DRAFT

Draft Terrestrial Invertebrate Management Plan for Nova Energy Twizel Solar Farm

Contract Report No. 7414a

Providing outstanding ecological services to sustain and improve our environments

Wildlands

DRAFT

Draft Terrestrial Invertebrate Management Plan for Nova Energy Twizel Solar Farm

Contract Report No. 7414a

September 2026

Project Team:
Vikki Smith – Report author
David Johnston – Aerial habitat survey
Justyna Giejsztowt – Peer review (first version)
Nick Goldwater – Peer review (updated version)

Prepared for:
Nova Energy Ltd
95 Customhouse Quay
PO Box 3142
Wellington 6141

Reviewed and approved for release by:

[redacted]

27/08/2026

Nick Goldwater
Senior Principal Ecologist
Wildland Consultants Ltd
24/02/2026

Cite this report as follows:

Wildland Consultants (2026). *Draft Terrestrial Invertebrate Management Plan for Nova Energy Twizel Solar Farm.* Wildland Consultants Contract Report No. 7414a. Prepared for Nova Energy Ltd. 28pp.

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

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

www.wildlands.co.nz

Contents

1.0 Introduction

This management plan relates to Nova Energy Limited's proposed solar farm (**the development**) located on a property (**the site**) east of Twizel township. Nova Energy commissioned Wildland Consultants (Wildlands) to provide an assessment of the site's ecology and potential ecological effects for the project (Wildland Consultants, 2026a). Based on the findings of the assessment, Wildlands recommended several ecological management plans, including a Terrestrial Invertebrate Management Plan (TIMP).

1.1 Project site and context

The site (Lot 3/DP422901/RT489342) is a long, narrow section of land to the east of Twizel. It is currently used as pastoral land for farming in a Rural Zone and is located in an area that is classified as an Outstanding Natural Landscape. The site is located on outwash plain and river terraces between the Twizel and Ōhau Rivers and includes areas of historic river channels and old oxbows. Figure 1 shows the location of the site and the intended layout of the solar panels.

1.2 Summary of survey results

Invertebrates found in surveys on site are shown in Figure 2. Coverage of the site by different survey methods (except for the UAV survey) is shown in Figure 3. For a full breakdown of the invertebrate habitat values found by this survey, see Section 4.

1.2.1 General invertebrate survey

Initial surveying in February and March 2023 comprised a desktop assessment, followed by a walkthrough survey with sweep net.

Initial surveys confirmed New Zealand blue butterfly (*Zizina oxleyi*; Not Threatened, Hoare et al., 2017) and minute grasshopper (**MG**; *Sigaus minutus*; Threatened - Nationally Vulnerable, Trewick et al., 2022) to be on site. Two other notable[1] grasshopper and one notable wētā species were also considered possibly present on site. These findings triggered further surveying for grasshoppers and wētā.

1.2.2 Grasshopper and ground wētā survey

A transect survey was conducted in December 2023, to assess the distribution of MG and other notable grasshopper species on site. Live-capture pitfall traps were also set for Tekapo ground wētā (**TGW**; *Hemiandrus fabella*; Threatened – Nationally Endangered) (Figure 3).

The transect survey detected Otago short-horned grasshopper[2] (**OSG**; *Phaulacridium otagoense*; At Risk – Declining). The ground was too hard for extensive pitfall trapping, but TGW was detected on site. The distribution of OSG and MG was found to be likely confined to areas at the margins of the site (Figure 2). However, extensive habitat for both species was found throughout the site, with no clear reason as to why the habitat did not seem to be occupied. A TGW survey to assess distribution, and a habitat survey using an unmanned aerial vehicle (UAV), was recommended.

[1] The notable species concept is defined in Section 3.1.

[2] *Phaulacridium otagoense* does not have an official common name; for the purposes of this report, it is called the Otago short-horned grasshopper (OSG).

DRAFT

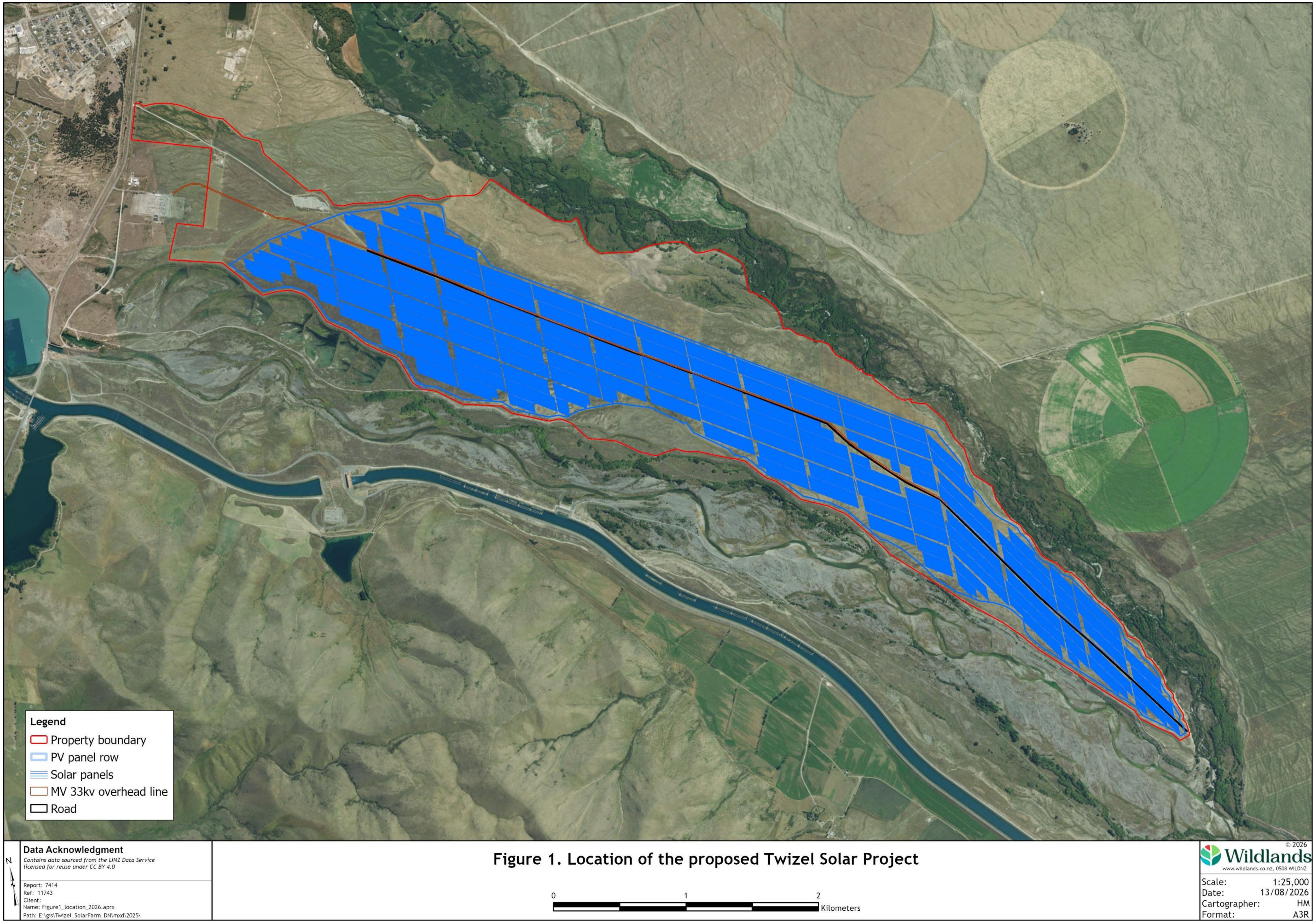
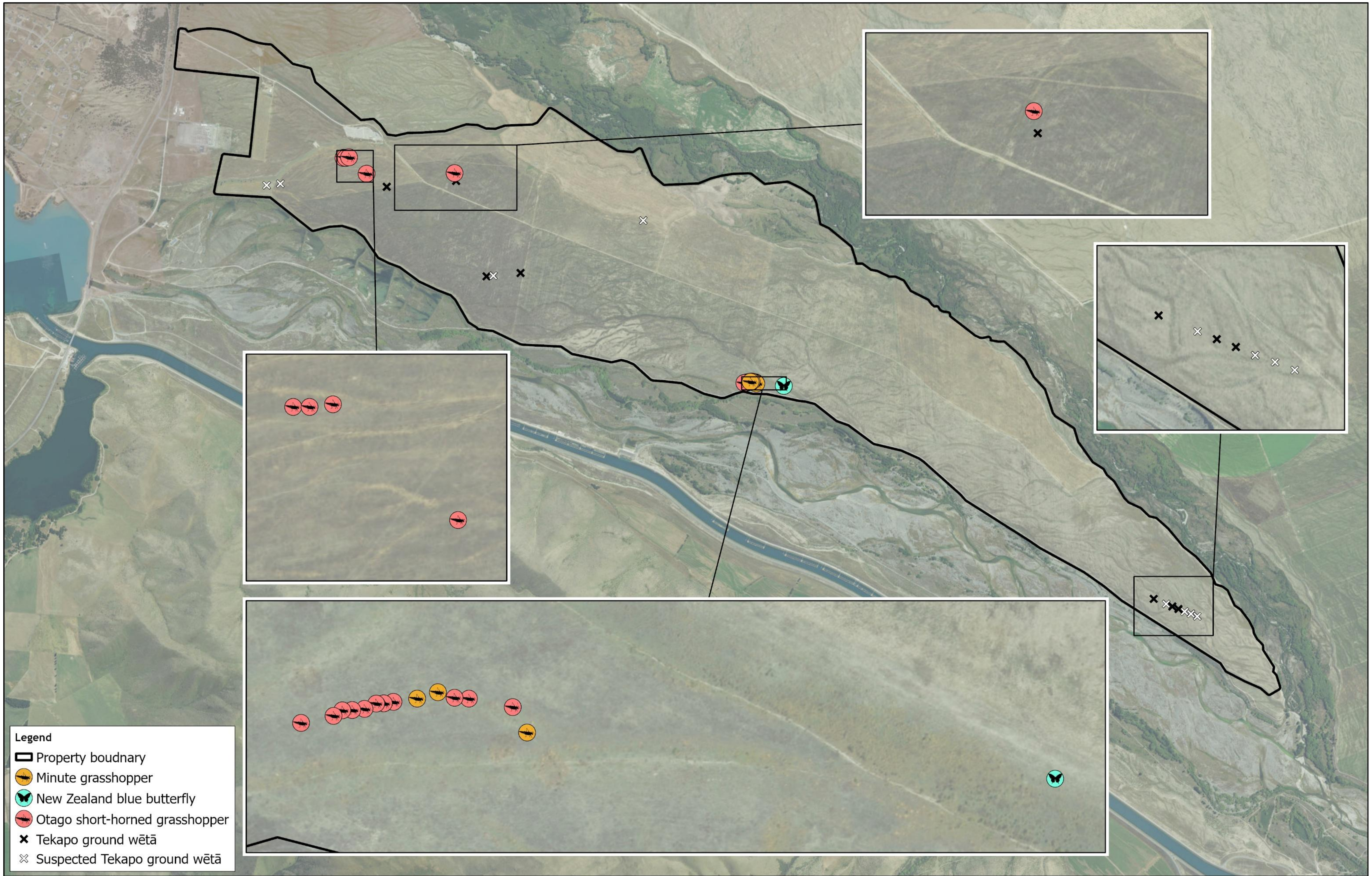


