Technical Memorandum

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Company:	FRV		**SLR Consulting New Zealand**
cc:	Tim Grace	**Date:**	11 May 2026
		Project No.	810.032031.00001

RE: Rangitīkei Solar Farm
Technical Memorandum for Referral Application
Ecology

Introduction

SLR Consulting New Zealand (SLR) have been engaged by Fotowatio Renewable Ventures (FRV) to provide ecology advice for the proposed Rangitīkei Solar Farm. This technical memorandum provides a description of the ecological features associated with the some 507-hectare site for the solar farm, as well as an assessment of anticipated and known adverse effects, the anticipated measures to avoid, remedy, or mitigate these adverse effects, and the significance of these anticipated and known adverse effects with the anticipated mitigation.

The ecological features have been identified through the completion of a review of the available background information, literature and databases and the completion of site assessments and investigations.

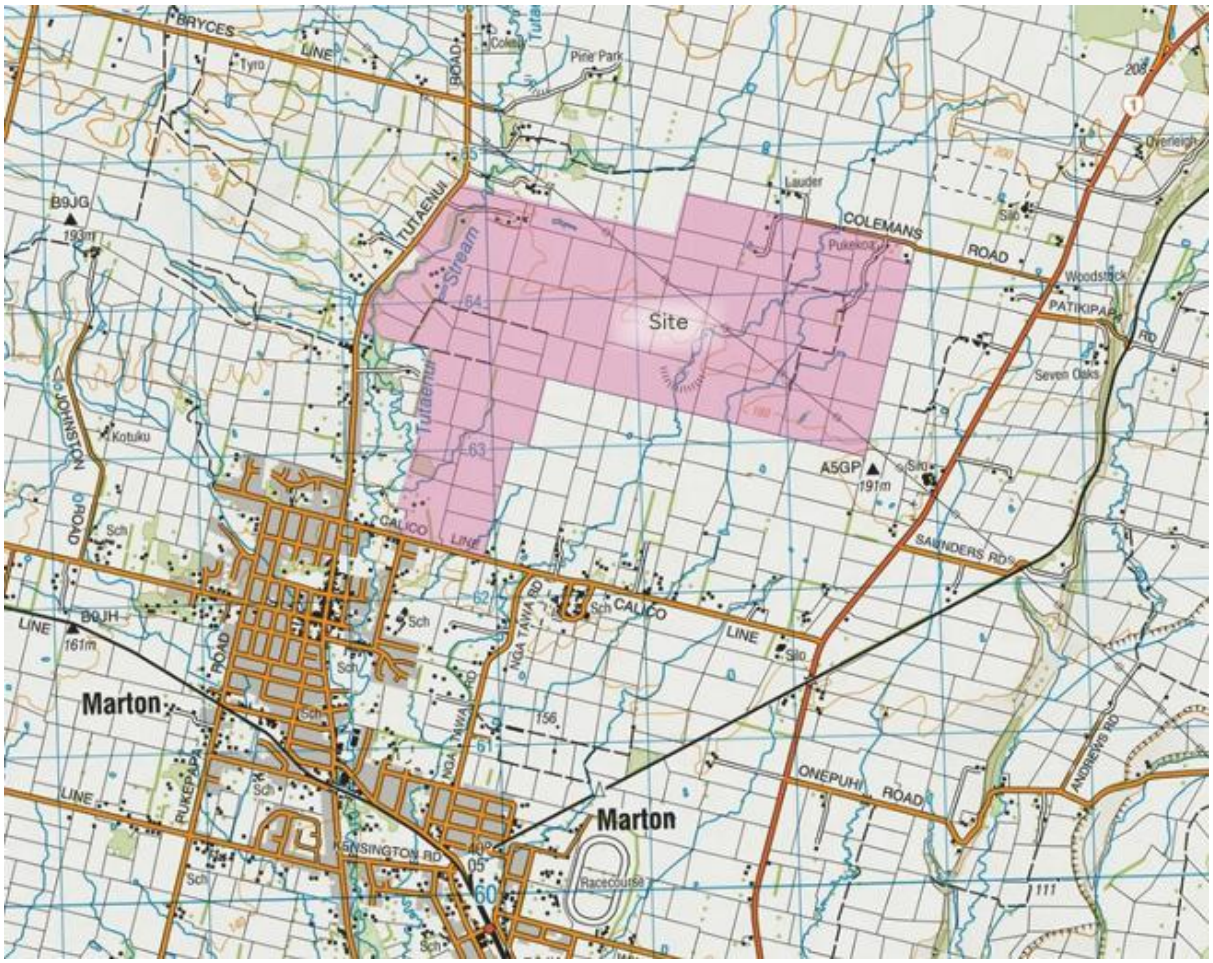
An initial desktop assessment was completed in January 2026, with the results summarised. The information compiled in that summary was used to plan and support the site assessments, which were completed in late January 2026.

Project Overview

FRV propose to construct, operate and maintain, and where necessary decommission, a utility scale solar farm, associated substation and battery energy storage system (BESS), and ancillary activities and infrastructure, including provision for access to the site, to connect and supply electricity to the National Grid near Marton.

The site location is shown on Figure 1 below. The site is located immediately north-east of Marton and is bounded by Tūtaenui Road, Calico Line, State Highway 1, and Colemans Road. A broader scale locality map of the proposed site is provided in Attachment A.

Figure 1 Site Location



The site is held in four land holdings and has a total combined area of some 507 hectares. The site details are outlined in Table 1 below.

Table 1: Site Details

Address	Land Area	Legal Description
240 Tūtaenui Road, Marton	167.07 ha	Lot 2 DP 3350, Lot 2 DP 87115, Lot 1 DP 87829, Lot 1 DP 3391
119 and 178 Colemans Road, Marton	161.19 ha	Lot 2 DP 87829, Lot 2 DP 500699, Lot 1 A 2030, Lot 2 A 2030
Tūtaenui Road, Marton	128.83 ha	Part Blk XXXVII Rangitīkei DIST, Lot 1 DP 69932, Part Lot 1 DP 1669
65 Calico Line, Marton	49.76 ha	Part Blk XXXVIII Rangitīkei DIST

The key elements of the project are described in Table 2 below. A high-level concept plan that was used to inform assessments is provided in Attachment 1.

