Ecological Impact Assessment – Solar Farm at Upper Kina Road

Report

Prepared for Energy Farms Ltd
Prepared by Beca Limited

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Contents

Appendices

Revision History

Revision Nº	Prepared By	Description	Date
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on behalf of	Beca Limited		

Executive Summary

Energy Farms Limited (EFL) is considering the development of 189 hectares of land, comprised of two properties, on Upper Kina Road in Ōpunake within the Taranaki Region for solar farm generation. Beca Limited (Beca) have been commissioned by EFL to undertake an Ecological Impact Assessment (EcIA) to support the resource consent application for the proposed works, including triggers under the National Environmental Standards for Freshwater (NES-FW, 2020) with respect to earthworks and vegetation removal in proximity of a 'natural wetland, as well as regional triggers controlling the placement of new culvert structures as identified by the NES-FW and Fresh Water Plan for Taranaki Regional Council.

The properties are both currently used for dairy farming with paddocks comprised of typical pasture species with scattered remnant native vegetation, mature exotic trees, and several small wetland systems comprised of hydrophytic vegetation that meet the NES-F definition of a 'natural wetland'. It is expected that the extent of hydrophytic vegetation expands and contracts depending on weather patterns and land management practices. The properties also contain several intermittent and permanent watercourses.

Ecological features within the properties provide habitat for native bird species, and native fish including At – Risk kōaro (*Galaxias brevipinnis*) and longfin eel (*Anguilla dieffenbachia*). There is also potential habitat for long-tailed bat and lesser short-tailed bat, as well as native skinks.

The completion of a preliminary ecological constraints assessment has ensured that the ecological effects of installing solar panels and associated infrastructure on the site have been avoided and minimised where possible through design.

There are several potential construction phase and operational adverse effects as a result of the proposal which include:

- Potential injury and/or mortality of native fauna;
- Vegetation clearance and loss of terrestrial habitat;
- Erosion and earth disturbance leading to potential deposition of suspended sediments into receiving environments;
- Loss of potential ecological value;
- Increased impervious surface landcover and potential alterations to hydrology; and
- Alteration to permanent watercourses.

Proposed measures to address these effects include:

- Timing of construction to avoid bird nesting season (Sept – Feb) or pre-clearance nest surveys;
- Implementation of robust erosion and sediment control measures to avoid sediment runoff into the wetland and watercourses;
- Completion of both lizard and bat surveys prior to the commencement of work and the development and implementation of management plan if native lizards or bats are present;
- Implementation of good practice watercourse and stormwater management; and
- Wetland management and restoration.

The overall ecological effect of the proposal is considered to be **Low to Very Low** assuming the recommended mitigation measures are implemented. Additionally, if watercourse and wetland management is implemented as recommended there may be a net gain in ecological value due to increased indigenous dominance and improved habitat value for native fauna over a medium to long term time scale.

1 Introduction

Energy Farms Limited (EFL) is proposing the development of 189 hectares of land on Upper Kina Road in Ōpunake, Taranaki Region for solar farm generation. The proposed works include installing solar panels and associated infrastructure (i.e. roads to facilitate internal access, inverter stations, installation of internal transmission cables) on the site, which is currently used for pastoral and farming purposes.

Beca Limited (Beca) have been commissioned by EFL to undertake an Ecological Impact Assessment (EcIA) to support the resource consent application for the proposed works which various triggers under the National Environmental Standards for Freshwater (NES-FW, 2020)Fresh Water Plan for Taranaki Regional Council.

1.1 Purpose and Scope

The purpose of this ecological impact assessment is to quantify the values of the ecological features and species within the site, and to determine the level of ecological effects arising from the proposed development of the site for solar farm generation.

The scope of this report includes:

- Site visits undertaken on the 20th- 22th of January 2022 and 28rd – 30th of March 2022.
- A desk-based review of:
  - Information held by Taranaki Regional Council and Department of Conservation on the ecological values of the site; and
  - iNaturalist, New Zealand Freshwater Fish Database, and eBird species data; and
  - Other publicly accessible reports or information.
- An assessment of the ecological values within the site.
- An assessment of ecological effects and recommended mitigation prepared in general accordance with the EIANZ Ecological Impact Assessment Guidelines (Roper-Lindsay et al., 2018).

An initial ecological constraints assessment (Beca, 2022) was prepared for this site to identify areas of high ecological value and potential constraints to development. This report was used to inform preliminary design and ensure adverse effects were avoided and minimised in the first instance, where possible.

1.2 Proposed Activity

EFL propose to develop the site as a solar farm. The solar farm will consist of solar modules attached to steel tracking systems. The tracking systems will allow the modules to rotate to maximise the solar resource and will be attached to the ground via piled pitches.

The solar modules will be connected to approximately 11 inverter stations located across the site, which will be connected to an on-site substation via underground cabling. From the substation, the solar farm will be connected to Transpower's Ōpunake substation, located at 909 Ihaia Road (some 5km from the site). The connection will either be established over private land or will be erected within the road reserve. EFL continue to liaise with Transpower regarding the preferred method for interconnection. A battery storage facility will also be established near the substation area. This will provide the ability to store electricity generated by the solar farm, allowing for a controlled and optimised release back into the grid. This facility will consist of up to seven Tesla megapack battery storage blocks located within an enclosed building. Access tracks will be created (where they do not already exist) to facilitate access to the various areas of panels. A 5m grassed buffer will also be maintained around the various areas of panels to facilitate ease of access.

Where possible, existing farm access roads will be repurposed. A comprehensive analysis of the hydraulic and structural integrity of these has not been undertaken at this time, so the potential effects of upgrading of existing culvert crossings has not been assessed at this time. If this is determined to be necessary, a separate ancillary assessment will be undertaken to support any consents required.

Panel installation will require minimal vegetation clearance, due to the primary cover being grassland. The northern stand of kahikatea will be retained. Five new culverts will be installed across the site. Four will be along the existing farm road within the northern property (two within intermittent watercourses, one within an artificial drain, and one within a permanent watercourse), and one will be a new crossing within Manganui stream (permanent watercourse) within the southern property. The effects of the installation of these culverts have been assessed as part of the scope of this report.

While it is intended to work with the existing contour as much as practicably possible, the establishment of the internal access roads, construction laydown area, substation, and pads for the inverters will require earthworks. In addition to these broader earthworks, trenching will be required to lay power cables to connect lines of panels to the inverters, and from the inverters to the switch yard. It is expected that these trenches will be dug by hydraulic excavator with cables being progressively installed as the excavation processed and the trench immediately backfilled. Alternative methods for cable installation could also be applied, but the trenching methodology provides an envelope of effects for consideration which have been considered for the purpose of this report. The overall area and volume of earthworks are estimated at approximately 31,700 m^2 area respectively.

A preliminary concept design has completed for the site, which allocates areas for the various aspects associated with the solar farm. The concept design shows approximately 152,000(+/-5%) panels. The concept design is subject to change during the detailed design process, which will be undertaken following the granting of consent.

2 Site Location and Ecological Context

The site is located near Oaonui within the Egmont Ecological District (ED)[1]. The Egmont ED includes the Pleistocene andesite volcanoes of Mt Taranaki (2518m a.s.l.), Pouakai and Kaitake and their surrounding tephra covered ring plains of lahar, debris flow and tephra deposits. Soils are mainly deep, friable, well drained volcanic ash soils from andesitic ashes, with significant areas of shallow and bouldery soils from laharic deposits, poorly drained, gleyed soils where watertables are high, and well drained alluvial soils along rivers and streams[2].

The site is located on Upper Kina Road, to the west of Mt Taranaki and to the North of the coastal town of Ōpunake (Figure 1). The site covers two property boundaries – 574 and 575 Kina Road (the sites will be referred to as “north site” and “south site” from hereforward. Historically, lowland vegetation in the area would have consisted of tawa, kohekohe, rewarewa, hinau, podocarp forest (WF13), and kahikatea, pukatea forest (WF8)[3],[4]. However, the site and surrounds have been largely cleared for agriculture and few areas of indigenous vegetation remain (<10%; LENZ Level 4).