Figure 1. Location of the proposed Twizel Solar Project

DRAFT



N

Data Acknowledgment

Contains data sourced from the LINZ Data Service licensed for reuse under CC BY 4.0

Report: 6986
Ref: 11743-2015
Client: Nova Energy
Name: Figure2_Invertebrates_Feb2026.aprx
Path: \\v64gis\gis2\gis\Twizel_SolarFarm_DN\mxd\2025\

Figure 2. Results from the 2023-2025 general and targeted invertebrate surveys at the Twizel Solar Project site

0 625 1,250 m

Wildlands
www.wildlands.co.nz, 0508 WILDNZ

Scale: 1:25,000
Date: 6/12/2024
Cartographer: LW
Format: A3R

DRAFT

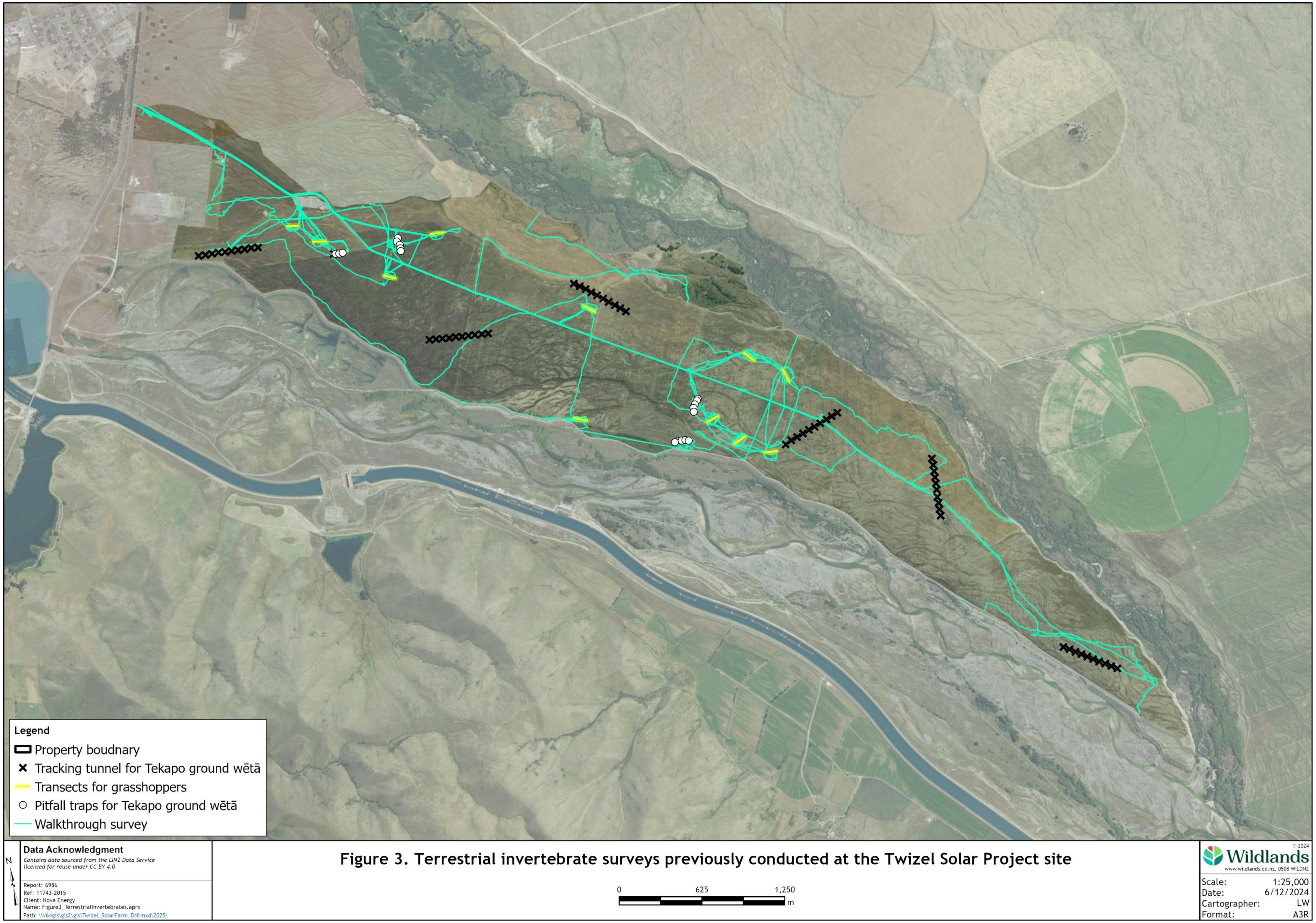


Figure 3. Terrestrial invertebrate surveys previously conducted at the Twizel Solar Project site

1.2.3 Tekapo ground wētā survey

In April 2024, a tracking tunnel survey was carried out to assess the likely distribution of TGW on site. Tracking tunnel lines were set up throughout the site and found TGW tracks, or potential TGW tracks, in the eastern tip and western third of the site.

2.0 Unmanned Aerial Vehicle Survey Methods

Previous surveys identified habitat for MG and OSG throughout the site, but the size of the site made mapping the major habitat areas on foot unfeasible.

In November 2024, a UAV survey was undertaken to map as much of the habitat that had not been walked through as possible, where MG and OSG habitat had been found or was suspected. Some areas could not be mapped due to legal constraints (proximity to aerodrome) and the logistics of mapping such a large area. However, the UAV and walkthrough surveys combined have given detailed mapping of MG and OSG habitat distribution. The areas of habitat shown in Figure 4 include patches identified during the walkthrough and UAV surveys, but the extent to which habitat patches spread outside of the UAV polygons is unknown.

This project represents the first-time aerial photography has been used to denote MG and OSG habitat. However, UAV imagery has been investigated as a habitat mapping technique (Case et al., 2019; Kay, 2020), including for braided river environments in Aotearoa New Zealand where it was found to be a useful and efficient monitoring method (Khan et al., 2021). Large, open patches that are likely to be suitable habitat for MG and OSG were obvious in the photographs. However, results should be interpreted with the understanding that some habitat aspects that may affect MG and OSG distribution may not be apparent in the photographs.