Table 2 Project Summary

Project element	Summary
Addresses	119 and 178 Colemans Road, 206 Tūtaenui Road, 240 Tūtaenui Road and 65 Calico Line
District Council	Rangitīkei District Council
Regional Council	Horizons Regional Council
Electricity Generating Works	Construction, operation, maintenance, and where necessary decommissioning, of a some 220 MWAC solar farm over an approximate development area of some 403 hectares, including elements such as: • Solar arrays installed on a single-axis tracking system or fixed-tilt mounts on pile-driven supports. It is anticipated that approximately 300,000 individual monocrystalline photovoltaic panels will be installed within a maximum height envelope of 4.5 metres. • Inverters and transformers and associated external cabling. • Underground cabling. • Provision for construction of some 190 MW BESS (battery energy storage system). • Construction of a new transmission substation and connection to Transpower's 220 kV overhead transmission lines which run through the site. • The proposed development will be delivered as a single-stage construction comprising the solar farm and all ancillary activities and infrastructure. The BESS is the only component that may be constructed separately, after the solar farm has been established and is operational. No further staging is proposed.
Ancillary Infrastructure	Construction of: • New primary site access from Calico Line and new secondary site access from Colemans Road. • Any necessary (yet to be determined) road or intersection upgrades, which may include widening of Colemans Road, and / or upgrade to the intersection of State Highway 1 / Colemans Road and / or right turn bay on Calico Line. • Temporary construction laydown and yard areas and associated temporary construction buildings and facilities. • Permanent storage and maintenance buildings and site office buildings and associated yard areas. • Water tanks and other fire prevention, management and mitigation measures, as required. • Internal access and maintenance roads and parking areas. • Lighting, fencing and security and monitoring cameras and devices. • Any necessary (yet to be determined) acoustic barriers.
Earthworks	Completion of earthworks required to construct the solar farm and the ancillary infrastructure, including: • Construction of new site accesses. • Completion of road upgrades (as required). • Formation of temporary construction laydown and yard areas. • Formation of internal access roads. • Piling of solar array support posts. • Construction of platforms for inverters and transformers. • Trenching of cables.

Project element	Summary
	• Formation of permanent building platforms and yard areas for substation and BESS.
Subdivision	Subdivision to give effect to long-term lease (lease more than 35 years) which at a minimum will result in the creation of new lots over land to be retained by the landowners, and resulting lots containing the solar farm and the associated infrastructure.
Planting	Boundary mitigation planting, riparian planting around streams and wetlands and mid-block mitigation planting around infrastructure.
Construction Duration	Anticipated 18 to 24 months, with an anticipated peak construction period of 4 to 6 months.
Construction Workforce	Approximately 250 FTE during peak construction period.
Operational Hours	24 hours a day, seven days a week.
Operational Workforce	Approximately 4 – 6 FTE.
Operational Duration	Approximately 40 years, unless repowered.
Decommissioning and Rehabilitation	At the end of the operational life of the project, if the solar farm is not repowered, infrastructure would be decommissioned and the site would be rehabilitated to enable resumption of agricultural activities.

Methodology

The terrestrial and freshwater habitat characteristics of the site and surrounding area were assessed during a site visit on the 27 – 29 January 2026. A walkover of the site was undertaken to assess the ecological values and habitat potentially affected by the proposed development.

Terrestrial Habitats

During the site visit, both native and exotic plant communities were recorded, and a qualitative assessment of on-site habitats was conducted. The assessment focused on the botanical and ecological value of plant communities. Notes were collected on areas with potential for restoration.

Natural Inland Wetlands

Potential wetland features of the site were assessed using the wetland delineation protocols developed by the Ministry for the Environment[1]. The site assessment was undertaken under 'normal circumstances', with fine weather conditions predominating.

During the site assessment, a number of representative vegetation plots were established within potential wetland and non-wetland habitat in order to ascertain whether a designated area would meet the definition for a Natural Inland Wetland per the National Policy Statement for Freshwater Management 2020 (Amended 2025). Vegetation and cover were recorded per stratum within the plots, whilst soil sampling was undertaken as an additional measure where marginal results were recorded for the wetland indicator status tests (Dominance Test and Prevalence Test). For most sites, the rapid test was undertaken but a conservative approach was taken to ensure that wetlands meeting the definition were identified.

[1] Ministry for the Environment. 2022. Wetland delineation protocols. Wellington: Ministry for the Environment. ISBN: 978-1-991077-04-2 Publication number: ME 1713

Aquatic Habitats

Qualitative instream and riparian observations were made, where characteristics of freshwater habitats, such as descriptions of watercourses and vegetation, were recorded during the site visit. Locations of instream structures including culverts and bridges were also recorded.

A Rapid Habitat Assessment as per the National Rapid Habitat Assessment Protocols was carried out at six locations, for each survey reach[2]. Ten habitat parameters were scored from 0 (poor) to 10 (optimal). This was then used to characterise the overall quality of each survey reach.

Three Environmental DNA (eDNA) samples were collected from the streams, one in the Tūtaenui Stream near to where it leaves the site and two in the Foley Stream, one where it leaves the site and a second sample near to the middle of the site. eDNA assessments survey cellular material of species that are dispersed into the environment and include genetic information from cells such as larvae, urine, scales and exoskeletons [3]. Each sample included six replicates, with each replicate filtering up to one litre of stream water through a 1.2 µm cellulose acetate encapsulated syringe filter. Once one litre of stream water was pushed through the filter, or once the filter was saturated with material, and no additional water could be pushed through, the sample was preserved using 3ml of a DNA/RNA preservative. All equipment used was sterile, and samples were taken using sterile nitrile gloves.

Terrestrial Fauna Surveys

Bats

The site was assessed for bat habitat suitability as part of the field survey. A bioacoustics survey to detect the presence of the New Zealand long-tailed bat (*Chalinolobus tuberculatus* – Threatened: Nationally Critical[4]) was conducted at seven locations. Monitoring equipment was deployed in late January 2026, and retrieved during March 2026.

Birds

To supplement the information collected in the desktop assessment, all birds seen and heard during the site visit were recorded. Additional birds identified through eDNA were also recorded.

Skinks and Geckos

The site was briefly assessed for skinks and gecko habitat suitability as part of the field survey. Artificial cover objects (ACOs) were also installed on site during the initial site visit. A total of ten double layered ACOs were installed in various habitat types considered suitable for native skinks, including forest edges, hedgerows and woodpiles. The ACOs were deployed in late January and were retrieved in March 2026.

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[2] Clapcott, J. 2015. National rapid habitat assessment protocol development for streams and rivers.: Northland Regional Council.
[3] David, B.O., Fake, D.R., Hicks, A.S., Wilkinson, S.P., Bunce, M., Smith, J.S., West, D.W., Collins, K.E., Gleeson, D.M. 2021. Sucked in by eDNA–a promising tool for complementing riverine assessment of freshwater fish communities in Aotearoa New Zealand. New Zealand Journal of Zoology, 48(3-4), pp.217-244.
[4] O'Donnell, C.F.J.; Borkin, K.M.; Christie, J.; Davidson-Watts, I.; Dennis, G.; Pryde, M.; Michel, P. 2023: Conservation status of bats in Aotearoa New Zealand, 2022. New Zealand Threat Classification Series 41. Department of Conservation, Wellington. 18 p.