Figure 1. Site location within the surrounding landscape (Ecological Constraints Report, 2022).

[1] McEwen, W. M. (1987). *Ecological Regions and Districts of New Zealand*. Department of Conservation.

[2] See 1

[3] Singers, N. J. D., & Rogers, G. M. (2014). A classification of New Zealand’s terrestrial ecosystems. In *Science for Conservation 325*. Department of Conservation. www.doc.govt.nz

[4] Taranaki Regional Council. (2020). *Taranaki Regional Council biodiversity spatial data – potential ecosystems*. https://data-trcnz.opendata.arcgis.com/datasets/potential-ecosystems/explore

3 Methodology

3.1 Desktop Review

A desk-based study was undertaken using ecological information from the following sources:

- New Zealand Freshwater Fish Database (NZFFD, administered by NIWA), and eBird (eBird, 2022)
- Auckland Council geospatial layers
- Freshwater Ecosystems of New Zealand geospatial layers (Leathwick et al., 2010)
- Google Earth and LINZ aerial imagery
- DoC fauna records
- Other publicly accessible reports or information

3.2 Field investigations

Following the desktop review, a site visit was undertaken on 20th – 22nd January 2022 to conduct high level freshwater and terrestrial habitat assessments, investigate soils, and assess the likelihood of natural wetlands being present (refer to Ecological Constraints Report). Following the initial site assessment, Beca Ecologists undertook a second field investigation on 28th – 30th March 2022 to assess and delineate potential wetlands initially identified, as well as survey and evaluate other ecological features (e.g. watercourses) (see Figure 2 for locations of investigations). Weather during the second site visit timeframe was clear and sunny, with between 4 mm – 35 mm of rain in the week prior (Met Service, 2021)[5].

3.2.1 Freshwater Surveys

3.2.1.1 eDNA

An eDNA sample was taken from Oaoiti Stream – this was due to the generally consistent habitat types observed within all the permanent streams as being likely representative of the species assembly across them. Mini eDNA kits with 1.2 µm and 5 µm CA filters were used during the second site visit on the 28rd – 30th of March 2022. Multi-species analyses by DNA metabarcoding were undertaken on eDNA samples by Wilderlab Ltd to produce a list of all DNA sequences detected within a broad taxonomic group (e.g., fish, insects, birds, mammals) and the number of times each appears in the sample. These DNA sequences are then compared against a reference database to assign species names and characterise the community as a whole.

3.2.1.2 MCI

Two samples for MCI were collected from Oaoiti Stream and were amalgamated to derive one MCI score due to the sample size and the fact that these two samples were taken from similar representative habitat; and one sample was collected from Manganui Stream. MCI samples were collected using the foot-kick sampling method, to dislodge the upper layer of cobbles and gravel, with an MCI net placed downstream of the sampling[6]. Samples were preserved in isopropyl alcohol and processed by EIA Laboratory.

3.2.1.3 Fish survey

Fish surveying was also conducted at Oaoiti Stream. Eight un-baited gee-minnow fish traps were deployed at approximately 5:00PM on 29/03/2022, left overnight, and checked at 9:00AM the next morning. Fish

[5] Met Service. (2021). https://www.metservice.com/rural/regions/taranaki/locations/hawera/past-weather

[6] Stark, J.D., Boothroyd, I.K.G., Harding, J.S., Maxted, J.R., & Scarsbrook, M.R. (2001). Protocols for sampling macroinvertebrates in wadeable streams. Prepared for the Ministry for the Environment.

trapping was conducted in accordance with the New Zealand Fish Sampling Guidelines[7]. The findings from Oaoiti Stream would largely represent fish species present within permanent streams across the site.

3.2.2 Rapid Habitat Assessments

A high-level assessment of vegetation was undertaken with species, approximate height, and potential habitat value for native fauna (including birds, bats and lizards) recorded during the first site visit to capture the species composition and ecological value of terrestrial and riparian vegetation. Watercourse assessments were completed in general accordance with methods outlined in the Watercourse Assessment Methodology: Infrastructure and Ecology Document (Version 2.0) at each sampling location to provide a high level assessment of the existing watercourses (Lowe et al., 2016). Although this protocol was developed for watercourses in Auckland, the assessment methodology has been applied across New Zealand and provides a good base for describing ecological values of watercourses.

Water temperature and dissolved oxygen concentrations were measured using a YSI ProSolo during the 23rd – 25th of March 2022 site visit.

Data collected included: channel condition and morphology, bank and channel modification, stream bank erosion, standing water characteristics, channel shade and riparian vegetation.

[7] Joy, M., David, B., & Lake, M. 2013. New Zealand Freshwater Fish Sampling Guidelines, Part 1 for wadeable rivers and streams. Massey University.

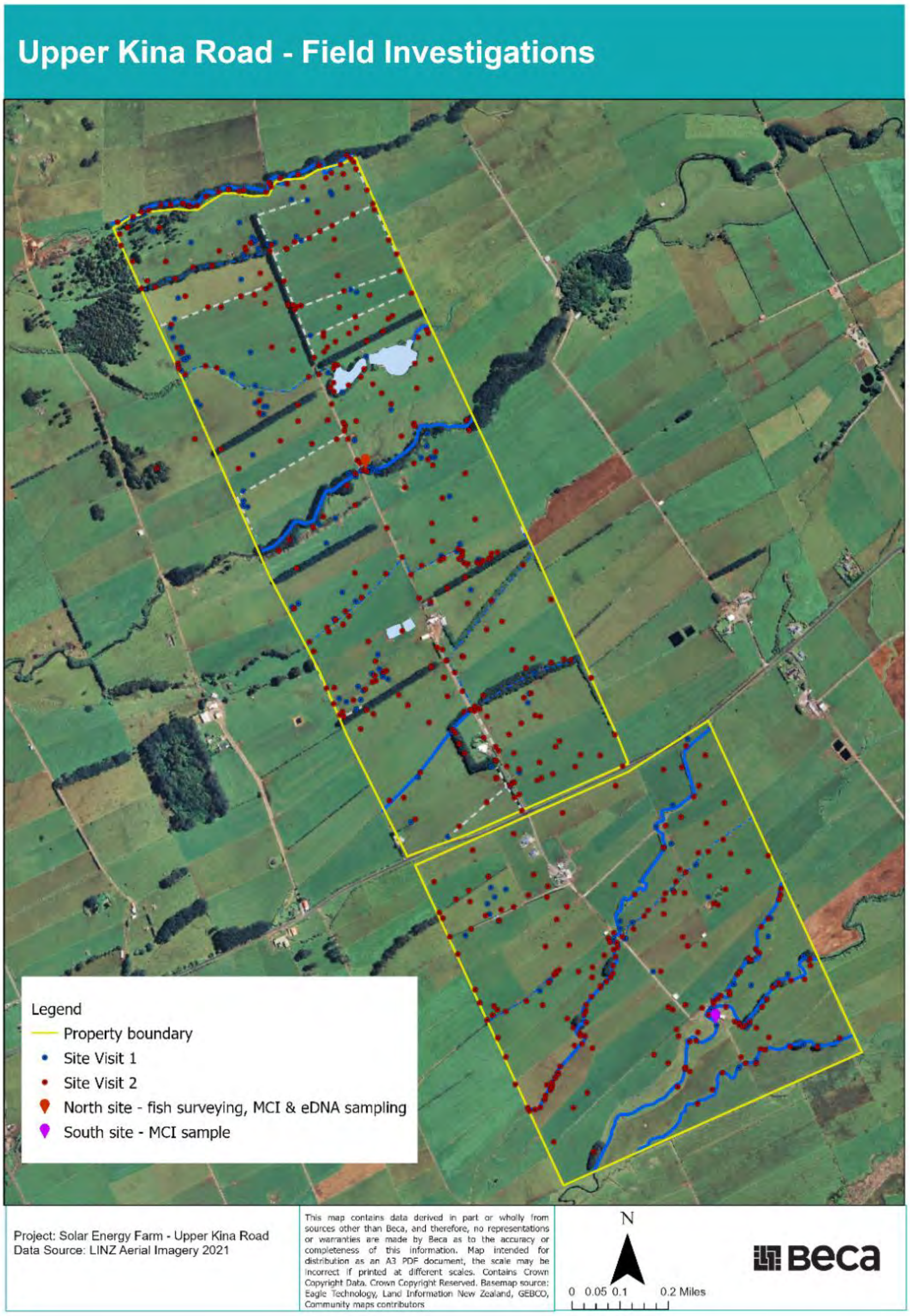

Figure 2: Locations visited during the two site visits.