Out of 107 hectares mapped by UAV, 48 hectares were identified as potential MG or OSG habitat, characterised by short-stature vegetation mixed with bare ground and/or stones (Figure 4). 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 MG and OSG.

3.0 Invertebrate Management Approach

3.1 Overview

Invertebrate assessments and surveys to date have revealed four notable species to be present on site (Table 1). Additional notable species may be present, particularly moths and beetles. Important invertebrate values have been found particularly in the westernmost quarter of the site, and the central southern river terrace. However, TGW appear to be active over large parts of the site, with only the central-eastern quarter having no evidence of their presence (Figure 2).

This TIMP sets out the methods that will be used to help increase invertebrate values (including grasshopper abundance) in enhanced areas around the perimeter of the site, and reduce the impacts of potential population declines within the panel area. The TIMP provides details on how to avoid, minimise, remedy, and compensate for potential adverse effects on invertebrate biodiversity, with a focus on notable invertebrates. This TIMP defines ‘notable invertebrates’ as any species that meets at least one of the following criteria:

Table 1 – Notable invertebrates recorded from surveys.

Species	Common Name	Conservation Status	Preferred Habitats	Likelihood of Occurrence
Sigaus[1] *robustus*	Robust grasshopper	Threatened-Nationally Endangered (Trewick et al., 2022). Protected under the Wildlife Act 1953.	Open rocky areas on braided riverbeds.	Unlikely – habitat not present.
Sigaus minutus	Minute grasshopper	Threatened - Nationally Vulnerable	Open areas with bare ground and short-stature vegetation (Jamieson, 1996).	Confirmed.
Phaulacridium otagoense	Otago short-horned grasshopper	At Risk - Declining	Open rocky areas and herbfields. Habitat characterised by aridity and short vegetation (Sivyer, 2016; Westerman & Ritchie, 1984).	Confirmed.
Hemiandrus fabella	Tekapo ground wētā	Threatened - Nationally Endangered	Braided riverbeds and adjacent areas.	Confirmed.
Zizina oxleyi	New Zealand blue butterfly	Not Threatened (Hoare et al., 2017)	Open, sunny areas with leguminous plants.	Confirmed.

[1] Recently changed to *Sigaus* from *Brachaspis*; Trewick, S. A., Koot, E. M., & Morgan-Richards, M. (2023). Māwhitiwhiti Aotearoa: phylogeny and synonymy of the silent alpine grasshopper radiation of New Zealand (Orthoptera: Acrididae). *Zootaxa*, *5383*(2), 225-241

DRAFT

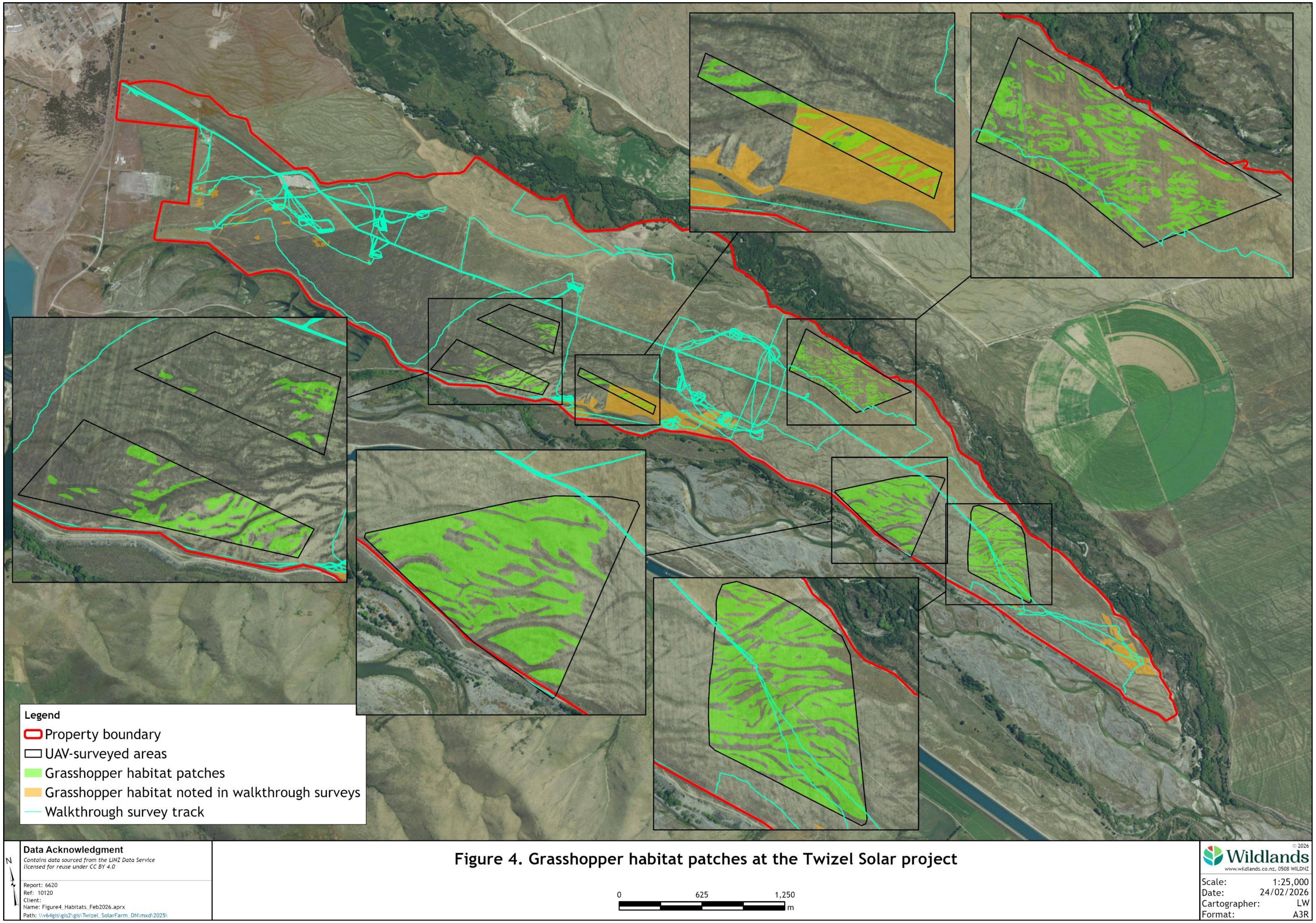


Figure 4. Grasshopper habitat patches at the Twizel Solar project

- Protected under the Wildlife Act (1953)[1]; or
- Threatened or At Risk, having been assessed under the New Zealand Threat Classification System; or
- Locally endemic[2]; or
- Large-bodied and reliant on a specific indigenous habitat type.

Invertebrate management needs to balance the needs of individual notable invertebrate species with the needs of the invertebrate communities present on site. The management methods in this TIMP are aimed at the notable species that have been confirmed on site (Section 1.2). However, the habitat types that support the species identified in Section 1.2 are also likely to support other indigenous invertebrates, particularly moths and beetles. By protecting these habitat types from harm where possible, and restoring them where they cannot be protected, potential detrimental effects on whole invertebrate communities will be managed. Many invertebrate species will also benefit from pest mammal control, which is prescribed in a separate report (Wildland Consultants, 2025).

This TIMP is designed to be implemented alongside the Wildlands Lizard (LMP), Avifauna (AMP), Pest Mammal Management (PMMP) and Biosecurity and Vegetation (BVMP) Management Plans. Effects will be managed from planning through to development, and monitoring will continue for the life of the project.

Post-construction monitoring is required to enable adaptive management. Populations of notable invertebrates such as those found on site grow slowly and trends in population size can be difficult to detect, but trends are likely to become apparent despite other confounding factors such as climate patterns.

3.2 Responsibilities associated with this plan

The implementation of the TIMP will be supervised by a suitably qualified and experienced entomologist (the Project Entomologist). The responsibilities of the Project Entomologist are to:

- Facilitate a project start-up meeting with the Project Ecologist, site manager, site engineer(s) and earthworks contractors before construction commences, to enable forward planning and avoid delays in the construction schedule.
- Identify, and report to the Site Manager, opportunities for mana whenua to participate in and support any translocation deemed necessary and appropriate, to ensure appropriate exercise of kaitiakitanga responsibilities and that cultural concerns are addressed.
- Maintain clear lines of communication between the Project Ecologist, Site Manager, Site Engineer(s) and construction contractors regarding changes in the works schedule.
- Brief new personnel about the construction contractor's responsibilities under this plan.

