Graminoid	Indigenous Endemic
Festuca rubra	Red fescue	Graminoid	Exotic
Galium aparine	Cleavers	Forb	Exotic
Galium palustre	Marsh bedstraw	Forb	Indigenous Non-Endemic
Glossostigma diandrum		Forb	Indigenous Endemic
Holcus lanatus	Yorkshire fog	Graminoid	Exotic
Hypericum perforatum	St Johns wort	Subshrub	Exotic
Hypochaeris radicata	Catsear	Forb	Exotic
Juncus articulatus	Jointed rush	Graminoid	Exotic
Juncus bufonius	Toad rush	Graminoid	Exotic
Juncus conglomeratus	Soft rush;	Graminoid	Exotic
Juncus effusus	Soft rush	Graminoid	Exotic
Juncus tenuis	Track rush	Graminoid	Exotic
Leontodon taraxacoides	Hawkbit	Herb	Exotic
Limosella lineata	Mudwort	Forb	Indigenous Non-Endemic
Linum catharticum	Purging flax	Forb	Exotic
Lolium arundinaceum	Tall fescue;	Graminoid	Exotic
Lolium species		Graminoid	Exotic
Lotus pedunculatus	Lotus	Forb	Exotic
Lupinus polyphyllus	Russell lupin	Forb	Exotic
Marrubium vulgare	Horehound	Forb	Exotic
Melicytus alpinus	Porcupine shrub	Shrub	Indigenous Endemic
Microtis unifolia	Māikaika, onion orchid	Forb	Indigenous Non-Endemic

Species	Common Name	Plant Type	Status
Muehlenbeckia australis	Puka	Vine	Indigenous Non-Endemic
Muehlenbeckia axillaris	Pōhuehue	Vine	Indigenous Non-Endemic
Myosotis laxa	Water forget-me-not	Forb	Exotic
Navarretia squarrosa	Californian stinkweed	Forb	Exotic
Orobanche minor	Broomrape	Forb	Exotic
Phleum pratense	Timothy	Graminoid	Exotic
Pilosella officinarum	Mouse-ear hawkweed	Forb	Exotic
Pilosella praealta	King devil	Forb	Exotic
Pinus contorta	Lodgepole pine	Tree	Exotic
Pinus nigra	Black pine	Tree	Exotic
Plantago lanceolata	Narrow-leaved plantain	Forb	Exotic
Poa cita	Silver tussock	Graminoid	Indigenous Endemic
Poa pratensis	Kentucky blue grass	Graminoid	Exotic
Poa trivialis	Rough stalked meadow grass	Graminoid	Exotic
Potamogeton cheesemanii	Mānahi	Forb	Indigenous Non-Endemic
Potentilla anserinoides	Kōwhai kura, Silver weed.	Forb	Indigenous
Prunella vulgaris	Selfheal	Forb	Exotic
Ranunculus glabrifolius	Kawariki	Forb	Indigenous Non-Endemic
Ranunculus repens	Creeping buttercup	Forb	Exotic
Ranunculus sceleratus	Celery-leaved buttercup	Forb	Exotic
Raoulia australis	Common mat daisy	Subshrub	Indigenous Endemic
Rosa rubiginosa	Sweet brier	Shrub	Exotic
Rumex acetosella	Sheep's sorrel	Forb	Exotic
Rumex crispus	Curled dock	Forb	Exotic
Salix fragilis	Crack willow	Tree	Exotic
Sambucus nigra	Elder	Shrub	Exotic
Schoenus pauciflorus	Bog rush, sedge tussock	Graminoid	Indigenous Endemic
Sedum acre	Stonecrop	Forb	Exotic
Silene species		Forb	Exotic
Solanum dulcamara	Bittersweet	Subshrub	Exotic
Sonchus asper	Prickly puha	Forb	Exotic
Stellaria alsine	Bog stitchwort	Forb	Exotic
Stellaria media	Chickweed	Forb	Exotic
Thelymitra longifolia	Māikaika, white sun orchid	Forb	Indigenous Non-Endemic
Trifolium arvense	Haresfoot trefoil	Forb	Exotic
Trifolium dubium	Suckling clover	Forb	Exotic
Trifolium pratense	Red clover	Forb	Exotic
Trifolium repens	White clover	Forb	Exotic
Verbascum thapsus	Woolly mullein	Forb	Exotic
Verbascum virgatum	Moth mullein	Forb	Exotic
Veronica serpyllifolia	Turf speedwell	Forb	Exotic
Veronica verna	Spring speedwell	Forb	Exotic
Vulpia myuros	Vulpia hair grass, rats tail fescue	Graminoid	Exotic
Wahlenbergia albomarginata	New Zealand harebell	Forb	Indigenous Endemic