3.3 Identification of Potential Wetlands

The Resource Management Act 1991 (RMA) defines wetlands as, “permanently or intermittently wet areas, shallow water, and land water margins that support a natural ecosystem of plants and animals that are adapted to wet conditions”.

The National Environmental Standards for Freshwater (2020; NES-F) sets out controls relating to developments relating to 'natural wetlands'. 'Natural wetlands' are defined in the NES-F (via the National Policy Statement for Fresh Water Management (2020; NPS-FM) as:

'… a wetland (as defined in the Act) that is not:

a) A wetland constructed by artificial means (unless it was constructed to offset impacts on, or restore, an existing or former natural wetland); or

b) A geothermal wetland; or

c) Any area of improved pasture that, at the commencement date, is dominated by (that is more than 50% of) exotic pasture species and is subject to temporary rain-derived water pooling.

Desktop screening for 'natural wetlands' was undertaken for each block of land using ArcGIS Pro 2..2 desktop geospatial software.

GIS data and ecological information were used from the following sources:

- Google Earth and LINZ aerial photography;
- Retrolens historical imagery
- Land Resource Information Systems (LRIS) portal soil information
- Freshwater Ecosystems of New Zealand (FENZ) historic wetland typology geospatial layer (Leathwick et al., 2010).

The Site was first examined for any predicted (prehuman arrival) wetland extents as modelled by Ausseil et al., 2008 and shown in FENZ geospatial layers (Leathwick et al., 2010). Subsequently, the most current aerial imagery from Google Earth (2021) and LINZ (2020) were visually inspected for wetland features, such as wetland vegetation and hydrology. Surface vegetation was analysed for hydrophytic plant communities using visual cues such as colour, shape, texture, and location. Particular attention was also paid to low stature vegetation which may be indicative of rushlands, and sharp changes in vegetation composition. The aerial imagery was explored for any evidence of inundation (a primary indicator of wetland hydrology), and soil saturation (a secondary indicator of wetland hydrology).

Potential wetlands (those that may qualify as 'natural wetlands' in accordance with the NES-F) were then given a risk rating based on high-level observations during the initial site visit which was undertaken (see Table 1) between 12th and 14th of January in summer.

Table 1. Risk levels associated with the confidence in the wetland identification.

Likelihood of area to meet the definition of 'natural wetland'	Description
High	The Potential Wetland was identified with high confidence. Evidence of ponding, hydric soils, and/or high percentage cover of wetland vegetation is present. It is considered likely a 'natural wetland' is present.
Moderate	The Potential Wetland was identified with moderate confidence. There is evidence of soil saturation in aerial imagery or in the field, hydric soils and/or wetland hydrology are likely present, and scattered wetland vegetation is present. Without further site investigation it is considered *as likely as not* that these areas could be considered 'natural wetland'.
Low	The Potential Wetland was identified with low confidence. Although hydric soils or indicators of wetland hydrology may be present, the area is highly modified, and it is likely it would not meet the definition of a 'natural wetland', although this may change based on weather patterns and land use practices.

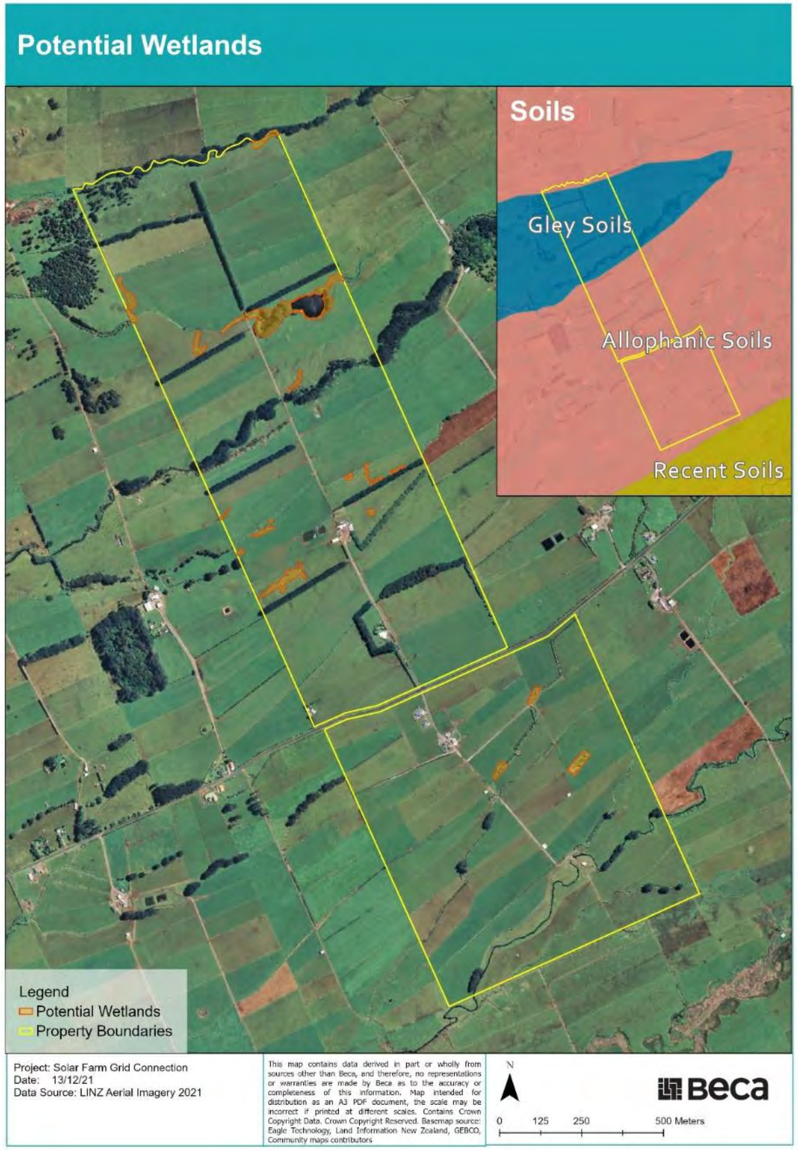

Figure 3: Potential wetlands identified via desktop review, inclusive of soil properties (left) Potential wetland areas assessed within the property and associated likelihood of classification (right).

3.4 Wetland Classification Delineation

During the second site visit, an assessment of any potential wetland areas within 10m of proposed earthworks was undertaken in accordance with the New Zealand Wetland Delineation Protocols and current Ministry for the Environment guidance in order to classify wetlands and delineate extent where necessary (Clarkson, 2018; Ministry for the Environment, 2020, 2021; see Figure 4). Due to the size of the property and time constraints, detailed investigations were not deemed necessary where an area was dominated by pasture species and/or only contained a few very scarce *Persicaria* or rushes amongst pasture vegetation. More detailed investigations were undertaken where wetland vegetation covered an area greater than 2m x 2m and where there were other landscape clues (such as minor depressions in the relief) that could suggest that wetland hydrology could be present. It is worth noting that at the time of the March site visit, it was evident that the *Persicaria* species present in pastoral settings (and not otherwise adjacent to watercourses) appeared to be highly stressed from a long period of low rainfall over summer. To delineate the wetland boundary adjacent to the works area, a suspected boundary was determined using visual clues such as changes in topography and vegetation. Where boundaries were unclear, several sample plots were established to help substantiate the boundary location where possible.