All personnel working on site are responsible for alerting the Project Entomologist, Site Engineer(s) and the Site Manager if any 'At Risk' or 'Threatened' invertebrates not otherwise identified in this TIMP are discovered.

[1] No protected species have been found - or are suspected to be present – at the site; therefore no Wildlife Approval is necessary for this development with respect to terrestrial invertebrates.

[2] Locally endemic generally means restricted to an ecological district, though the species' range must be considered in the context of its dispersal ability.

The Project Entomologist is responsible for reporting the discovery of 'At Risk' or 'Threatened' invertebrates to the Local Area Manager (Department of Conservation) if necessary, and for maintaining a database with an incident register and file log of actions taken for each discovery of an 'At Risk' or 'Threatened' invertebrate not otherwise identified in this TIMP.

Invertebrate management will be carried out in consultation with the Project Ecologist, liaising with the Project Entomologist. See Table 2 for a list of roles involved in managing and implementing terrestrial invertebrates on site.

Table 2 – Roles and responsibilities associated with this TIMP.

Title	Responsibility	Timeline
Project owner - Nova Energy	Project delivery, including overall compliance with approval conditions and TIMP.	From receipt of this TIMP until the final invertebrate monitoring report has been submitted.
Project engineer(s) - TBD	• Project engineering, project management, and delivery. • Liaison between contractors and ecologists. • Confirm implementation of TIMP. • Confirm compliance with TIMP.	December 2024 to construction completion.
Construction Contractor - Site Manager (TBD)	• Compliance with TIMP • Implementation of actions required by the TIMP including: - Reading and understanding the TIMP requirements - Facilitating a project start-up meeting with the Project Ecologist, site manager, site engineer(s) and earthworks contractors before construction commences. - Maintaining clear lines of communication with both the Project Engineer, Project Ecologist, and Contractors regarding changes to the works schedule. - Implementing actions where responsibility has been identified. - Briefing new personnel about the contractor's responsibilities under this TIMP.	December 2024 to construction completion.
Project Ecologist	• Liaising with the Project Owner, Project Engineers, Project Contractor, and any other necessary parties to help with implementation of this TIMP and other Ecological Management Plans. • Ensuring that this TIMP and other Ecological Management Plans are implemented correctly and providing advice and guidance where necessary. • Liaising with the Project Entomologist where necessary to seek and clarify aspects of invertebrate management on site.	From receipt of this TIMP until the final invertebrate monitoring report has been submitted.

Title	Responsibility	Timeline
Project Entomologist - Wildland Consultants Ltd	The Project Entomologist has been engaged by the Project Owner to provide technical advice to the Project Engineer(s), and to assist Project Engineer with compliance against this TIMP. The Project Entomologist will: • Prepare and update the TIMP as required. • Ensure any required WAA permits are attained and on hand during site works. • Implement practical invertebrate management. • Where necessary, assist with contractor training. • Complete the required compliance reporting.	From receipt of this TIMP until the final invertebrate monitoring report has been submitted.

4.0 Invertebrate Habitat

4.1 Overview

The major habitat types that are important for the notable species identified in Table 1 are characterised by open, bare ground with rocks, lichens, and short-stature vegetation. These include scarp herbfield and grassland, haresfoot trefoil herbfield, and old river terrace. Parts of the browntop-sweet vernal-clover grassland are also inhabited by OSG and TGW, and sweet brier shrubland also appears to be inhabited by TGW. The habitat requirements of TGW are not well-understood, though they are expected to prefer open habitat similar to MG and OSG (T. Murray, pers. comm. 2024). Important habitat characteristics

Habitat with short-stature vegetation and open spaces provides basking areas for MG, OSG and butterflies. Basking allows these species to warm up their muscles for activity such as jumping and flying. Without basking areas, species such as MG do not survive.

Lichens, mosses, and other herbfield species such as mat daisy (*Raoulia* spp.) provide food for grasshoppers, which eat a variety of food, apparently preferring short-stature species with soft leaves (Jamieson, 1996).

Short vegetation is less able to conceal predatory mammals such as mice and rats, so that these predators cannot ambush invertebrates. With enough open space around them, MG, OSG, and butterflies can more easily detect and escape potential predators.

4.2 Potential habitat

Large expanses of apparently suitable habitat, found during walk-through and UAV surveys (Section 2), appear not to be inhabited by MG or OSG. These species may be present in low numbers, or the habitat may be unsuitable for them due to higher predator activity or other factors such as heavy metals, herbicide or pesticide sprays, to which grasshoppers in the family Acrididae (which includes MG and OSG) are particularly sensitive (Heliovaara, 2018). The sensitivity of MG and OSG to various chemical sprays may explain the patchy distribution of MG on farmland (Jamieson, 1998).

5.0 Effects on invertebrates

5.1 Potential effects

This section details potential effects of the Project on invertebrates, before any effects management is applied.

5.1.1 Habitat removal

The proposed development, including during the construction phase and any other minor earthworks undertaken, will remove a small amount of low-quality habitat that supports notable invertebrates at this site. This effect is likely to be **minor**.

5.1.2 Mortality and disturbance

All earthworks, including during the construction phase and any other minor earthworks undertaken, will cause removal and destruction of notable invertebrates. Dust and vehicle strikes will cause disturbance and potentially mortalities. Noise and vibration from vehicles will likely stress invertebrates and interrupt communication and sensory processes. Works during the day will mainly affect MG and OSG, but only in the areas where they are found. Earthworks may still cause mortality of TGW. Overall mortality and disturbance on invertebrates are expected to be **more than minor**.

5.1.3 Habitat modification

Over the central southern river terrace, and the western paddocks where MG, OSG, and TGW were found, shading from solar panels is likely to cause a **significant** effect due to the loss of basking space and the change in vegetation.

These effects are reduced due to the use of rotating solar panels, and wide gaps between rows and panels. However, rotating solar panels have been found to alter soil, temperature, and moisture microclimates underneath them due to the effects of dynamic shading patterns, impacting 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). The taller vegetation and the shading from the solar panels will decrease the amount of habitat available for MG, OSG, and likely TGW, as the taller vegetation will out-compete short-stature herbfield vegetation that these species require for food and basking. Taller vegetation also provides more habitat for predators which will eat MG, OSG, and TGW.

If grazing does not continue, this will also be detrimental to invertebrate populations as short-stature herbfield vegetation will likely be out-competed by exotic vegetation.

Soil changes due to altered vegetation cover may have unforeseen or indirect effects on TGW abundance. A conservative approach assumes effects to be potentially detrimental, due to the lack of knowledge concerning TGW ecology. Effects are therefore considered to be **significant**.

5.2 Level of effects

The level of ecological effects on indigenous invertebrates without mitigation actions taken are presented in (Table 3).

Table 3 - Potential level of effects to invertebrates and their habitats without mitigation.

Effect	Level of Effect Without Mitigation
Habitat removal	Minor
Mortality and disturbance	More than minor
Habitat modification	Significant

5.3 Management of effects

This section summarises all proposed effects management measures.

Effects management is organised here according to the effects management hierarchy, including considerations for avoidance, minimisation, and remediation. Effects management is prioritised in that order, with avoidance of effects being the highest priority.

5.3.1 Avoidance

Habitat avoidance

The panel layout (Figure 1) shows that the central southern river terrace[1] will be avoided along with other indigenous vegetation around the outside of the site.

Destruction of indigenous legumes (such as indigenous broom) and other indigenous flowering plants will 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 near the river will be avoided to minimise loss of basking areas for New Zealand blue butterfly. These areas are excluded from the panel layout (Figure 1). The most important habitats are around the perimeter of the site, which is being avoided.

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 MG or OSG habitat. They must also be avoided anywhere TGW have been found or are suspected (Figure 2). Weed control will instead be mechanical, hand-weeding, or use cut and paste herbicide.

Dust management

Managing dust will avoid its impact on indigenous invertebrates. The main access track will have a gravel surface, which will avoid dust effects. However, in dry weather or if traffic is travelling at high speed, some dust effects may still occur. Management measures will include:

- Visually monitoring dust levels along tracks and reporting high levels of dust indicated by large plumes, or dust travelling more than 20 metres from the track.
- Using water trucks to dampen dusty tracks before and during use if high levels of dust are reported.
- Implementing and enforcing speed limits. The speed limits will be decided based on dust levels caused by vehicles moving at different speeds.

[1] an important area where MG and OSG are found, and the only known location on site for MG

- Avoiding work during dry weather if work sites cannot manage dust using other methods.

5.3.2 Remediation

Enhancement planting

Potential invertebrate habitat enhancement areas are present around the perimeter of the site (Figure 5), and at the lizard biodiversity nodes (refer to the LMP) that are suitable for being planted for invertebrate values. Invertebrate habitat enhancement areas will be enhanced and protected to manage the loss of important invertebrate habitat present on site. Plantings to benefit lizards are likely to also benefit invertebrates, and vice-versa. The invertebrate habitat enhancement areas as shown in Figure 5 will be enhanced using indigenous vegetation as indicated in the Lizard Management Plan (Wildlands 2025) and will include the species listed in Table 4 below.