Ecological Features and Characteristics

Site Overview

The site was dominated by cropping and dry stock grazing. It is generally of a flat grade, with a number of shallow gullies that eventually drain to the Tūtaenui Stream. Historically, the site has been subject to extensive drainage activities, with the majority of small gullies and swales now containing tile drainage. The Tūtaenui Stream flows through the site in a more or less north to south direction, near to the western boundary of the site, with the Foley Stream flowing through the middle of the site, also in a southerly direction.

Terrestrial Habitats

Six broad vegetation types were identified on site, namely, exotic pasture grass cover, crops, exotic shelterbelts, exotic shrubland, native bush and mixed exotic / native treeland. There were also a small number of individual cabbage trees observed sporadically within the grazed areas. An overview of the distribution of on-site habitats is provided in Attachment B.

Pasture grass and crops were the dominant landcover, which is expected given that the predominant land use within the property is dry stock grazing and cropping. Common pasture grasses observed within this vegetation type included rye grass (*Lolium perenne*), *Poa annua,* Yorkshire fog (*Holcus lanatus*) and red clover (*Trifolium pratense*). Other exotic herbaceous species within pasture were in lower abundance but included buttercup (*Ranunculus repens*) and narrow leaved plantain (*Plantago lanceolata*). Crop species cultivated within the site included maize (*Zea mays*), barley (*Hordeum vulgare*) and *brassica* species. Shelterbelts were typically comprised of exotic species, including river red gum (*Eucalyptus camaldulensis*), *Cupressus sp.* (see Photo 1)*, Poplar sp.* and *Pinus sp.* with one mixed shelterbelt also containing the native lemonwood (*Pittosporum eugenioides*). No smaller hedgerows were observed on site.

Photo 1: Young *Cupressus* sp. shelterbelt with brassica crop observed.

Riparian vegetation was largely absent along the Foley Stream, with only small areas of shading vegetation observed, primarily comprising of exotic tree species. The Tūtaenui Stream supported larger areas of well-established trees, particularly in the north western corner of the site. This area included mature tawa (*Beilschmiedia tawa*), titoki (*Alectryon excelsus*), lancewood (*Pseudopanax crassifolius*), kaikomoko (*Pennantia corymbose*), kanuka (*Kunzea sp.*), matai (*Prumnopitys taxifolia*), mahoe (*Melicytus ramiflorus subsp. Ramiflorus*), hinau (*Elaeocarpus dentatus*) and cabbage tree (*Cordyline australis*) interspersed with exotic trees including English oak (*Quercus robur*) and sycamore (*Acer preudoplatanus*).These trees also supported a number of native climbing species, including native passionflower (*Passiflora tetrandra*), supplejack (*Ripogonum scandens*), New Zealand jasmine (*Parsonsia capsularis*) and large leafed muehlenbeckia (*Muehlenbeckia australis*). A riparian understory was also present, dominated by *Coprosma sp. Paratrophis microphylla*.

Natural Inland Wetlands

Wetland habitat comprising a variety of obligate wetland (OBL) and facultative wetland (FACW) herbaceous species were scattered throughout the site, primarily within the low points in the landscape, likely associated with blocked or poorly performing tile drains. The primary OBL and FACW grasses that were prevalent in wetland areas included creeping bent (*Agrostis stolonifera*), mercer grass (*Paspalum distichum*) and blue sweet grass (*Glyceria declinata*), while water pepper (*Persicaria hydropiper*) and kneed foxtail (*Alopecurus geniculatus*) were also common. A total of 13 wetlands were identified and delineated using the ‘Rapid Test’, with four vegetation plots implemented onsite to aid in the

delineation of some of these wetlands, where the dominant species were not clearly FACW or OBL.

Certain areas within low points on site comprised mud, standing water and a mix of pasture and wetland grasses. These areas were, however, excluded as wetland habitat in terms of the wetland delineation protocols developed by the Ministry for the Environment (MfE 2022[2]) as they meet the pasture exclusion criteria.

All but one of the wetlands identified were dominated by exotic species, were highly degraded and/or were of overall low quality. The largest wetland, located in the northwestern corner of the site adjacent to the Tūtaenui Stream, was fenced and appeared to include some planted wetland species, including *Carex secta*.

Representative images of wetland habitat on site are included in Photo 2, below.

Photo 2: View of wetland habitat associated with a former channel of the Tūtaenui Stream. Note this wetland forms part of the wider planned retention areas, and is outside of the solar farm activity area.

Artificial ponds

Nine artificial ponds were identified within the site. Although these ponds were all dominated by hydrophytic vegetation, it was clear that they had been constructed, and were either used for water abstraction and/or for duck shooting purposes. As a deliberately constructed wetland, these artificial ponds are excluded from the definition of ‘natural inland wetland’. These ponds support some of the higher value biodiversity values present within the site, supporting numerous waterfowl species and a range of wetland plant species. They also

provide refuge habitat at drier times of year, when the streams that flow through these ponds reduce in flow and potentially dry up. One of these ponds was dry at the time of the site visit, with the bed of the pond being dominated by dense growths of *Persicaria sp.* and *Roripa palustris*. An example of these artificial ponds is shown in photo 3.

Photo 3 An example of an artificial pond located within the site. Note this pond forms part of the wider planned retention areas, and is outside of the solar farm activity area.

Streams

The Tūtaenui Stream is the largest stream that flows through the broader site, but is located to the west of the actual solar farm proposed development area. This is a permanent stream, which includes diverse instream habitats, including pools, riffles and undercut banks. This habitat diversity is reflected in the RHA score of 89 units (out of a possible 100[5]). It is relatively well protected by mature vegetation along most of its length, although some of this vegetation is non-native and includes weed species.

The Foley Stream flows through the middle of the site, with the solar farm infrastructure intended to be set back from this stream. It is a relatively small stream, and based on aerial photo imagery, it appears that this is an intermittent stream, which ceases to flow during very dry periods. During the site visit, this stream was flowing well. This stream supports a range of different habitats, including deeper pools and shallow riffles in addition to stretches that are congested with macrophyte growth. This stream has been subject to historical modification activities, and in areas is experiencing erosion and slumping of the stream banks. It also supports two artificial ponds, one of which was formed by the installation of

[5] Clapcott, J. 2015. National rapid habitat assessment protocol development for streams and rivers.: Northland Regional Council.

flood detention infrastructure. Scores of 32-55 were recorded across the four RHA assessments undertaken in the Foley Stream, reflective of its poor condition.

There was one other stream observed on the site. This stream, which is located to the east of the Foley Stream, has been extensively drained, and appears to predominantly flow underground, through tile drains. There are areas where these tile drains have either blocked or at capacity from time to time, as there is a stream channel evident on the ground surface, which carries flowing water at wetter times of the year. This stream could be considered an intermittent stream, but is not protected from stock access and contains limited to no instream habitat. One RHA assessment was undertaken in this tributary, with this assessment completed where it leaves the site. The stream contained water at this location, but appeared stagnant, resulting in an RHA score of 41.