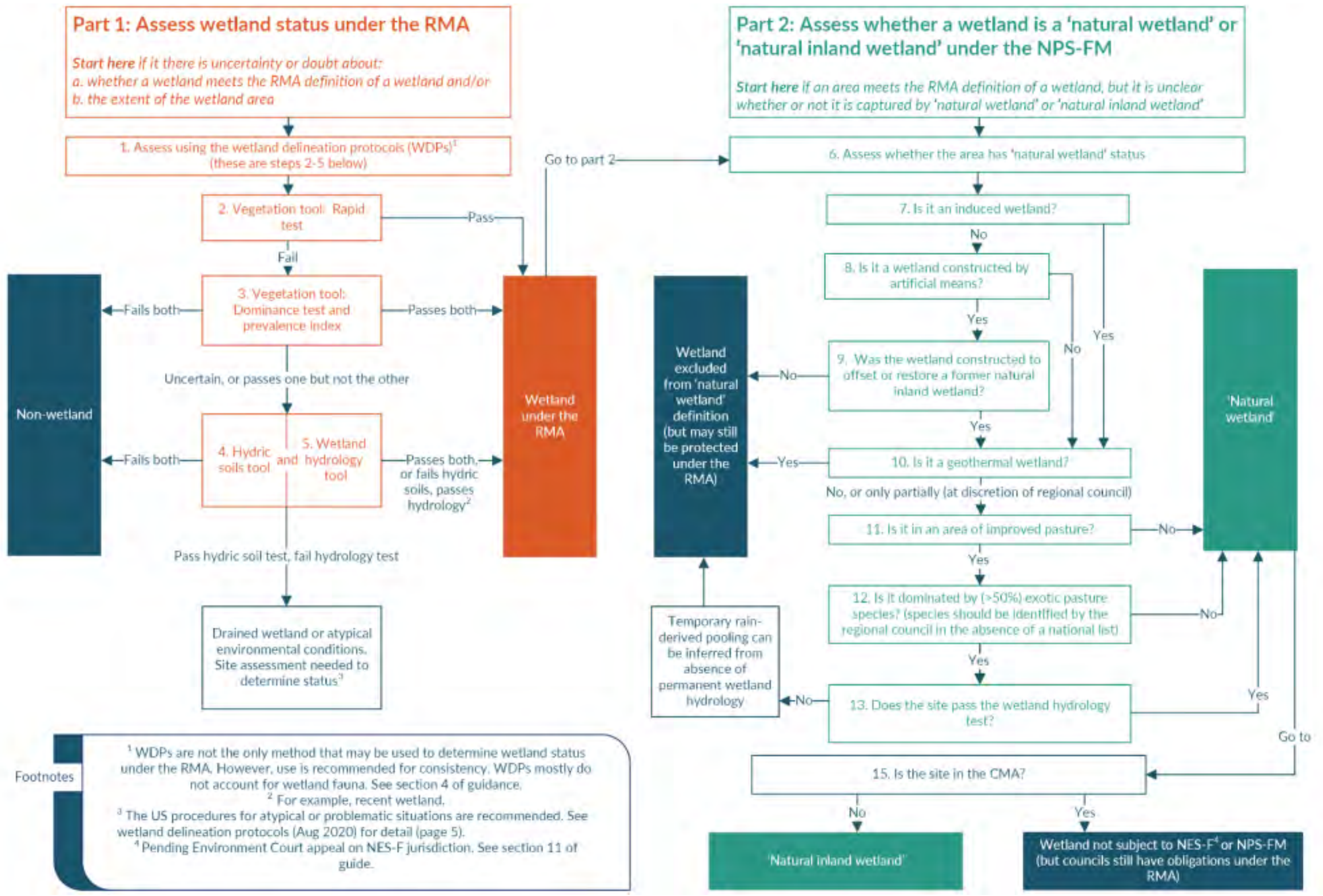

Figure 4: Assessing 'natural wetland' and 'natural inland wetland' status under the NPS-FM (Ministry for the Environment, 2021).

3.5 Watercourse Classification

A preliminary, high level watercourse classification was completed based on the below Taranaki Regional Council definition (which references the RMA definition).

River means a continually or intermittently flowing body of fresh water and includes a stream and modified watercourse but does not include any artificial watercourse (including an irrigation canal, water supply race, canal for the supply of water for electricity power generation, and farm drainage canal)[8].

It should be noted that watercourse classification assessments are best undertaken between July and October due to seasonal variability in groundwater and surface water hydrosystems. While this was not possible given project timeframes watercourse classifications were undertaken during two seasons (January and March) and professional judgement applied.

3.6 Assessment Methodology

An assessment of ecological effects was undertaken in accordance with Ecological Impact Assessment (EcIA) EIANZ guidelines for use in New Zealand: terrestrial and freshwater ecosystems[9].

The EIANZ guidelines set out a methodology to assign ecological value to species and ecosystems based on four assessment criteria which are consistent with significance assessment criteria set out in the Proposed National Policy Statement for Indigenous Biodiversity (2019) Appendix 1: Criteria for identifying significant indigenous vegetation and significant habitat of indigenous fauna. These are reproduced in this report as Appendix 1: Tables 1.1-1.4. In summary:

- Attributes are considered when considering ecological value or importance. They relate to matters such as representativeness, the rarity and distinctiveness, diversity and patterns, and the broader ecological context.
- Determining Factors for valuing terrestrial species; terrestrial species span a continuum of very high to negligible, depending on aspects such as whether species are native or exotic, have threat status, and their abundance and commonality at the site impacted
- Ecological Values are scored based on an expert judgement, qualitative and quantitative data collected.

Once ecological values have been identified and valued, the severity of potential impacts is assessed by determining the change from baseline ecological values likely to occur as a result of the proposal along the lines of a magnitude of effect as determined by the criteria set out in Appendix 1:Table 1.5.

Finally, once these two factors have been determined (the ecological value and the magnitude of effect), an overall level of effect on each of the identified ecological values is determined by applying the matrix shown in Appendix 1:Table 1.6.

[8] Taranaki Regional Council. (2018). *Regional Fresh Water Plan for Taranaki*. https://www.trc.govt.nz/assets/Documents/Plans-policies/FreshwaterPlan/v3-Public_Regional_Fresh_Water_Plan_as_amended_March_2021.PDF

[9] Roper-Lindsay, J., Fuller, S. A., Hooson, S., Sanders, M. D., & Ussher, G. T. (2018). *Ecological impact assessment. EIANZ guidelines for use in New Zealand: terrestrial and freshwater ecosystems. 2nd edition*. Environmental Institute of Australia and New Zealand.

4 Wetland Classification and Delineation

Modelling of the wider Taranaki area has indicated there are several wetland classes present including bogs, marshes, seepages[10], however, the subject sites have been converted for agricultural use and the majority of the area is now pasture and cropland. Pollen data of adjacent areas in the Ōpunake area indicate that historic vegetation in this area consisted of mainly a low-growing shrubby coastal forests (*Metrosideros spp., Myoporum laetum, Myrsine spp., Dodonaea viscosa, and Ascarina lucida*)[11]. In historic aerial imagery patches of vegetation are observed through the site with a large area of remnant vegetation observed at the northern end of the site (Figure 5). In the present day, that area consists of a small stand of remnant kahikatea (MF4[12]). Scattered wetland vegetation and/or scrub is visible in aerial imagery from 1956 (see Figure 5). The majority of these areas and a number of the numerous smaller watercourses and flow paths that historically ran through the site have since been converted to grazed pasture or diverted into straightened channel. Along these channels, subsoil drainage (e.g., novacoil) outlets were also evident at intervals across the site, indicating a range of pastural improvements historically undertaken. Some further open channels appear to have been dug to further assist in drainage to aid pastoral land use. A number of areas consisting of varying densities of hydrophytic vegetation were observed during the initial site walkover. Some of these vegetation patches were localised in lower lying areas therefore encouraging ponding in certain circumstances. There was also evidence of other factors also contributing to the presence of *Persicaria* species in certain localities – particularly alongside areas where cattle were known to congregate either at a farm gate or next to shelter belts to shelter from the elements – this knowledge has also informed the classification and delineation of wetlands (i.e., not wetland areas in the majority of these types of cases) as it was confirmed with the farmers of each site during the March site visit . During the second site visit, further investigations of potential wetland areas within 10m of proposed earthworks were undertaken in accordance with the methodology described in Section 3.4.