EVALUATION OF THE ECOLOGICAL SIGNIFICANCE OF VEGETATION AND HABITATS USING THE CANTERBURY REGIONAL POLICY STATEMENT APPENDIX 3 CRITERIA SET[1]

Ecological Significance Criteria	Indigenous Habitat							Exotic Habitats			
	Ephemeral wetland	**Flood channel shrubland**	**Tall fescue-rautahi marsh**	**Scarp herbfield and grassland**	**[Wilding conifer]/scarp herbfield and grassland**	**Old river terrace**	**Sweet vernal-mouse-ear hawkweed herbfield and grassland**	**Improved pasture (**Browntop-sweet vernal-clover grassland, Alluvial grassland, Hares foot trefoil herbfield, Hares foot trefoil-sweet vernal grassland**)**	**Sweet briar shrubland**	**Crack willow forest**	**Alder forest**
Representativeness											
1. Indigenous vegetation or habitat of indigenous fauna that is representative, typical or characteristic of the natural diversity of the relevant ecological district. This can include degraded examples where they are some of the best remaining examples of their type, or represent all that remains of indigenous biodiversity in some areas.	This criterion is not met	This criterion is not met	This criterion is not met	This criterion is not met	This criterion is not met	This criterion is not met	This criterion is not met	This criterion is not met	This criterion is not met	This criterion is not met	This criterion is not met
2. Indigenous vegetation or habitat of indigenous fauna that is a relatively large example of its type within the relevant ecological district.	This criterion is not met	This criterion is not met	This criterion is not met	This criterion is not met	This criterion is not met	This criterion is not met	This criterion is not met	This criterion is not met	This criterion is not met	This criterion is not met	This criterion is not met
Rarity/Distinctiveness											
3. Indigenous vegetation or habitat of indigenous fauna that has been reduced to less than 20% of its former extent in the Region, or relevant land environment, ecological district, or freshwater environment.	**Criterion met**. Land use intensification and pastoral development have resulted in an estimated loss of 90% of wetlands in Canterbury	This criterion is not met	**Criterion met**. Land use intensification and pastoral development have resulted in an estimated loss of 90% of wetlands in Canterbury	This criterion is not met	This criterion is not met	This criterion is not met	This criterion is not met	This criterion is not met	This criterion is not met	**Criterion met**. Land use intensification and pastoral development have resulted in an estimated loss of 90% of wetlands in Canterbury	**Criterion met**. Land use intensification and pastoral development have resulted in an estimated loss of 90% of wetlands in Canterbury
4. Indigenous vegetation or habitat of indigenous fauna that supports an indigenous species that is Threatened, At Risk or uncommon, nationally or within the relevant ecological district.	**Criterion met**. Indigenous avifauna may use this site to forage, including kotoreke/marsh crake (*Zapornia pusilla affinis*, At Risk – Declining), and Māpunga/black shag (*Phalacrocorax carbo novaehollandiae,* At Risk –Relict) and kawaupaka/little shag (*Microcarbo melanoleucos brevirostris*, ,At Risk – Relict) and pārera/grey duck (*Anas superciliosa*,	This criterion is not met	**Criterion met**. *Carex kaloides* (At Risk-Declining) is present. Indigenous avifauna may use this site to forage and breed, including kotoreke/marsh crake (*Zapornia pusilla affinis*, At Risk – Declining).	**Criterion met**. *Convolvulus verecundus f. verecundus* **,** *Pimelia sericeovillosa* subsp. pulvinaris**,** and *Rytidosperma exiguum* are present. Indigenous avifauna may use this site to forage and breed. At Risk indigenous lizard species (southern grass skink and Southern Alps gecko) are found in this habitat. New Zealand blue butterfly are found in this habitat. At Risk and	**Criterion met**. Three species listed as At-Risk Declining, *Carmichaelia vexillata, Raoulia australis, and Carmichaelia petriei* (all At Risk-Declining), are present within this vegetation type. At Risk indigenous lizard species (southern grass skink) are found in this habitat. At Risk and Threatened invertebrates may be present in this habitat. Indigenous avifauna may use	**Criterion met**. *Convolvulus verecundus f. verecundus* (Threatened-Nationally Vulnerable) is present. Indigenous avifauna may use this site to forage and breed. At Risk indigenous lizard species (southern grass skink) are found in this habitat.	**Criterion met**. *Carmichaelia petriei and Convolvulus verecundus f. verecundus are* present. At Risk indigenous lizard species (southern grass skink and Southern Alps gecko) are found in this habitat. Indigenous avifauna may use this site to forage and breed.	**Criterion met.** Tōrea/South Island pied oystercatcher (*Haematopus finschi,* At Risk – Declining) is present and possibly breeding, and other avifauna may use this site to forage and breed. Minute grass hopper, (Threatened-Nationally Vulnerable), is present on the central southern terrace, Otago short-horned grasshopper (At Risk – Declining) is present on the western side, and Tekapo Ground Wētā (Threatened – Nationally Endangered) is present in parts of the site.	This criterion is not met	This criterion is not met	This criterion is not met