Example reaches of streams that flow through the site are shown in Photo 4.

Photo 4 Streams present within the site extent.

From left to right: Tūtaenui Stream, Foley Stream, Unnamed tributary

Fauna

Birds

All birds seen and heard during the site visit were noted. In total, 25 bird species were observed on site, with eDNA indicating the presence of an additional four species. The bird community comprised 13 Introduced: Naturalised species, 11 Not Threatened native species, one At Risk – Naturally uncommon native species, two At Risk – Relict native species, and feral chickens, which were unlisted. eDNA also returned a result for an unknown *Anas* species (either *Anas chlorotis* : Threatened – Nationally Increasing or *gracilis*: Not Threatened).

Most of the native bird species recorded were either associated with the native trees around the Tūtaenui Stream, or the artificial ponds located in former stream channels that have been tile drained.

Fish

No active electrofishing or fish trapping was undertaken within the site. Environmental DNA sampling was conducted within the Tūtaenui and Foley Streams. The results found that the Foley Stream contained a particularly depauperate fish community, with only common bully

(*Gobiomorphus cotidianus*) and Kaharore bully (*G. mataraerore*) detected in this stream. These bully species were also detected in the Tūtaenui Stream, along with longfin and shortfin eel (*Anguilla dieffenbachii* and *A. australis*) and European perch (P*erca fluviatilis*). Although Salmonidae DNA was also detected in the Tūtaenui Stream, it was a very low detection rate and indicative of potential contamination of the sample, or that this DNA was introduced to the stream by external influences, e.g. people feeding eels, or faeces from piscivorous birds. Kaharore bully is classified as being At Risk – Naturally Uncommon, and longfin eel are At Risk – Declining. Common bully and shortfin eel are Not Threatened while perch are introduced and naturalised[6].

Skinks and Geckos

Potential skink and gecko habitat was briefly searched during the field survey but yielded no specimens. 10 ACOs were placed within potential skinks and geckos habitat on site during the site visit and were checked in March 2026. No skinks and geckos were detected within the ACOs and it is highly unlikely that significant skink or gecko populations will be present within the site, due to the limited availability of suitable habitat and history of regular disturbance for farming activities.

Bats

The closest records of long-tailed bats within the Department of Conservation (DOC) bat database are within 4 km to the south of the site. The results of the completed bat survey conducted as part of this study using ABMs placed within potential bat fly ways found regular utilisation of the site by bats at each monitoring location, confirming their presence on site.

Pest Animals

Although no pest animals were observed during the site visit, eDNA detected the presence of Norway and black rats, mice, rabbits, possums, hedgehogs and hares. The presence of these species has potential ramifications for any potential biodiversity focused actions undertaken on site, either through grazing damage of new plantings and/or predation of native birds, and skinks, geckos and bats.

Anticipated adverse ecological effects and mitigation

The works associated with the proposal include the construction and installation of solar panel arrays, a Battery Energy Storage System (BESS), a substation, roading, and various types of ancillary infrastructure. Construction and operational impacts associated with the proposed solar farm may result in the following direct and indirect ecological effects:

- Small-scale soil disturbance, associated with piling for insertion of the steel poles holding the solar array structures will result in localised habitat disturbance. Piles will be vibro- or hammer driven with limited associated soil disturbance. This will occur throughout the site.
- Potential hydrological alteration within identified wetland habitat;
- Earthworks associated with construction of access roads and cable trenches within the proposed solar farm area resulting in localised habitat disturbance;

[6] Dunn, N.R., Closs, G.P., Crow, S.K., David, B.O., Goodman, J.M., Griffiths, M., Hicks, A.S., Hickford, M.J.H., Jack, D.C., Kitson, J.C., Ling, N., Water, J.M., Whlie, M.J., Hitchmough, R.A. and Makan, T. 2024. Conservation status of New Zealand Freshwater Fishes, 2023. New Zealand Threat Classification Series 46. Department of Conservation, Wellington.

- Earthworks to facilitate construction of ancillary infrastructure associated with the proposed solar farm (e.g. inverter / STS units, lay down areas, etc.) resulting in localised habitat disturbance;
- Earthworks to form the building platforms and yard areas for the BESS and substation resulting in localised habitat disturbance;
- Stormwater runoff during construction potentially resulting in watercourse sedimentation and habitat disturbance and ongoing stormwater runoff from panel arrays, buildings, the substation and BESS and other ancillary infrastructure;
- Minor habitat disturbance and alteration of aquatic habitat resulting from potential culvert implementation in the watercourses;
- Possible collision of birds and bats with solar panels during ongoing operation of the solar farm;
- Proposed removal of three exotic tree shelterbelts on the site, resulting in negative indirect effects (and possible direct effects) on bats;
- Lighting and noise associated with on-site works and infrastructure causing disturbance of terrestrial fauna; and
- Minor vegetative and hydrological effects relating to decommissioning.

There is potential for positive ecological effects associated with the proposal. Based on the initial design plans, positive effects would include improved aquatic habitat and water quality resulting from the change to a less intensive land use type (anticipated to be sheep grazing at worst), improved biodiversity values through potential restoration plantings along watercourses, exotic vegetation removal, potential pest animal control and enhanced connectivity of natural areas in a landscape context through buffer implementation and corridor plantings. The anticipated ecological effects and measures to address these effects are discussed below and summarised in Table 3.

Avoidance

The design approach (with the design process continuing) will enable avoidance of multiple identified ecological features within the site including wetlands, artificial ponds, native bush, mixed exotic/native treeland, exotic shrubland and the majority of exotic trees, however, three exotic tree shelterbelts have been identified for removal. The vast majority of the proposed infrastructure will be placed in exotic pasture and previously cropped areas.

Effects on terrestrial vegetation

The vegetation that may be affected by the proposed works comprises, almost entirely, pasture used for stock grazing with a comparatively lower abundance of cropped areas.

Vegetation disturbance is expected to be limited to the clearance of pasture and a relatively small areas of exotic trees to allow for the construction of panels; disturbance of vegetation from piling rigs installing the piles; and earthworks disturbance associated with formation of roads, creation of platforms for structures and buildings and trenching for cabling. It is likely pasture will be resown or re-established as required once the panels have been placed on site.

Effects on watercourse habitat

There is potential for sediment to discharge into the receiving streams during the construction period for general site preparation works and installation of new culverts, if they

are required. New internal access tracks will be required, while other existing unsealed farm tracks should be retained as far as practicable as part of the ongoing design process. The applicant will likely make use of existing culverted crossings as far as possible although additional culvert crossings may be required to facilitate access, possibly resulting in minor habitat disturbance. The site is low gradient and provided appropriate sediment and erosion control measures are implemented and adhered to during the construction phase including provisions relating to the timing of the earthworks (i.e. only taking place during earthworks season), the spatial and temporal effects of these risks to the receiving environment are anticipated to be low. Sediment discharge risk associated with potential decommissioning is also anticipated to be low provided the above-mentioned control measures are followed.