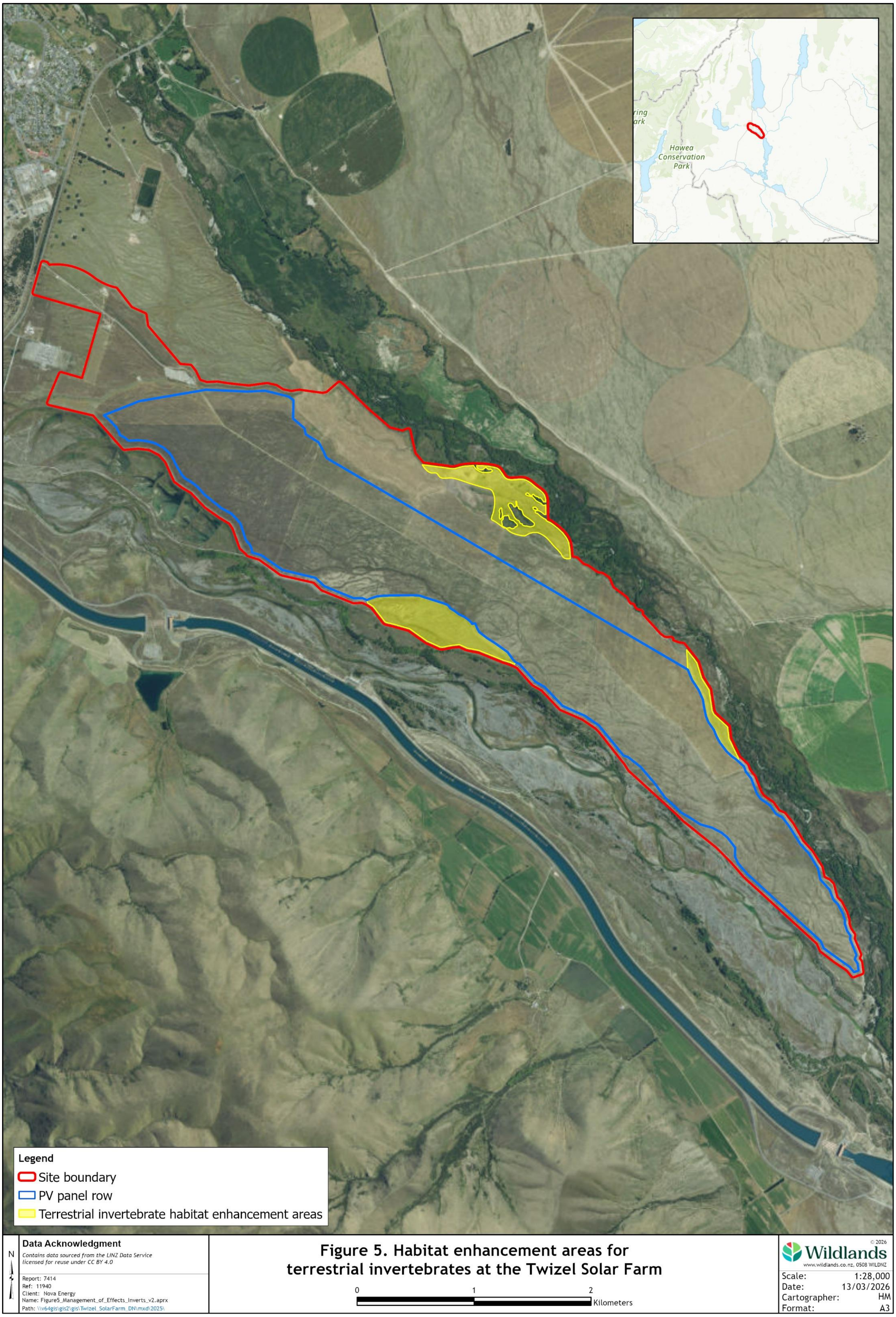
The enhanced habitat will provide a patchwork of habitat types, many of which will include the open, short-stature vegetation, dry bare ground and rock, and herbfield species that benefit indigenous grasshoppers including MG and OSG.

Table 4 – List of enhancement planting species to benefit MSG and OSG as well as other invertebrates. These plantings will also benefit lizards and are to be implemented in conjunction with the Lizard Management Plan (Wildlands 2025).

Species	Benefits to Invertebrates	Currently Present at Site?	Beneficiaries	Growth Habit
Porcupine shrub (*Melicytus alpinus*)	Provides nectar and hiding spaces.	Yes	Moths, butterflies, beetles, spiders	Forms small prostrate shrubs.
Mat pōhuehue (*Muehlenbeckia axillaris*)	Provides nectar and hiding spaces.	Yes	Moths, butterflies, beetles, spiders	Forms small prostrate shrubs.
Common mat daisy[1] (*Raoulia australis*)	Provides food and basking places.	Yes	Grasshoppers, moths	Mat-forming.
Dwarf broom (*Carmichaelia vexillata*)[1]	Provides food.	Yes	Grasshoppers, moths, NZ blue butterfly	Low-growing, spreading dwarf shrub.
Coprosma petrei	Provides food and basking places.	Yes	Grasshoppers, moths	Forms mats or cushions.

[1] Low-growing, mat-forming, and sprawling species such as this help to maintain the open, exposed character of short-stature herbfield environments, which are vital for MG and OSG.

DRAFT



Data Acknowledgment

Contains data sourced from the LINZ Data Service licensed for reuse under CC BY 4.0

Report: 7414
Ref: 11940
Client: Nova Energy
Name: Figure5_Management_of_Effects_Inverts_v2.aprx
Path: \\v64gis\gis2\gis\Twizel_SolarFarm_DN\mxd\2025\

Figure 5. Habitat enhancement areas for terrestrial invertebrates at the Twizel Solar Farm

© 2026
Wildlands
www.wildlands.co.nz, 0508 WILDNZ

Scale: 1:28,000
Date: 13/03/2026
Cartographer: HM
Format: A3

The site contains large patches of dry, open habitat suitable for MG and OSG (see Section 2), some of which will not be impacted by the panels. The areas shown in Figure 5, which include the central southern terrace, will be enhanced using the plants listed in Table 4. These plantings will benefit MSG and OSG, and lizards. The central southern terrace is already good-quality habitat for MG and OSG but will be improved by replacing introduced weeds with indigenous herbfield plants.

Before operation of the solar farm commences, invertebrate-friendly plants (Table 4) will be installed to increase the complexity of the habitat and provide more habitat for MG and OSG. Planting will be undertaken by a suitably qualified contractor. No plantings will occur within five metres of Threatened or At Risk plant species identified on site.

Pest mammal control

Pest mammal control throughout the site will likely benefit terrestrial invertebrates. The pest mammal management plan (Wildland Consultants, 2025b) will be implemented to reduce predation pressure on indigenous invertebrates. Pest mammal control has been shown to benefit grasshoppers, including MG (Schori et al., 2019). Any amendments to the pest mammal management plan will need to be discussed with, and approved by, the Project Ecologist before beginning pest mammal control.

5.3.3 Minimisation

Leave short-stature herb patches

Short-stature herbs, even invasive species such as hawkweed, will not be controlled unless they are going to be replaced with indigenous herbfield vegetation.

Grazing management

Grazing will be encouraged throughout the panel area to keep the exotic grasses short. This will minimise the habitat modification effects for TGW and potentially also MG and OSG. It will also minimise exotic grasses smothering herbfield vegetation.

Salvage and translocation

Salvage of OSG and TGW will need to be undertaken prior to construction by a suitably-qualified ecologist throughout their known range on site, including contiguous suitable habitat adjacent to locations where they have previously been found (Figure 6). The Salvage and Translocation Protocol (Appendix 1) will need to be followed. One salvage operation will be undertaken, prior to construction.