[1] The quarry area was not evaluated for ecological significance

Ecological Significance Criteria	Indigenous Habitat							Exotic Habitats			
	Ephemeral wetland	**Flood channel shrubland**	**Tall fescue-rautahi marsh**	**Scarp herbfield and grassland**	**[Wilding conifer]/scarp herbfield and grassland**	**Old river terrace**	**Sweet vernal-mouse-ear hawkweed herbfield and grassland**	**Improved pasture (**Browntop-sweet vernal-clover grassland, Alluvial grassland, Hares foot trefoil herbfield, Hares foot trefoil-sweet vernal grassland**)**	**Sweet briar shrubland**	**Crack willow forest**	**Alder forest**
	Threatened – Nationally Vulnerable) within the pond area..			Threatened invertebrates may be present in this habitat.	this site to forage and breed.						
5. The site contains indigenous vegetation or an indigenous species at its distribution limit within Canterbury Region or nationally.	This criterion is not met	This criterion is not met	This criterion is not met	This criterion is not met	This criterion is not met	This criterion is not met	This criterion is not met	This criterion is not met	This criterion is not met	This criterion is not met	This criterion is not met
6. Indigenous vegetation or an association of indigenous species that is distinctive, of restricted occurrence, occurs within an originally rare ecosystem, or has developed as a result of an unusual environmental factor or combination of factors.	**Criterion met**. Ephemeral wetlands are listed as rare ecosystems	This criterion is not met	This criterion is not met	This criterion is not met	This criterion is not met	This criterion is not met	This criterion is not met	This criterion is not met	This criterion is not met	This criterion is not met	This criterion is not met
Diversity and Pattern											
7. Indigenous vegetation or habitat of indigenous fauna that contains a high diversity of indigenous ecosystem or habitat types, indigenous taxa, or has changes in species composition reflecting the existence of diverse natural features or ecological gradients.	This criterion is not met	This criterion is not met	This criterion is not met	This criterion is not met	This criterion is not met	This criterion is not met	This criterion is not met	This criterion is not met	This criterion is not met	This criterion is not met	This criterion is not met
Ecological Context											
8. Vegetation or habitat of indigenous fauna that provides or contributes to an important ecological linkage or network, or provides an important buffering function.	Criterion not met	Criterion not met	Criterion not met	**Criterion met.** This habitat provides important connectivity within the site	**Criterion met.** This habitat provides important connectivity within the site	Criterion not met	Criterion not met	Criterion not met	Criterion not met	Criterion not met	Criterion not met
9. A wetland which plays an important hydrological, biological or ecological role in the natural functioning of a river or coastal system.	Criterion not met	Criterion not met	Criterion not met	Criterion not met	Criterion not met	Criterion not met	Criterion not met	Criterion not met	Criterion not met	Criterion not met	Criterion not met
10. Indigenous vegetation or habitat of indigenous fauna that provides important habitat (including refuges from predation, or key habitat for feeding, breeding, or resting) for indigenous species, either seasonally or permanently.	**Criterion met.** This habitat type provides important year-round habitat for indigenous avifauna.	**Criterion met.** This habitat type provides important year-round habitat for indigenous avifauna	**Criterion met.** This habitat type provides important year-round habitat for indigenous avifauna.	**Criterion met.** This habitat type provides important year-round habitat for indigenous lizard species (McCann's skink, southern grass skink and Southern Alps gecko). This habitat type provides important seasonal habitat for indigenous avifauna.	**Criterion met.** This habitat type provides important year-round habitat for indigenous lizard species (McCann's skink and southern grass skink). This habitat type provides important seasonal habitat for indigenous avifauna.	**Criterion met.** This habitat type provides important year-round habitat for indigenous lizard species (McCann's skink, southern grass skink and Southern Alps gecko). This habitat type provides important year-round habitat for indigenous avifauna.	**Criterion met.** This habitat type provides important year-round habitat for indigenous lizard species (McCann's skink, southern grass skink and Southern Alps gecko). This habitat type provides important seasonal habitat for indigenous avifauna.	**Criterion met.** This habitat type provides important habitat for indigenous lizard species (McCann's skink).	Criterion not met	Criterion not met	Criterion not met

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