Three discrete 'natural wetland' types were identified within 10 m of proposed earthworks:

- A riverine wetland system near the northern end of the north site. The wetland is believed to be associated with the stream and passed the two-vegetation tests; dominance and prevalence test.
- Several palustrine marsh wetlands within small depressions and low-lying areas, that receive rainwater runoff.
- Several lacustrine wetland systems within and adjacent to all ponds on the north site that are hydrologically influenced by the open body of freshwater (pond) they are associated with.

The following sections discuss the classification of the putative wetlands in relation to vegetation, soils, and hydrology observed onsite. Detailed results of site investigations are included in Appendix 2.

[10] Ausseil A.G., Gerbeaux P., Chadderton W.L., Stephens T., Brown D., L. J. (2008). *Wetland ecosystems of national importance for biodiversity: Criteria, methods and candidate list of nationally important inland wetlands. Landcare Research Contract Report LC0708/158*. Prepared for: Department of Conservation.

[11] McGlone, M.S., & Neall, V.E. (2012). The late Pleistocene and Holocene vegetation history of Taranaki, North Island, Zealand Zealand. *New Zealand Journal of Botany, 32:3, 251-269*.

[12] Singers, N. J. D., & Rogers, G. M. (2014). A classification of New Zealand's terrestrial ecosystems. In Science for Conservation 325. Department of Conservation. www.doc.govt.nz

Figure 5: Aerial imagery of the site from the 1950s. Yellow outline is the property boundary (Source: Retrolens).

4.1.1 Vegetation

Throughout the site, hydrophytic vegetation is typically scattered and in variable cover percentage. There are some areas where it is clear that historical overland flow paths and other low-lying areas that receive runoff from surrounding pasture have encouraged the development of some of this vegetation. However, there are other area where conversations with the farmers have indicated that larger volumes of irrigation or localities adjacent to shelter have also increased the density of certain hydrophytic vegetation that aren't associated with natural hydrology processes. In these cases, removal of stock or decrease/removal of irrigation would therefore likely decrease the density of hydrophytic vegetation in these areas.

Vegetation extents are expected to expand, and contract based on weather patterns and land use practices. Therefore, may reduce during the drier summer season and increase during the wetter months. Within the ponds and alongside the margins several native hydrophytic vegetation types were observed including raupō and *P. hydropiper*.

Some of the potential wetland areas consisted solely of terrestrial pasture vegetation or terrestrial weeds and have been classified as non-wetlands, while areas that passed or returned uncertain vegetation test results were typically dominated by soft rush (*Juncus effusus*), mercer grass (*Paspalum distichum*), dallis grass (*Paspalum dilatatum*), and/or *Persicaria maculosa*. Other hydric species present included: *Persicaria hydropiper*, spike sedge (*Eleocharis acuta*), oval sedge (*Carex leporina*), *Glyceria fluitans*, jointed rush (*Juncus articulatus*), umbrella sedge (*Cyperus eragrostis*), raupō (*Typha orientalis),* crack willow (*Salix* *fragilis*), and slender clubrush (*Isolepis cernua*), and *Juncus australis.* Vegetation test results are included in Appendix 2.

4.1.2 Soils onsite

The majority of the site is mapped as gley soils and allopanic soils (Figure 3), which is likely due to material transfer deposited from Mount Taranaki. Soil investigations within most of the potential wetland extents (as identified in the January screening report) during the March site visit areas found non-hydric soils (high chroma, silt/sand-based soil with some black and orange deposits) typically within pasture-dominated landscapes (Figure 6). A Beca hydrogeologist was consulted for further insights into the soils present onsite. They noted that gley soils are less prone to recharge, they have a higher ability to store water and would more likely support wetland-suitable vegetation types. Allopanic soils, however, are permeable and more prone to recharge, but can allow pockets of permeability where water can be stored at a shallow depth. As such, it was more likely that wetland-suitable vegetation types would be found within the northern end of the north site, which is mapped as consisting of gley.

Soil investigations during the second field investigation did not uncover any soils that would typically be considered hydric or met the indicators of the WDP Hydric Soil Tool, even at depths of 70cm+. As such, a majority of the putative wetland areas are assessed as not having hydric soils. The confirmed wetland areas (discussed in Section 4.1.5) are typically moist to saturated but did not present other, more typical hydric soil indicators.

Figure 6: Typical soil auger samples from wetland sites at depths of 30 – 60cm.

4.1.3 Hydrology onsite

The property has a clear broad drainage pattern that flows to the northwest into the South Taranaki Bight. At a local scale, the two properties have a relatively flat topography, generally flowing towards the streams and drainage channels at low gradients, with the exception of banks that slope down to Oaoiti Stream. Some localised areas within each of the pastures contain some small depressions where overland flow paths or old river alignments appear to have historically had flow but are now also grazed.

The first site visit was completed in the middle of summer during a period of low antecedent rainfall, so no ponding was observed across the site, however, some areas remained damp/muddy and had small amounts of surface water. All of the confirmed wetland areas identified during the second field investigation had two primary hydrology indicators and one secondary indicator of wetland hydrology according to the Wetland Hydrology Tool[13]:

- 1A: presence of surface water that indicates higher water table.
- 1B: presence of groundwater
- 4B: presence of localised geomorphology that indicates water accumulation potential.

Only in areas where there were noticeable low points or significant wetland vegetation (i.e. those where the confirmed wetlands were situated) was the water table observed close to the surface or where there was moist or saturated soils found. Across the remainder of the site, most of the areas investigated had soils with good drainage properties and hence had limited wetland features or a significant amount of soil / ground moisture.

The confirmed 'natural wetland' areas are considered to have wetland hydrology features.

4.1.4 Summary

The site includes a number of degraded and highly modified palustrine wetland systems located within low-lying depressions, several lacustrine wetland systems along the pond margins, and one riverine wetland system. These meet the NPS-FM definition of a 'natural wetland' and are not subject to any of the three exclusion criteria.

Riverine wetland systems are described as[14]:

"*Wetlands associated with rivers, streams, and other channels, where the dominant function is continually or intermittently flowing freshwater in open channels. The riverine hydrosystem includes open flowing waters and both the beds and margins (riparian zones) of channels. It embraces natural waterways and artificial ones such as canals, irrigation channels, and drains . . .* "

Palustrine marsh wetland systems are described as[15]:

"*All freshwater wetlands fed by rain, groundwater, or surface water, but not directly associated with estuaries, lakes, or rivers. The term palustrine derives from the Latin, palus = marsh. Most wetlands are palustrine, and it is this hydrosystem that includes the greatest range of wetland classes and vegetation types*.

A mainly mineral wetland, having moderate to good drainage, fed by groundwater or surface water of slow to moderate flow, and characterised by moderate to great fluctuation of water table or water level. Marshes are often periodically inundated by standing or slowly moving water. They are usually mesotrophic to eutrophic, and slightly acid to neutral in pH. Marshes differ from swamps by having better drainage, a generally lower water table, a usually more mineral substrate, and a higher pH. Marshes occur mainly on slight to moderate slopes, especially on valley margins, valley

[13] Ministry for the Environment. (2021). *Wetland delineation hydrology tool for Aotearoa New Zealand*. Ministry for the Environment.

[14] Johnson, P., & Gerbeaux, P. (2004). Wetland Types in New Zealand.

[15] See 14

floors, and alongside water bodies such as rivers and lakes. Vegetation is most often rushland, grassland, sedgeland, or herbfield. ."

Lacustrine wetland systems are described as[16]:

"Lacustrine Wetlands associated with the waters, beds, and immediate margins of lakes and other bodies of open, predominantly freshwater which are large enough to be influenced by characteristic lake features and processes such as fluctuating water level, wave action, and usually permanent and often deep water that has nil or only slow flow. Lakes can be arbitrarily defined as having a major dimension of 0.5 km or more."