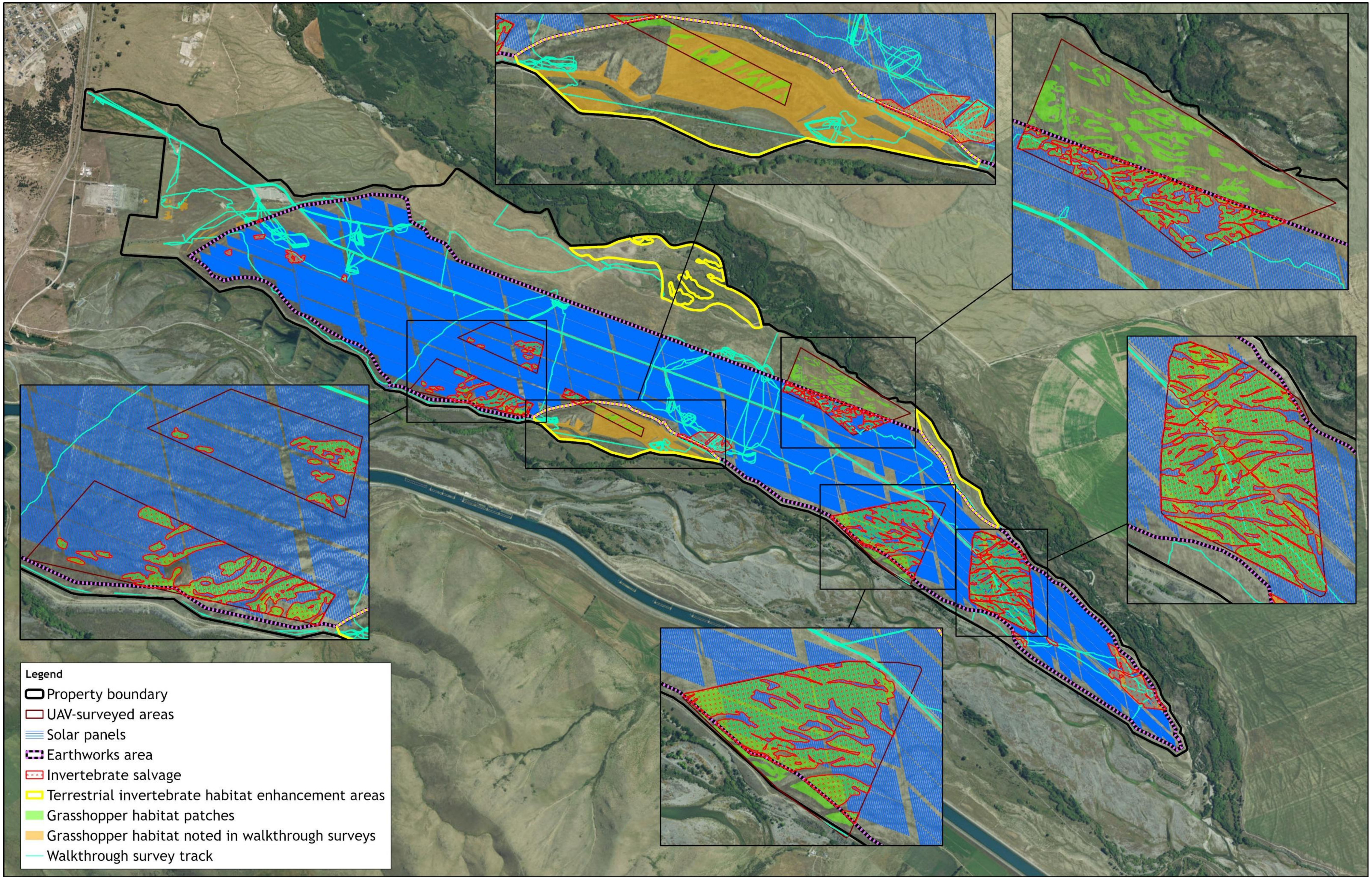
Throughout the site, excluding the central western portion, TGW have been found. They may be present anywhere on site as their habitat requirements are not well-understood. Salvage of TGW will need to be undertaken throughout their known distribution on site prior to construction.

The OSG salvage will need to be undertaken around known populations at the western end of the site (Figure 2).

The only known MG population on site is outside the panel area, so pre-construction salvage is unnecessary. Minute grasshoppers may need to be salvaged and translocated if more populations are found on site (see Incidental discovery protocol, IDP, below).

Salvaged invertebrates will be translocated into the invertebrate habitat enhancement areas (Figure 6). The first 30 individuals from any species or combination of species will be released into the central southern terrace; subsequent individuals will be released into the other enhancement areas.

DRAFT



Data Acknowledgment

Contains data sourced from the LINZ Data Service licensed for reuse under CC BY 4.0

Report: 6620
Ref: 10120
Client:
Name: Figure_Inv_Salvaged_Released.aprx
Path: E:\gis\Twizel_SolarFarm_DN\mxd\2025\

Figure 6. Areas where invertebrates will be salvaged and released

© 2026 Wildlands
www.wildlands.co.nz, 0508 WILDNZ

Scale: 1:25,000
Date: 14/08/2026
Cartographer: LW
Format: A3R

Incidental Discovery Protocol

During construction, particularly in areas that have been identified as potential or apparently unoccupied MG or OSG habitat (Figure 4), new populations of MG or OSG may be discovered. If MG or OSG are observed during sunny summer weather, work must be stopped and the IDP followed (Appendix 2).

Monitoring

Monitoring of MG, OSG, and TGW will be undertaken:

- Annually for the first three years following the onset of construction, and
- Once every three years thereafter for the remainder of the project lifetime.

An experienced entomologist will be present to audit the first three rounds of monitoring to ensure monitoring is conducted accurately.

Monitoring will use the transects already established (Figure 3) and the same methods as the initial surveys (Wildland Consultants, 2024a, 2024b) without pitfall trapping. Additional transects for MG and OSG and tracking tunnels for TGW will be set up in the margins of the site, in areas that are being enhanced for MG, OSG and TGW, particularly where any salvaged individuals are released (if 20 or more individuals from any species or combination of species are released within one patch of suitable habitat within the enhancement area, then monitoring will encompass that patch of habitat). The purpose of the additional transects is to monitor the effects of enhancement so that adaptive management can be applied if necessary to achieve biodiversity gains in the margins that balance biodiversity losses within the development area.

Reporting

A monitoring report will be produced following each monitoring period, detailing outcomes and results of the monitoring on site. It will also recommend adaptive management measures, if required.

Monitoring reports will be provided to Mackenzie District Council, DOC, and relevant iwi. Monitoring results will be shared with researchers and entomologists (for example, the Entomological Society of New Zealand) to help understand the responses of Threatened and At Risk grasshoppers and wētā to management.

Performance standards

Invertebrate management as outlined in this TIMP and the AEE is designed to achieve the following outcomes, detected by monitoring:

- Detection rates of OSG and/or MG will increase or remain the same within the enhancement areas (Figure 6) throughout the life of the project.
- Detection rates of TGW will increase or remain the same within the panel area and/or within the enhancement areas.

If any deviation from the above can be reasonably attributed to factors beyond Nova's control (for example, climate or weather patterns), the performance standards will still be considered to be met.

Adaptive management

Adaptive management will be triggered if, after **two** monitoring periods:

- Detection rates of OSG and/or MG have declined within the enhancement areas; or
- Detection rates of TGW have declined within the panel area and within the enhancement areas.

Adaptive management will be the same for either of these outcomes, and will include the following actions:

- The most recent tracking tunnel results will be assessed to see if rodents are active in the enhancement areas.
- If rodents are active in the enhancement areas, rodent baiting will be carried out based on the protocols outlined in the PMMP. Rodent baiting will continue until rodent tracking is less than 5%.
- Enhancement plantings will be assessed by viewing results from the latest vegetation surveys and photopoints.
- If enhancement plantings appear to be healthy and growing well, and weeds are not invading the planting area, then more patches of bare, stony ground and mat-forming plants such as scabweed (*Raoulia australis*) will be created in any areas that appear to be suboptimal habitat within the enhancement areas.
- If enhancement plantings do not appear to be healthy and growing well, or weeds are invading the enhancement area, these problems will be resolved by following the guidelines in the BVMP.

Further effects management may be necessary if, despite adaptive management, four or more consecutive monitoring periods indicate either or both of the following:

- No increase in the number of OSG and MG.
- TGW populations decline both within the panel area and in the released populations.

If either of these scenarios persist despite adaptive management, results of monitoring will be compared with any available monitoring results from relevant invertebrate populations off site (for example, robust grasshopper monitoring undertaken by DOC at the robust grasshopper reserve at Paterson's Terrace) to see if population declines are limited to the solar farm or could be explained by other phenomena, for example unfavourable weather conditions.

If population declines are limited to the solar farm, then DOC and a suitably-qualified ecologist will be consulted to assess if other management measures are appropriate, such as controlling possums or hedgehogs, or management based on findings that DOC may have from its work with the Tekapo ground wētā.

If further management cannot be implemented, or populations continue to decline, compensation in the form of research funding will be supplied (Section 5.3.4).

5.3.4 Compensation

<u>Overview</u>

Compensation is not a requirement for this project, as effects will be able to be managed adequately using the above measures, with reasonable confidence. However, if monitoring shows that populations of OSG, TGW, and/or MG on site are declining despite adaptive management, compensation will be considered as a backstop to address the biodiversity loss. The amount of compensation required in response to performance targets not being met will be determined based on the nature of any decline detected, with more severe declines requiring more compensation. Appropriate compensation amounts will be discussed with the Department of Conservation if the need for compensation is triggered.