The solar panel array tables are separated by 2m – 6m gaps, are installed on elevated steel frames and pasture will be retained below the panels. As such, only a relatively small area of the site will be formed as hard stand impervious area (e.g. the substation, BESS, compacted aggregate yard areas, compacted aggregate access tracks, etc). Runoff from the panels will be on to pasture, where it can be expected to infiltrate the ground or follow current land contours to the receiving watercourses.

The project proposes watercourse buffers ranging from 5 m to 20 m dependant on the nature of the watercourses on site, with perennial streams being assigned a wider buffer compared to seasonal / intermittent streams. Planting will also likely be undertaken alongside watercourses on the site (which will also provide mitigation of landscape effects), which is anticipated to result in increased shading of the stream, increase bank stability, and filtration of overland flows to the benefit of any aquatic fauna temporarily utilising the stream. Riparian planting extent and species are to be agreed upon with Horizons Regional Council, who are sensitive to the effects on flood flows. A reduction in nutrient loss associated with the potential conversion of the site from pastoral and cropping to solar generation (with possible associated agrivoltaics such as sheep grazing) is expected to result in a small positive effect on downstream water quality. As such, the long-term effects of the proposal on the aquatic environment are anticipated to be positive.

Effects on wetland habitat

The solar farm layout is being designed with consideration to wetland features. These will primarily be avoided unless there is an operational and/or functional need to located within a wetland. It is anticipated that restorative riparian planting will be undertaken that will likely be around the wetlands near the Tūtaenui Stream and along the margins of the Foley Stream. The wetlands on site are located within actively grazed pasture or cropping areas and we anticipate an overall minimal change in the integrity of the affected wetland habitat compared to the observed conditions, should works be required within them.

While no direct hydrological impacts to wetlands are anticipated, there are potential indirect effects related to hydrological modification of the catchment. These effects relate primarily to potential hydrological interruption, as solar panels represent disconnected impervious surfaces that redistribute rainfall and discharge to the pervious pasture surface below during rainfall events. While rainfall interception by panels may locally alter the distribution of water across the site, disruption to hydrological connectivity is anticipated to be minimal and is not expected to be fully severed, and the movement of water through the soil profile to recharge wetland groundwater tables is expected to continue as per current conditions.

Indirect effects to wetlands within the site can arise because of landform and hydrological changes to the contributing catchment. Minimal changes to landform are anticipated near the wetlands. As discussed above, stormwater runoff from the solar panels will occur to a pervious surface (i.e. the pasture below) during rainfall events. An anticipated gap between panel rows should allow for infiltration to the ground below. The framing poles that will

support the solar panels should also not present a significant barrier to surface flows or sub-surface interflow of water to wetlands located downslope and trenches for cabling will be backfilled to reinstate landform. As a result, changes to the hydrological function of the wetlands in proximity to construction are unlikely.

Provided appropriate erosion and sediment control measures are implemented during construction works and any areas of bare earth are revegetated in a timely manner, the risk to the wetlands within the site from sedimentation is anticipated to be low.

Effects on aquatic fauna

As noted above, the sediment discharges associated with the development will be managed through appropriate sediment and erosion control measures that will minimise potential adverse effects of sediment discharges on aquatic fauna. Instream works have the potential to directly impact aquatic fauna if not managed appropriately. Following best practice construction methods, isolation and localised dewatering to enable installation of the culverts 'in the dry' would be recommended, to avoid sediment discharges during works to downstream receiving environments. However, dewatering has the potential to strand fish, resulting in death. Fish salvage and relocation prior to and/or during dewatering of works reaches would also be recommended to minimise potential adverse effects on native fish and any large invertebrates that may also be present.

To ensure new culverts do not create new barriers to upstream migration of fish, where native fish are likely to be present and where upstream fish habitat is present, any culverts should be sized and installed in line with the rules of the Horizons One Plan and design considerations listed in the National Environmental Standards for Freshwater (NES-F) and the New Zealand Fish Passage Guidelines[7].

In the longer term, the proposed riparian planting will result in increased shading and habitat for the watercourse to the benefit of aquatic animals. The reduction in nutrient loss as a result of the anticipated reduction in the current farming practices(grazing of animals, application of fertilizer, etc), is expected to improve water quality. As such, the long-term effects of the proposal on the aquatic environment should be positive.

Effects from lighting associated with on-site structures

No visible lights are generally present on a solar farm, though some security lighting may be required around infrastructure at the site. To minimise any adverse effects on threatened bats utilising the site for foraging, it is recommended that the following considerations are followed as part of the lighting design:

- lighting limited to specific purposes (security lighting for infrastructure buildings);
- use of shielding to avoid upward light spill;
- limit of 0.3 lux at the infrastructure perimeter at any height;
- use of non-reflective, dark surfaces; and
- use of adaptive controls such as motion sensors where feasible.

Note that New Zealand does not have any official bat-friendly lighting guidelines at present, and these controls are informed by the UK guidelines, research in Australia and discussions

[7] Franklin, P., Baker, C., Gee, E., Bowie, S., Melchior, M., Egan, E., Aghazadegan, L., and Vodjansky, E. 2024. New Zealand Fish Passage Guidelines - Version 2. Hamilton: National Institute for Water and Atmospheric Research.

between New Zealand bat experts. These recommendations will inform the ongoing design process.

Effects of noise on fauna

Construction disturbance linked to the implementation of the solar panels using a small piling rig may create some localised noise disturbance, which has been recorded at a Sound Pressure Level (SPL) OF 85 decibel (dB) LAeq[8] at a 10 m distance in previous works on similar sites. At a distance of 75 m, this SPL would comply with the 70 dB LAeq limit prescribed by NZS 6803:1999 (i.e. the latest national standard of construction noise) which is similar level of sound to agricultural implements such as a tractor (*Pers. Comm. – P. Runcie : SLR Acoustics and Vibration Expert*). The actual piling produces an intermittent higher pitched noise, which is temporary and will progress across the site as construction progresses. Mobile fauna may temporarily move out of the immediate area of works during construction, although the temporary noise disturbance will not be too dissimilar to ongoing agricultural activities at the site (in particular the seasonal cropping activities).

Operational solar panels are considered noise-free with only the inverters producing a slight hum. This noise would only be audible from within the site and only during the day when the panels are generating electricity. The levels of noise emitted by the inverters is highly localised and not expected to adversely affect fauna utilising the wider site.

Effects of solar panels on birds

Overseas studies show that birds strike on solar panels can cause injury or death, possibly as a result of reflections of the sky, misinterpreting the reflective surface as water, or due to polarisation of light. Similar impacts are seen with other reflective surfaces like windows in buildings.