The density and extent of wetland vegetation cover varies throughout these areas based on extent of erosion, land use practices, and weather patterns, but several are located along, or are connected to intermittent streams or historical ephemeral pathways, and three are located alongside ponds. They all generally do not have strong hydric soils identified, and drainage from most of the soils appears to be reasonable, although some areas have displayed moist or saturated soil properties (as a result of their position in the landscape). They are associated with several indicators of wetland hydrology.

More detailed results of individual potential wetland investigations are included in Appendix 2.

4.1.5 Confirmed 'natural wetland' extent

Wetland locations and extent are shown below in Figure 8. Wetland boundaries were delineated using the methods described in 3.4 where they were within the works footprint, or within 10 m of proposed earthworks.

[16] See 14

5 Ecological Features and Values

5.1 Overview

With the exception of banks that slope down to Oaoiti Stream, the two properties have a relatively flat topography, with some small depressions where overland flow paths or old river alignments appear to have historically had flow. Both properties are grazed by cattle and contain limited native vegetation, which is mostly confined to riparian margins with the exception of one patch of remnant podocarps at the northern end of the north site. Numerous hard-bottomed watercourses traverse the properties and artificial drainage channels have also been constructed within the northern property.

Given the significant size of the site and number of ecological features of note (Figure 7), a generalised approach to delineation and discussion of those features and their value has been taken, with specific features or values of note explicitly discussed where considered important for context. A large number of site photographs and records have been collected during the ecological surveys undertaken in January and March – individual georeferenced records can be made available for regulatory review if required. Indicative and representative imagery has been provided in the main body of this report to illustrate the features across the site.

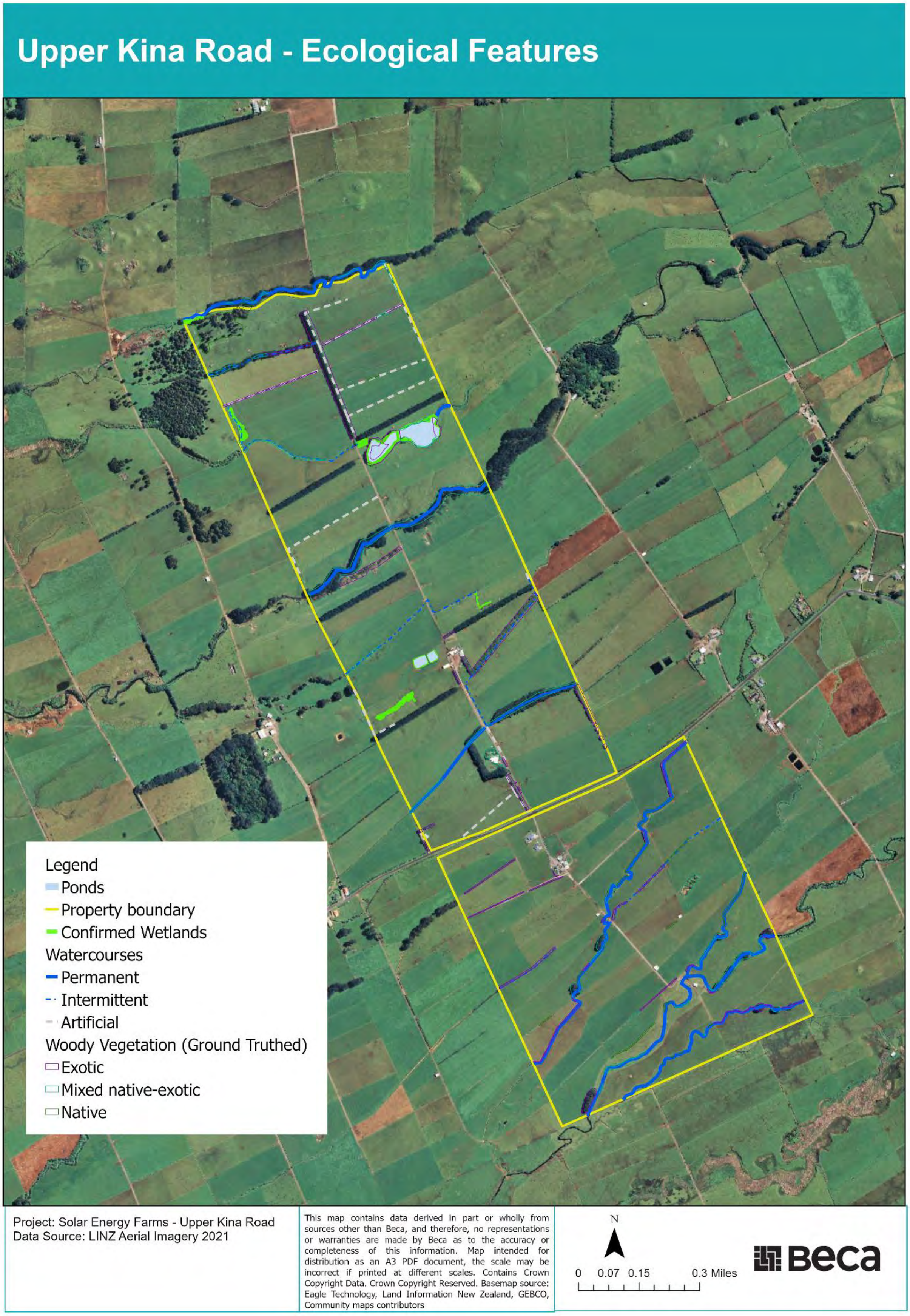

Figure 7: Overview of ecological features mapped within the site following the second site visit.

5.2 Wetlands

Within the northern property seven wetlands were identified (Figure 8). These wetlands were all located in isolated patches within the pasture fields. Ongoing grazing, stock trampling, and drainage has led to these wetlands being in a significantly degraded state. Nevertheless, they had retained enough characteristics to be classified as 'Natural Wetlands' according to the New Zealand Wetland Delineation Protocols[17,18] and NPS-FM (2020). No wetlands were identified on the south site.

Historical imagery of the site indicates that the area has been used for agriculture since at least the 1950s. Features throughout the general Ōpunake area and west of Mount Taranaki, indicates that the entirety of the land is a large floodplain, with drainage passages (watercourses) throughout, draining materials from east to west. Aerial imagery from the 1950s shows the presence of numerous smaller channels through the wider area as well as within the project site (Figure 5). It is highly likely that during high rainfall events these smaller alluvial channels were the preferential pathways for water movement. Of the seven wetlands identified onsite (see Section 4), one has been classified as riverine (Wetland 1), three are classified as palustrine (Wetlands 2, 5 and 6) and three are classified as lacustrine (Wetlands 3, 4 and 7).

The following sub-sections will describe the wetlands and associated ecological value. An overall ecological value of all the wetlands can be found at the end of Section 5.2.2.

[17] Ministry for the Environment. (2021). Defining 'natural wetlands' and 'natural inland wetlands.' Ministry for the Environment.

[18] Clarkson, B. 2018. Wetland delineation protocols. Manaaki Whenua – Landcare Research Contract Report LC3354 for Tasman District Council. 6 p.

Figure 8: Locations of all confirmed wetlands within the north site

5.2.1 Riverine Wetland System (Wetland 1)

Riverine wetlands are associated with streams, rivers, and other channels of permanently or intermittently flowing freshwater. Many riverine wetlands also include the beds and margins (riparian zones) of watercourses

There is one riverine wetland within the north site, near the Moutoti Stream (Figure 9). Wetland 1 is associated with the floodplain of the stream, with evidence of drift deposits identified on a waratah and fence wiring within the area. The continually flowing freshwater (the stream) is expected to overtop the stream channel on occasion allowing for the establishment of wetland vegetation[19]. Vegetation consisted of *Ranunculus repens, Paspalum distichum, Trifolium pratense, Juncus effusus, and Plantago lanceolata*, of which two are facultative wetland species (FACW). The riverine wetland is approximately 624 m^2.

Figure 9: Wetland 1 vegetation plot (left) and surrounding area (right).