<u>Research funding</u>

The efficacy of salvage and translocation alone (see Salvage and Translocation above) in managing the effects of habitat modification and mortality of invertebrates is unknown. However, combined with research into its viability and potential methods, salvage and translocation would improve effects management for TGW, MG, OGH and closely related species (including robust grasshopper) to benefit biodiversity.

Assessing trends in monitoring data would be extremely helpful in understanding the impacts of land-use changes on invertebrates in the Mackenzie Basin. This research would help to understand effects management and help in the overall conservation of the species impacted by this project.

A grant (suggested amount $15,000 per annum for three years, depending on the severity of grasshopper and/or wētā declines), plus access to the site for research purposes, would help to fund a PhD-level research project. The funds would be needed to ensure the research project is able to happen. The amount proposed is meant to reflect the potential severity of the biodiversity lost if salvage, translocation and habitat enhancement fail to produce any biodiversity gains.

If no research student is available at the start of the project, the baseline monitoring could be undertaken by a suitably qualified ecologist and the grant offered for the following three years. The student would then be able to use the grant to conduct the research, comparing grasshopper population sizes and continuing the monitoring. If no student takes the grant after the third year of offering it, the money will be donated to the New Zealand Entomological Society specifically to use for conducting research into TGW, MG, and OSG conservation ecology, with a preference for studies investigating effects mitigation.

5.4 Summary of effects significance with management

Table 5 shows the level of effects on invertebrates with and without management.

Table 5 - Potential significance of effects to grasshoppers and wētā and their habitats with and without mitigation.

Effect	Level of Effect Without Mitigation	Level of Effect With Mitigation
Habitat removal	Minor	Less than minor
Mortality and disturbance	More than minor	Negligible
Habitat modification	Significant	Minor

5.5 Approximate timetable for effects management

Table 6 shows the order and approximate timing in which effects management will be undertaken.

Table 6 – Approximate timetable for implementation of effects management.

Task	Approximate timing
Finalise panel layout	Complete
Advertise research position (if necessary)	As soon as the need for compensation is identified
Identify suitable release site	Eight months prior to construction
Enhancement planting at release site	Six months prior to construction

Task	Approximate timing
Begin pest mammal control	Six months prior to construction
Plan dust management[1]	Four months prior to construction
Plan and commence weed control	Four months prior to construction
Salvage and translocation	Two weeks prior to construction
Incidental discovery protocol	Throughout construction
Begin enhancement of areas outside panel area	Prior to panel installation
Monitoring	Beginning with construction, continued throughout the life of the project
Adaptive management	For the life of the project

1 Dust management will likely be included in the erosion and sediment control plan, traffic management plan and the construction management plan.

References

Case, B. S., Buckley, H. L., Fake, M., Bryan, S., Bilkey, J., & Griffiths, J. (2019). *Assessing the use of UAV-collected data for characterising the distributions and frequencies of sand dune vegetation cover types at Kaitorete Spit, Canterbury*. PublishingTeam, Department of Conservation.

Grodsky, S. M., & Hernandez, R. R. (2020). Reduced ecosystem services of desert plants from ground-mounted solar energy development. *Nature Sustainability*, *3*(12), 1036–1043.

Heliovaara, K. (2018). *Insects and pollution*. CRC press.

Hoare, R. J. B., Dugdale, J. S., Edwards, E. D., Gibbs, G. W., Patrick, B. H., Hitchmough, R. A., & Rolfe, J. R. (2017). *Conservation status of New Zealand butterflies and moths (Lepidoptera), 2015* (New Zealand Threat Classification Series 20, p. 13). Department of Conservation.

Jamieson, C. D. (1996). *The grasshopper Sigaus minutus in Central Otago: A pilot study*. Department of Conservation Wellington, New Zealand.

Jamieson, C. D. (1998). *Distribution of the endangered grasshopper Sigaus minutus on the Earnscleugh Tailings Historic Reserve*. Citeseer.

Kay, T. J. (2020). *A methodology to assess river habitat quality: A thesis presented in partial fulfilment of the requirements for the degree of a Masters in Science in Ecology at Massey University, Manawatū, Aotearoa New Zealand*.

Khan, M. S. I., Ohlemüller, R., Maloney, R. F., & Seddon, P. J. (2021). Monitoring dynamic braided river habitats: Applicability and efficacy of aerial photogrammetry from manned aircraft versus unmanned aerial systems. *Drones*, *5*(2), 39.

Li, Y., Armstrong, A., Simmons, C., Krasner, N. Z., & Hernandez, R. R. (2025). Ecological impacts of single-axis photovoltaic solar energy with periodic mowing on microclimate and vegetation. *Frontiers in Sustainability*, *6*, 1497256.

Liu, Y., Zhang, R., Huang, Z., Cheng, Z., López-Vicente, M., Ma, X., & Wu, G. (2019). Solar photovoltaic panels significantly promote vegetation recovery by modifying the soil surface microhabitats in an arid sandy ecosystem. *Land Degradation & Development*, *30*(18), 2177–2186.

Ministry for the Environment. (1991). *Resource Management Act*. Ministry for the Environment Manatū Mō Te Taiao.

Schori, J. C., Maloney, R. F., Steeves, T. E., & Murray, T. J. (2019). Evidence that reducing mammalian predators is beneficial for threatened and declining New Zealand grasshoppers. *New Zealand Journal of Zoology*, *46*(2), 149–164.

Schori, J. C., Steeves, T. E., & Murray, T. J. (2020). Designing monitoring protocols to measure population trends of threatened insects: A case study of the cryptic, flightless grasshopper *Brachaspis robustus*. *PLOS ONE*, *15*(9), e0238636. https://doi.org/10.1371/journal.pone.0238636

Sherley, G., Stringer, I. A., & Parrish, G. (2010). *Summary of native bat, reptile, amphibian and terrestrial invertebrate translocations in New Zealand.* (Issue 303).

Sivyer, L. M. (2016). *Integrating species distribution models, genetics and morphology to infer species dynamics of New Zealand Phaulacridium grasshoppers: A thesis presented in partial fulfilment of the requirements for the degree of Masters of Science in Zoology at Massey University, Palmerston North, New Zealand*.

Trewick, S., Hegg, D., Morgan-Richards, M., Murray, T. J., Watts, C., Johns, P., & Michel, P. (2022). *Conservation status of Orthoptera (wētā, crickets and grasshoppers) in Aotearoa New Zealand, 2022*. Department of Conservation= Te Papa Atawhai.

Westerman, M., & Ritchie, J. (1984). The taxonomy, distribution and origins of two species of Phaulacridium (Orthoptera: Acrididae) in the South Island of New Zealand. *Biological Journal of the Linnean Society*, *21*(3), 283–298.

Wildland Consultants (2026a): Assessment of potential ecological effects of the proposed Nova Energy Solar Farm near Twizel. Wildland Consultants Ltd Contract Report No. 6620a. Prepared for Nova Energy. 91 pp.

Wildland Consultants (2024). *Additional lizard, vegetation, and invertebrate surveys of a proposed Twizel solar farm*. Wildland Consultants Contract Report No. 6986. Prepared for Nova Energy. 29pp.

Wildland Consultants (2024b). Tekapo ground wētā memorandum. Wildland Consultants Contract Report No. 6986b. Prepared for Nova Energy. 4pp.

Wildland Consultants (2025). Pest Mammal Management Plan – Nova Energy, Twizel. Wildland Consultants Contract Report No. 6905. Prepared for Nova Energy. 26pp.

Wildland Consultants (2026b). Lizard Management Plan for proposed Nova Energy Twizel solar farm. Wildland Consultants Contract Report No. 7414b. Prepared for Nova Energy. 43pp.

Wildland Consultants (2026c). Avifauna Management Plan for proposed Nova Energy Twizel solar farm. Wildland Consultants Contract Report No. 7414c. Prepared for Nova Energy. 22pp.

Wildland Consultants (2026d). Biosecurity and Vegetation Management Plan for proposed Nova Energy Twizel solar farm. Wildland Consultants Contract Report No. 7414d. Prepared for Nova Energy. 14pp.

Appendix 1

Salvage and translocation protocol

<u>Prior to Any Work Commencing</u>

Relevant contractors, the Project Engineer, Construction Contractor, and any other relevant personnel will undertake an induction to be briefed on the following:

- Where to look out for minute grasshopper (MG), Tekapo ground wētā (TGW), or Otago short-horned grasshopper (OSG), and what they look like.
- The Incidental Discovery Protocol (Appendix 2).
- Where TGW, MG and OSG management will be undertaken.
- The timeframe for associated works.