The ‘lake effect’ theory is that large fields of solar panels may appear to be water and birds (particularly water birds) may try to land on it or drink from it, resulting in injury[9]. There is very little data on the level of impact of solar panels on birds and none in the New Zealand context, however bird fatality detections from three solar farms in California showed rates of between 0.02 birds/ha/year to 0.6 birds/ha/year[10]. None of these studies showed high rates of water birds being adversely affected by solar panels and raptors made up only 0% to 4% of all birds impacted[12].

Photovoltaic panels causing polarisation of light has also been thought to be an issue for wildlife, however a study in South Africa found no evidence that birds were responding to polarised light[11]. Panels at this site will be placed with relatively large gaps (some 2m – 6m) between the rows. It is anticipated that the gaps will provide enough of a visual cue for birds to be able to perceive the panels themselves and not mistake them for water or be disoriented by reflections.

[8] The ‘A’ weighted equivalent noise level. It is defined as the steady sound level that contains the same amount of acoustical energy as the corresponding time-varying sound.
[9] Kagan, R. A., T. C. Viner, P. W. Trail, and E. O. Espinoza. 2014. Avian mortality at solar energy facilities in Southern California: a preliminary analysis. National Fish and Wildlife Forensics Laboratory, Ashland, Oregon, USA.
[10] Western Ecosystems Technology 2017. Draft Bird and Bat Conservation Strategy for the Palen Solar Voltaic Project. Prepared for Palen Solar III LLC by Western EcoSystems Technology Inc. 158 p.
[11] Visser, E., Perold, V., Ralston-Paton, S., Cardenal, A.C., Ryan, P.G. 2018. Assessing the impacts of a utility-scale photovoltaic solar energy facility on birds in the Northern Cape, South Africa, Renewable Energy (2018), https://doi.org/10.1016/j.renene.2018.08.106

Solar panels are designed to absorb light and not to reflect it, with panel arrays having a similar reflectance to still water, and less reflectance than concrete[12]. Whether the effects of solar panel arrays are any greater than that posed by buildings has not been well studied and the overall effect of solar arrays on birds is not well understood. In this regard, monitoring conditions will be formulated which can be used to gain an insight into the potential effects to birds.

It is expected that three existing shelterbelts located on the site will be removed. Clearance of these trees has the potential to have a direct effect on resident native birds if potential nesting sites are disturbed. Although no nesting native species were observed on site, a pre-construction survey can be completed to assess whether any native bird species nesting areas will be destroyed. It is anticipated this will be offered as a condition of consent.

Effects of solar panels on bats

Construction effects

The removal of the three exotic shelterbelt areas on site could potentially have a direct effect on resident bats, if potential roosting sites are disturbed.

Due to the presence of bats across the site and the potential roost trees proposed for removal, it has been recommended that bat roost protocols (BRPs) are implemented prior to clearing of large native or exotic trees[13]. This involves pre-clearance monitoring to check whether bats are using the impacted trees and subsequent actions to ensure no harm to bats. This monitoring should follow best practice requirements outlined in the protocols for minimising the risk of felling occupied bat roosts. The implementation of BRPs will form part of the application and anticipated to be offered as a requirement via conditions of consent.

Operational effects

The effects of solar panels on long-tailed bats are not currently known. Data from overseas suggests bats avoid solar farms to some extent, possibly due to the presence of solar arrays impairing bats' orientation. There is also evidence that there is the potential for collision from bats mistaking smooth, horizontal panel surfaces for water[14]. Other studies found that while there are species-specific differences as to how bats interact with solar farms, they overall appear to negatively affect bat activity in the area[15].

Panels may also attract insects that bats forage on. Further investigations are needed to reveal which insect groups are attracted to solar panels at solar farms, though solar cells may be sources of polarised light which attracts flying aquatic insects[16]. Long-tailed bats may preferentially feed on aquatic insects, especially Dipterans and Coleopterans[16]. However, it is currently unknown whether insect attraction around solar panels would be a beneficial outcome for long-tailed bats with respect to insect diversity and species, or if there

[12] Riley E., Olson, S., 2011. A Study of the Hazardous Glare Potential to Aviators from Utility-Scale Flat-Plate Photovoltaic Systems. ISRN Renewable Energy, vol. 2011.
[13] DOC (Department of Conservation). 2024. Protocols for minimising the risk of felling bat roosts. Version 4. Available at: https://www.doc.govt.nz/globalassets/documents/conservation/native-animals/bats/bat-recovery/protocols-minimising-risk-felling-occupied-bat-roosts.pdf
[14] Szabadi, K.L., Kurali, A., Rahman, N.A.A., Froidevaux, J.S., Tinsley, E., Jones, G., Görföl, T., Estók, P. and Zsebők, S., 2023. The use of solar farms by bats in mosaic landscapes: Implications for conservation. Global Ecology and Conservation, 44, p.e02481.
[15] Tinsley, E., Froidevaux, J. S. P., Zsebők, S., Szabadi, K. L., Jones, G. 2023. Renewable energies and biodiversity: Impact of ground-mounted solar photovoltaic sites on bat activity.
[16] Ling, N., Tempero, G.W. and Schamhart, T., 2023. Using faecal DNA metabarcoding to determine the diet of the long-tailed bat, Chalinolobus tuberculatus. New Zealand Journal of Zoology, pp.1-8.

may be the potential for an increased predation risk around lights[17] or collision risk with panels.

A Bat Management Plan (BMP) is recommended as part of the approach to managing effects on bats. This BMP is expected to manage direct effects on bats including potential mortality or injury during construction. The management plan would also address the loss of potential individual trees that are suitable for roosting by implementing site specific measures which may include the use of artificial roosts or the planting of trees known to be associated with bat roosting.

Effects of solar panels on skinks and geckos

No skinks and geckos were found during the survey, and the likelihood of native species presence within the site is low, given the lack of habitat, the regular land-use changes as well as ongoing agricultural practices within the site. Native skinks and geckos may be disturbed by sound, vibration or through direct vegetation disturbance, although the site survey found that limited potential habitat is planned for removal / disturbance.

The Wildlife Act 1953 protects native skinks and geckos, meaning they cannot be collected, handled, or kept in captivity without a permit from the Department of Conservation (DOC). This protection extends to all native geckos and skinks. A permit to handle, move, or disturb any native geckos and skinks will be required if the construction works were to disturb any habitat where native skinks and geckos are present. However, given the above, a Wildlife Permit is not anticipated to be required. An incidental discovery protocol should be completed and implemented during construction. It is anticipated this will be offered as a condition of consent.

Localised habitat improvements for any native skinks and geckos can be expected following establishment of the native riparian and screening planting proposed.

Potential positive effects

Enhancement and restoration measures are proposed that would result in positive outcomes from the proposed solar farm. These measures include restoration of natural plant communities through riparian planting, along with potential planting around certain boundaries of the site with an appropriate mix of species to enhance connectivity through the site and with the surrounding landscape.