5.2.2 Palustrine Marsh Wetland Systems (Wetlands 2, 5 & 6)

The site consists of three degraded and highly modified wetlands which are consistent with palustrine marsh wetland systems within lower-lying areas that receive runoff from surrounding slopes.

Marsh wetlands are generally fed by groundwater and/or surface water with a slow to moderate flow. Palustrine marsh wetland systems are generally located on lower to moderate slopes, which is consistent with the landscape of the north site, where old depressions made from river alignments allows for periods of inundation by standing or slow-moving surface water (Figure 10 and Figure 11).

Marsh wetland systems can reduce nutrient loading, which reduces nutrient runoff into waterways and improves water quality[20]. Vegetation within the palustrine wetland systems on the north site included a mixture of FAC, FACW, and FACU species, with FACW species dominant. The three palustrine marsh wetlands have a total combined area of 4,615 m^2.

[19] See 12

[20] Fisher, J., & Acreman, M.C. 2004. Wetland nutrient removal: a review of the evidence.

Figure 10: Wetland 2 plot (top) and surrounding environment (bottom) which shows a distinctive pathway of *Juncus* and *Persicaria* moving south.

Figure 11: Wetland 6 plot (top right) with very wet soils (top right) and distinctive pathway of *Juncus* sp. and *Persicaria* sp. within a lower lying depression.

5.2.3 Lacustrine Wetland Systems – Pond Margins (Wetland 3, 4 & 7)

The site consists of four highly modified / constructed ponds which have encouraged the development of fringing lacustrine wetland systems that occur within and alongside the ponds that were created on the north site. Vegetation types within the wetland consistent of tall reed-like species including raupō and *Juncus* sp, as well as *Persicaria hydropiper* and *Carex* sp (Figure 12**Error! Reference source not found.**). Lacustrine wetland systems are one type of wetland that occur within or next to lakes, reservoirs, and fresh waterbodies with shallow depth and usually have <30% vegetation cover

The three lacustrine wetland systems have a total combined area of 10, 614 m^2.

Figure 12: Raupō and C*arex* sp dominated lacustrine wetland along the pond margin.

Although the wetlands are in a degraded state due to alterations to hydrology and ongoing stock access, they may provide some limited ecosystem service values including reducing nutrient loads in surface water runoff and attenuating peak flows.

As such, the overall ecological value of all seven natural wetlands identified on the north site is **Low**, due to low ratings for representativeness, diversity and pattern, and ecological context and moderate rating for rarity/distinctiveness all four Matters (Table 2).

Table 2. Scoring and justification for assigned ecological value to the riverine, palustrine, and lacustrine within the north site.

Matter	Rating	Justification
Representativeness	Low	Most wetlands were dominated by exotic grass species. No At Risk or Threatened species.
Rarity/Distinctiveness	Moderate	Commonly found hydrophytic vegetation species identified. Species particularly common on farms. Wetland habitat is reduced in extent both regionally and nationally.
Diversity and Pattern	Low	Low diversity and complexity of vegetation types.
Ecological context	Low	Catchment dominated by agricultural land-use. Constant stock access to wetlands and nearby paddocks. Minimal provisioning of ecosystem services associated with typical wetland ecosystems.
		Overall value: **Low**

5.3 Watercourses

The north site includes Moutoti Stream along its northern boundary, Oaoiti stream, various unnamed, modified tributaries (both permanent and intermittent), and artificial drainage channels with no natural portions from their headwaters to their confluence with another river/stream. The south site includes the Manganui Stream and two permanent tributaries of it, as well as two straightened intermittent streams. Figure 13 sets out a summary of these watercourses and their locations.

Ephemeral streams/overland flow paths have not been mapped. In total, the two properties include 8.36km of permanent or intermittent watercourse, and 3.08km of artificial watercourse.

Further assessments of watercourses are separated into “Permanent Streams,” “Intermittent Streams,” and “Rural Drainage Networks.”

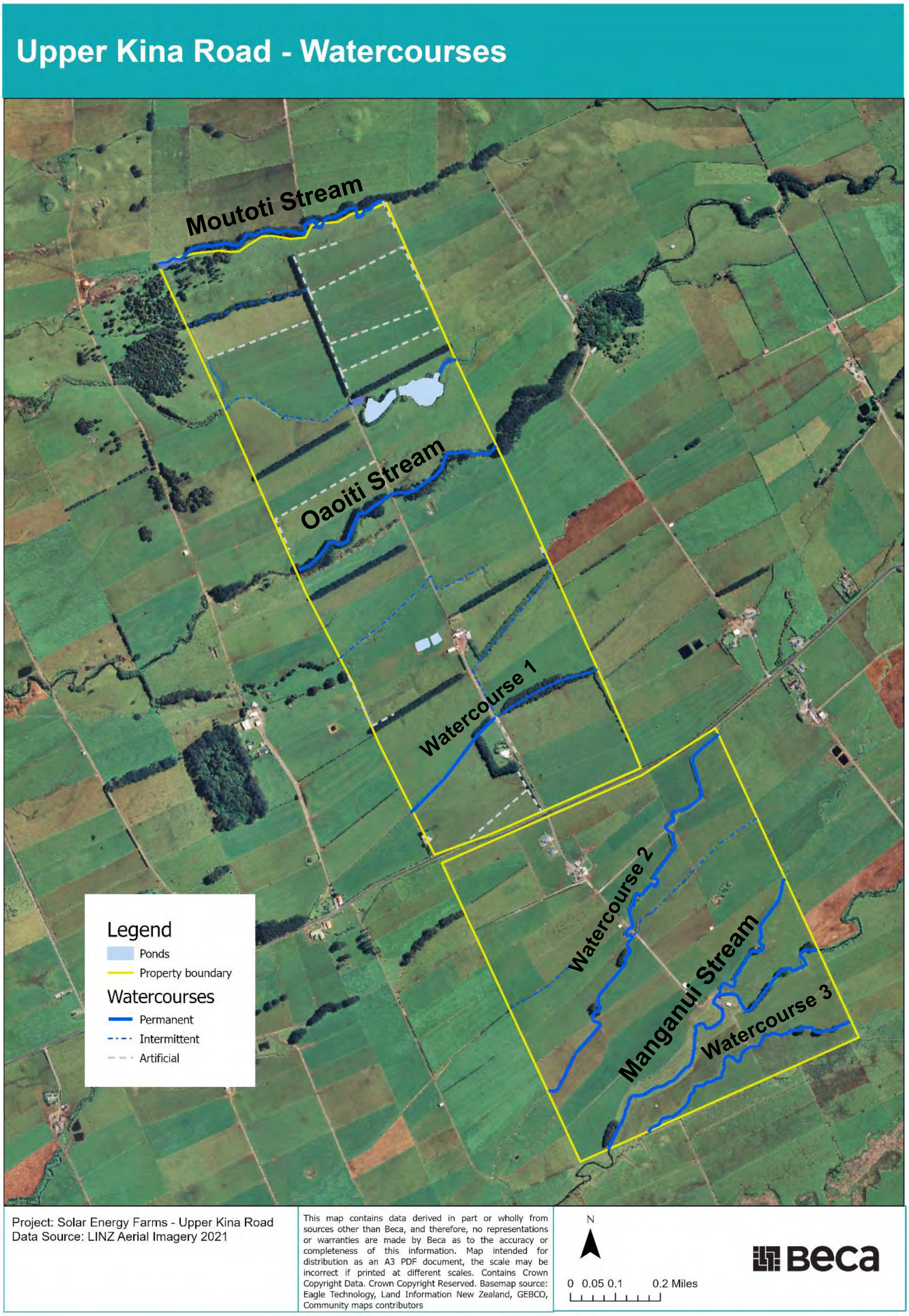

Figure 13: Watercourses within the properties.

5.3.1 Permanent Streams

Over the two properties there are six identified permanent streams (Figure 13**Error! Reference source not found.**). Watercourse assessments were conducted at all streams and eDNA samples were collected from Oaoiti Stream. MCI samples were collected from both Oaoiti Stream and Manganui Stream.