At each site where TGW and OSG have been detected during previous surveys and are likely to be impacted by the panels, salvage will begin before landscaping and construction commences. Salvage of MG is not necessary unless they are discovered during construction.

<u>Pre-clearance Salvage</u>

Salvage of TGW and OSG will be undertaken by a suitably-qualified ecologist and will use a mixture of transects and live-capture pitfall traps. Pitfall traps are mainly targeted at TGW but may also capture OSG; transects target both OSG (daytime transects) and TGW (nighttime transects).

While searching for OSG, MG may also be found since it has similar habitat requirements. If MG is found at any time during salvage, follow the Incidental Discovery Protocol (Appendix 2).

Transects

<u>Daytime transects (OSG)</u>

Ten 100 m long transects will be set up on site, at the western end of the site where OSG was previously found (Figure 2). Transects will be at least 100 m apart and target suitable habitat for OSG (Section 1.2).

Transects will be walked at a slow walking pace, with the walker moving their foot side to side slowly across the surface of the ground, as described by Schori *et al.* (2020). As OSG move, they will be collected. Great care must be taken, when setting up for a transect walk, and when leaving or returning to the transect after collecting an OSG, not to allow any shadow to fall along the transect.

Initially, the transects will be walked twice daily for seven consecutive days in sunny weather with temperatures above 13°C in the appropriate season (early December and early February). Every OSG spotted during the walk will be captured (see Collection and Transportation below).

Transects will be walked for a minimum of seven consecutive days. If numbers of OSG caught over the course of seven days declines, with ≤3 OSG captured on day seven, trapping will cease.

If the same or high numbers of OSG are still found at day seven (>3 individuals per day), transects may continue for another three days depending on numbers caught and the weather, at the discretion of the Project Entomologist.

<u>Nighttime transects (TGW)</u>

Twenty 200-metre-long transects will be set up across the site. Transects will be at least 100 metres apart and aim for even coverage of the site.

Each transect will be walked in the dark, before midnight, shining a torch from side to side to reveal any TGW foraging on the surface of the ground.

All transects will be walked between November and March. Initially, the transects will be walked for seven consecutive warm nights (above 13°C). Cloudy nights are preferred. Every TGW spotted during the walk will be captured (see Collection and Transportation below).

Transects will be walked for a minimum of seven consecutive days. If numbers of TGW caught over the course of seven days declines, with ≤3 TGW captured on day seven, trapping will cease.

If the same or high numbers of TGW are still found at day seven (>3 individuals per day), transects may continue for another three days depending on numbers caught and the weather, at the discretion of the Project Entomologist.

Live-capture pitfall traps

Live-capture pitfall traps consist of a 1L plastic bucket dug into the ground, which invertebrates may fall into and be unable to exit. Buckets will be covered with a lid, with a gap between the lid and the cup so that large wētā may enter. Holes drilled into the bottoms of the cups allow moisture to drain away. Traps will be baited with canned pear (Tara Murray pers. comm).

Live-capture pitfall trap grids will be set in advance of construction commencing. Each grid will have four traps arranged in a five-metre by five-metre square, with a fifth trap in the centre of the square (Sherley and Stringer 2016). Pitfall trap grids will be placed adjacent to transects, wherever the ground is not too hard to place them.

Once active, live-capture pitfall traps will be checked daily for a minimum of seven consecutive days. If trapping reveals trends of decreasing numbers of beetles over the course of seven days, with ≤3 TGW or OSG captured after day seven, trapping will cease.

If live-capture pitfall traps continue to get the same or high numbers of OSG or TGW over seven days (>3 individuals per day), trapping will continue for another three days, or until no more TGW or OSG are caught, at the discretion of the Project Entomologist.

To prevent harm to TGW and lizards, pitfall traps will be closed when not in use and checked every 24 hours when in use.

Data Collection

Data recorded upon capture will include species identity and age/sex class (male, female, or juvenile). Each stage of salvage will be recorded, including start/stop date and time, GPS coordinates, and a habitat description for the capture location. Weather conditions will be recorded during and at the beginning and end of each salvage event. Data collected will be shared with the research student (see Section 5.3.5 of the Terrestrial Invertebrate Management Plan; TIMP).

Collection and Transportation

Shade will need to be created for diurnally captured OSG and TGW through the construction of temporary shelters, such as beach tents. Alternatively, an air-conditioned vehicle or suitably furnished chilly bin[1] will suffice for animal storage.

All captured TGW and OSG will be temporarily placed in clean individual containers, in a relatively cool place[2]. A small amount of vegetation from the capture site will be placed inside the containers to provide cover and prevent dehydration. Any TGW and OSG captured will be handled and held carefully and as little as possible, with particular care taken not to damage their legs. They must not be held by a single leg under any circumstances. All individuals salvaged will be released as soon as practicable (and within 12 hours) to the pre-selected release area.

Relocation

Salvaged invertebrates will be released within the central southern terrace, where enhancement of habitat will already have begun. If more than 30 individuals from any species or combination of species are salvaged, then individuals that are surplus to 30 individuals will be released in other enhancement areas (Figure 6).

[1] An ice pack can be used to keep the chilly bin cool, but it should be well-insulated by wrapping in layers of towelling or bubble wrap so that animals inside the chilly bin are not subjected to harmful rapid temperature changes.

[2] Temperature extremes or sudden temperature changes should be avoided, but TGW and OSG should not be left out in the sun.

Appendix 2

Incidental discovery protocol

Overview

Incidental discovery protocols (IDP) are set out below and are to be followed if any minute grasshopper (MG), Tekapo ground wētā (TGW), or Otago short-horned grasshopper (OSG) are discovered during development, or if MG are discovered during salvage.

Identifying OSG, MG and TGW

Identifying OSG, MG and TGW is very difficult (Plates 1-3), as they look similar to other non-threatened species to which they are closely related. Species diagnosis is best left to an expert. However, any ground wētā found on site is likely to be TGW. Any small (<16 mm body length) grasshopper found in dry, open habitat should be assumed to be MG or OSG. A robust-looking grasshopper with a wide body and bumpy-looking tegument (surface of the exoskeleton) is likely to be MG. A slender-looking grasshopper with a smooth tegument is likely to be OSG. Colouration is highly variable within grasshopper species. Table A2.1 summarises the most useful characters for identifying potential MG, OSG and TGW in the field.

Plate 1 – Otago short-horned grasshopper (OSG).

Plate 2 – Minute grasshopper (MG).

Plate 3 – Tekapo ground wētā (TGW).

Table A2.1 – Identification characters of minute grasshopper, Tekapo ground wētā and Otago short-horned grasshopper.

Identification Character	Minute grasshopper	Otago short-horned grasshopper	Tekapo ground wētā
Habitat	Open, dry areas with short-stature vegetation and patches of bare ground, rocks, lichen and mosses.	Open, dry areas with short-stature or sparse vegetation and patches of bare ground.	May be found in most habitats. Unlikely to be near wetlands.
Size	Up to 16 mm	Up to 15 mm	Up to approximately 35 mm
Body appearance	Robust, widest where the thorax and abdomen join	Slender, widest where the thorax and abdomen join	Wide, cylindrical
Tegument (exoskeleton surface) appearance	Bumpy, resembling lichen	Smooth, matte, like paper or leather	Smooth, polished
Colouration or markings	Highly variable, commonly stone-grey or coloured to resemble lichen, usually well-camouflaged	Highly variable. Hind tibiae (long, thin portion of leg between the thicker femur and the foot) are never red.	Pale tan or straw-coloured with darker head and chocolate-brown markings along the back

Where OSG, MG and TGW Might be Found

See Section 4.1 of the Terrestrial Invertebrate Management Plan for habitat characteristics associated with OSG and MG. Habitat requirements of TGW are not well-understood, and they may be found throughout the site. They are likely to be in their burrows during the day, near the surface of the soil.

This IDP will be applied throughout construction anywhere on site, but OSG and MG are most likely to be found in and around patches of suitable habitat identified in Section 4.1.

Protocol Upon Discovering an OSG, MG or TGW

If a suspected OSG, MG or TGW is discovered:

1. Stop work in the immediate location. Send a photograph to the Project Entomologist and seek their advice.
2. Capture the specimen carefully in a hard plastic container such as a lunch box or jar. Place some vegetation in with the insect and put the container in a cool place, out of the sun, such as an air-conditioned vehicle or in the shade. No ventilation is needed.
3. Await further instructions from the Project Entomologist. Salvage and relocation may be necessary.
4. Do not continue work in the immediate location until further instructions from the Project Entomologist have been received.

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

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

Regional Offices located in Auckland; Christchurch; Dunedin; Hamilton; Invercargill; Queenstown; Tauranga; Wānaka; Wellington; Whangārei.

Wildlands