The change of land use to a solar farm (with the possibly of agrivoltaics such as sheep grazing under the panels) is expected to reduce the pressure on the land and impacts on downstream aquatic ecosystems and water quality through reduced nutrients (primarily nitrogen and phosphorus from fertilizers and manure) entering the watercourses.

The reduced nutrient loads achieved through the anticipated conversion to a solar farm in combination with likely riparian plantings is expected to enhance aquatic habitat values over time.

[17] Schamhart, T., Browne, C., Borkin, K.M., Ling, N., Pattemore, D.E. and Tempero, G.W., 2023. Detection rates of long-tailed bats (Chalinolobus tuberculatus) decline in the presence of artificial light. New Zealand Journal of Zoology, pp.1-11.

Summary of anticipated and known adverse effects and significance of adverse effects

Table 3 below provides a summary of the anticipated adverse ecological effects on identified ecological features along with an assessment of significance after the anticipated effects management measures are in place (i.e. post-mitigation).

The significance ratings use the scale: Very Low, Low, Low-Moderate, Moderate, Moderate-High, High, Very High.

Table 3 Summary of anticipated effects, likely management and post-mitigation significance

Environmental feature	Anticipated effect(s)	Likely / anticipated effects management	Post-mitigation assessed significance
Watercourses	Local direct effect related to bank disturbance and alteration of aquatic habitat from culvert crossing implementation during construction. Minor indirect effects from run-off and nearby vegetation clearing is possible. Effect will likely be at specific impact location and immediate receiving area.	Ideally, avoid any works in streams and drains. Where not avoided through design, then remedy through riparian planting, and mitigate: • Undertake a fish survey, followed by salvage and relocation of native fish species (culvert works). • Ensure new culvert design and installation is undertaken in line with NES-F requirements to maintain or provide fish passage, in locations where habitats for fish are present upstream. • Implement ecological setback buffers from watercourses of 5m, 10m and 20m. • Implement erosion and sediment control and stormwater management.	Low
Natural Inland Wetland Habitat	Minor indirect effects from run-off and nearby vegetation clearing are possible, no planned direct negative effects on the wetlands. Potential hydrological modification within wetlands. Effect will likely be at specific impact location and immediate receiving area.	Ideally, avoid any works in wetlands. Where not avoided through design, then mitigate: • Implement erosion and sediment controls where works are close to wetlands. • Restoration of proximal wetland habitat as a compensatory measure, if required. • Implement ecological setback buffers on wetlands 10m (per constraints plan).	Low

Environmental feature	Anticipated effect(s)	Likely / anticipated effects management	Post-mitigation assessed significance
Artificial Ponds	No effects are anticipated as these areas are to be avoided by development.	Avoid any works in artificial ponds.	Very Low
Pasture and Exotic Grass	Vegetation and earth disturbance of areas currently under pasture for trenching of cables, piling of solar arrays and construction of access roads, solar arrays, operations and maintenance buildings and other infrastructure (inverters, smart transformer stations, BESS, substation, etc). Effect will likely be at specific impact location.	No effects management required, likely a negligible value habitat.	Very Low
Exotic trees / shelterbelts	Disturbance / loss of exotic tree stands and shelterbelts (i.e. potential bird and bat habitat). Effect will likely be at specific impact location.	Ideally, avoid any works requiring tree removal. Most trees are being avoided, however, three exotic tree shelterbelts are planned for removal. Where not avoided through design, then mitigate: • A pre-construction nest survey should be completed for each tree to be removed. • A bat management plan is likely to be required as removal of exotic trees is planned. • At a minimum, BRPs must be implemented for each tree to be removed.	Very Low / Low
Exotic shrubland	Disturbance / loss of exotic shrubland habitat. Effect will likely be at specific impact location.	Exotic shrubland will be avoided, no effects are anticipated.	Very Low

Environmental feature	Anticipated effect(s)	Likely / anticipated effects management	Post-mitigation assessed significance
Mixed exotic / native treeland	Disturbance / loss of mixed exotic / native treeland habitat (i.e. potential bird and bat habitat). Effect will likely be at specific impact location.	Mixed exotic / native treeland will be avoided, no effects are anticipated.	Very Low
Crops	Vegetation and earth disturbance of areas currently used for cropping under highly modified agricultural land for construction of access roads, solar arrays and other solar farm infrastructure. Effect will likely be at specific impact location.	No effects management required, a negligible value habitat.	Very Low
Native Tree Dominant	Disturbance / loss of mature native-dominated tree stands (i.e. potential bird and bat habitat). Effect will likely be at specific impact location.	Native tree areas will be avoided, no effects are anticipated.	Very Low
Birds	Bird mortality / injury relating to earthworks, vegetation clearing, general plant movement and potential collision with solar panels. Noise and vibration disturbance from construction and operation noise, reducing habitat suitability for birds. Effect will likely be at specific impact location, and the surrounding area.	Bird monitoring is recommended after construction to ascertain effect (if any) on bird mortality. Mitigate potential for adverse effect: • A pre-construction nest survey should be completed for each tree to be removed.	Low
Fish	Fish habitat degradation due to increased turbidity of watercourses	Ideally, avoid any works in watercourses.	Low

Environmental feature	Anticipated effect(s)	Likely / anticipated effects management	Post-mitigation assessed significance
	related to surface run-off from construction. Construction effects during instream works, including sediment discharge to downstream receiving environments and fish kills from direct effects and / or dewatering. Potential for the formation of fish passage barriers from culvert installation resulting in a reduction in habitat availability during ongoing operation of the solar farm. Effect will likely be at specific impact location and immediate receiving area.	If can't avoid, then <u>remedy</u> through riparian planting, and <u>mitigate</u>: • Implement ecological setback buffers from watercourses of 5m, 10m and 20m. • Ensure works methodologies specify instream works are undertaken in isolated reaches to avoid sediment discharge to downstream environments. • Undertake salvage and relocation of native fish species from isolated works reaches, prior to or during dewatering. • Ensure new culvert design and installation is undertaken in line with NES-F requirements and national fish passage guidelines, to maintain or provide fish passage, in locations where habitats for fish are present upstream	
Skinks and Geckos	Potential mortality / injury to skinks and geckos relating to earthworks, vegetation clearing and general plant movement during construction, but considered unlikely because of apparent absence of habitat in development areas of skinks and geckos.	Avoid works within areas outside of identified solar development areas (i.e. areas to be retained by landowners and artificial ponds). An incidental discovery protocol should be compiled and implemented by the client during construction. All development projects are subject to the provisions of the Wildlife Act.	Very Low / Low
Bats	Mortality / injury to bats relating to potential tree clearing and additional construction works. Removal of shelterbelts potentially altering bat fly ways.	<u>Mitigate:</u> • Preparation and implementation of a bat management plan for removal of exotic trees. • Implementation of BRPs for each tree to be removed.	Low / Moderate

Environmental feature	Anticipated effect(s)	Likely / anticipated effects management	Post-mitigation assessed significance
	Artificial light at night associated with infrastructure during operation, potentially altering usual bat behaviour. Effect will likely be at specific impact locations, and the surrounding area.		

Summary

The proposed development site comprises almost entirely managed pasture and crops, with comparatively small areas of native and exotic trees, shrubland and artificial ponds. Multiple streams and dry overland flow paths are present within the site, whilst 13 generally low value wetland habitats have been identified within the site. In general, the site is highly modified, consistent with pastoral farming, it is likely that the ecological value of actively farmed areas will be low, however, the values of Tūtaenui Stream and proximal native vegetation will be higher compared to the surrounding landscape.

Values associated with birds will likely be Moderate, fish will be High and bats will be Very High given the presence of At Risk and Threatened species within the site and / or Zone of Influence. The value of lizards will likely be Low given that no native species were recorded.

A number of anticipated adverse ecological effects associated with the project are related to construction works, stormwater run-off from newly created structures and impervious surfaces, panel collision by birds and bats, as well as lighting and noise associated with on-site infrastructure. It is likely that all anticipated adverse effects related to the proposal will be adequately addressed through avoidance and mitigation, which should result in a very low to moderate relative significance of adverse effects.

In order to address anticipated adverse ecological effects from the proposal, the following is anticipated to be implemented as part of the project:

- Avoidance of construction works within wetland habitat, where practicable;
- Avoidance of construction works within watercourse habitat, where practicable;
- If culverts are to be installed in watercourses:
    - Use of works methodologies specify instream works are undertaken in isolated reaches to avoid sediment discharge to receiving environments.
    - Undertaking of salvage and relocation of native fish species from isolated works reaches, prior to or during dewatering.
    - Undertaking new culvert design and installation in line with NES-F and requirements and national guidelines to maintain or provide fish passage, in locations where habitats for fish are present upstream.
- Avoidance of the removal of native and exotic trees, where practicable;
- Implementation of watercourse and wetland buffers (including fencing where practicable) to assist in passive restoration and provide usable habitat for fauna. Some of these areas are provisionally earmarked for restoration planting;
- Implementation of appropriate sediment and erosion control measures;
- Implementation of an incidental discovery protocol for skinks and geckos;
- Undertaking a pre-construction nest survey for each tree to be removed;
- Completion of post construction bird strike monitoring; and
- Preparation and implementation of a Bat Management Plan and implementation of BRPs.

Retention of certain existing ecological habitat features and potential enhancement of the watercourses and terrestrial areas, should enable the proposed solar farm project to achieve a minor ecological ‘net gain’.

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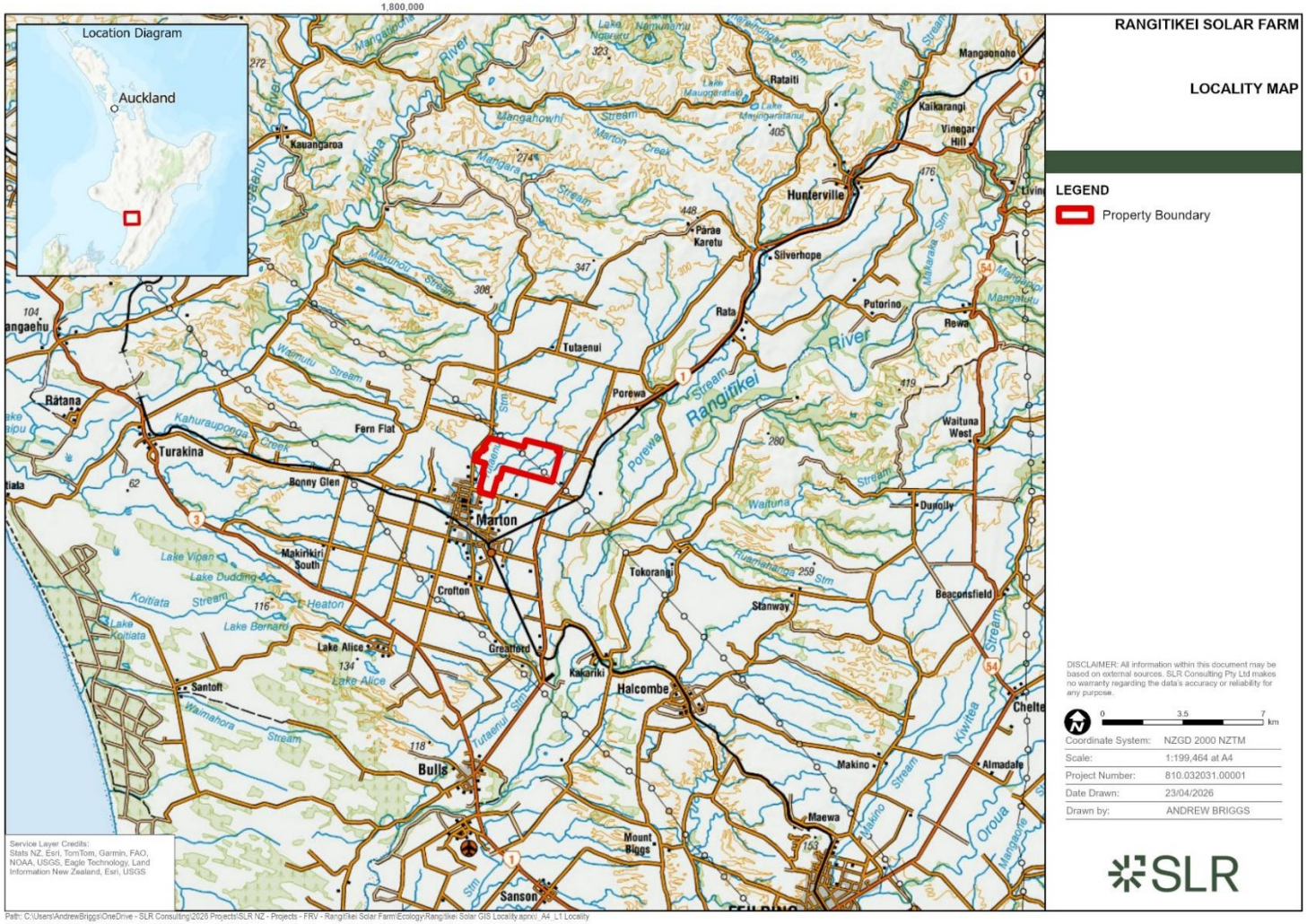
Associate Ecologist

Attachments Attachment A – Locality Map

Attachment B – Ecological Features Map

Attachment A – Locality Map



Attachment B – Ecology Overview Map