Further assessments of permanent watercourses are separated into “Permanent Named Streams” and “Permanent Unnamed Streams.”

5.3.1.1 Permanent Named Streams (Moutoti, Oaoiti, and Manganui Streams)

The characteristics of the permanent, named streams are relatively similar. All streams are hard-bottomed, with an equal mix of gravel and cobble and silt/mud/sand and boulders, with Oaoiti stream having large boulders 3 m+. Oaoiti and Manganui Stream had steep channels, with some incised sections and signs of erosion scarring and mass wasting (Figure 14).

Riparian vegetation was similar in stature across the Moutoti and Oaoiti (north site) streams and consisted of mixed native and exotic species including pines (*Pinus radiata*), gorse (*Ulex europaeus*), karamu (*Coprosma robusta*), kawakawa (*Piper excelsum)*, pampas (*Cortaderia selloana*) and inkweed (*Phytolacca octandra)*. All streams displayed good habitat for macroinvertebrates and moderate habitat for fish and eels, as they were all hard bottom with limited macrophyte growth. Instream vegetation was mainly limited to the exotic macrophyte watercress. Additionally, the Oaoiti and Moutoti streams were moderately shaded, with patches of taller riparian species. In these sections or pockets, there were also a range of mature exotic and native species ranging from mature pines, mahoe, karo, cabbage tree, tree and bracken fern, karamu alongside weedy species such as blackberry, bamboo and montbretia.

Manganui Stream displayed similar characteristics. Some small areas of nuisance macrophyte growth was observed in areas that were unshaded. Manganui Stream was sparsely planted for approximately 50 m downstream and upstream of the access race. Downstream of the race, riparian vegetation included mixed native and exotic species including flax (*Phormium tenax)*, karamū, pampas, sedges, and ferns (*Cyathea sp*) (Figure 14). Instream vegetation consisted of watercress and curly leaf pond weed (*Potamogeton crispus)*. Upstream riparian vegetation had bamboo shelter belts and also certain patches of mixed native and exotic vegetation of a similar composition to the other unnamed permanent streams on this property.

Generally, limited signs of erosion were observed at the north site permanent streams; although some evidence of mass wasting (likely associated with flood events historically) were present at certain localities along Oaoiti Stream; generally having healed over and vegetated to a certain extent since those events occurred. Extensive erosion was observed within the south site Manganui Stream.

The permanent, named streams are assessed as having **High** ecological values due to high ratings for rarity/distinctiveness, diversity and pattern, and ecological context, and moderate rating for representativeness (Table 3).

Table 3: Scoring and justification for assigned ecological value to the permanent named streams.

Matter	Rating	Justification
Representativeness	Moderate	Banks - modification has reduced habitat heterogeneity. Natural meander but some incised channel habitat. Mix of native and exotic riparian vegetation. . Continually flowing watercourse. Instream vegetation mainly consists of exotic weeds. Extension erosion of Manganui Stream banks
Rarity/Distinctiveness	High	High habitat availability for native species. Presence of sensitive freshwater macroinvertebrates within Oaoiti Stream. Presence of At Risk – Declining freshwater fish within Oaoiti Stream – which would broadly represent all permanent named streams due to similarity .

Matter	Rating	Justification
Diversity and Pattern	High	High diversity of freshwater fish species typically associated with this environment. Large stream extent. Complex community structure.
Ecological context	Moderate	Watercourse extends for several hundred kilometres – provides migration passage for diadromous native species. Catchment dominated by agricultural land-use. Streams are fenced from stock and/or have too steep banks for stock access. Evidence of poor water quality during the summer season.
		Overall value: **High**

5.3.1.2 Permanent Unnamed Streams (Watercourses 1, 2, and 3)

Within Watercourse 2 and 3, tall riparian vegetation was sparse along the permanent unnamed streams unless a clear riparian margin had been provided for. Planted riparian margin consisted of broadleaf (*Griselinia littoralis*) and/or bamboo, typically planted on one bank of the watercourse, providing some (but not full) shading to the stream (Figure 15). Upstream of the site race, vegetation consisted of tall stands of bamboo and broadleaf that provided shading for several hundred metres of the stream reach. Approximately 75 m downstream of the access road were tall pines providing shading of the waterbodies. The south site unnamed streams included a number of culverts for the main farm race alongside other access tracks, with structures that generally allowed for adequate water flow and fish passage (Figure 16).

Tall riparian vegetation along Watercourse 1 consisted of mainly small ferns, thick patches of gorse, and planted pines (Figure 14). Ground-dwelling riparian vegetation was mainly limited to creeping buttercup and exotic grasses, and instream vegetation consisted of large patches of watercress; although there were some contiguous areas of vegetation along all the reaches for certain sections. Downstream vegetation consisted of mainly small ferns, exotic grasses, *Tradescantia*, and convolvulus.

The permanent unnamed streams are assessed as having **Moderate** ecological value due to moderate ratings for representativeness and ecological context and low ratings for rarity/distinctiveness and diversity and pattern (Table 4).

Table 4: Scoring and justification for assigned ecological value to permanent unnamed streams.

Matter	Rating	Justification
Representativeness	Moderate	Banks - modification has reduced habitat heterogeneity. Mix of native and exotic riparian vegetation. Narrow latitudinal extent. Continually flowing watercourse. Instream vegetation consists of mainly exotic weeds. Exotic species dominate riparian margins. Narrow latitudinal extent.
Rarity/Distinctiveness	Low	Limited habitat availability for native freshwater fish species.
Diversity and Pattern	Low	Likely moderate community structure.
Ecological context	Moderate	Watercourse extends for several hundred kilometres – provides migration passage for diadromous native species. Catchment dominated by agricultural land-use. Streams are fenced from stock. Evidence of poor water quality during the summer season.
		Overall value: **Moderate**

Figure 14: Named permanent streams Manganui stream (left), Moutoti Stream (middle), and Oaoiti Stream (right) (photos taken on 30/03/2022).

Figure 15: Unnamed permanent streams – Watercourse 1, 2, and 3 (left to right) (photos taken on 29/03/2022).

Figure 16: Culverts observed within unnamed permanent streams on the south site (photos taken 29/03/2022).

5.3.2 Intermittent Streams

There were seven intermittent streams identified over the north and south site during the initial site visit. The intermittent streams were all relatively similar (Figure 17) and are judged as typically having been straightened historically (as distinct from drainage channels cut for that purpose, which are another feature across the site). These streams either had very sparse riparian vegetation; or had some reasonably contiguous riparian vegetation (albeit 1-2m wide along the lineal reach) that comprised of mainly exotic species including gorse, pampas, pine interspersed with some native individuals or species like bracken fern. All intermittent streams had above-ground water present, with depths ranging from 20 – 40cm and were hard-bottom based, mainly consisting of silt, gravels and cobbles. The two straightened intermittent streams within the southern property had similar characteristics with the addition of karo (*Pittosporum crassifolium)* and bamboo planted along the riparian edges – which provided partial shading. Streams provide intermittent aquatic habitat likely to support native fish species during wetter periods.

As such, the overall ecological value of the intermittent streams is assessed as **Low** (Table 5).

Figure 17: Intermittent streams identified within the two properties (photos taken on 29-30/03/2022).

Table 5: Scoring and justification for assigned ecological value to the intermittent streams within the north and south site.

Matter	Rating	Justification
Representativeness	Low	Some channels have been straightened - modification has reduced habitat heterogeneity. Overall lack of native riparian vegetation. Will have periods of low to no waterflow.
Rarity/Distinctiveness	Low	Unlikely to provide significant habitat for At Risk or Threatened species
Diversity and Pattern	Low	Low diversity and complexity.

Matter	Rating	Justification
Ecological context	Low	Important contribution to drainage of farmland. Little to no appropriate instream habitat. Lack of riparian habitat. Catchment dominated by agricultural land-use. Most of the streams are fenced from stock.
		Overall value: **Low**

5.3.3 Rural Drainage Networks

There are over 3 km of artificial watercourses/farm drains identified within the properties (refer to Figure 13). The farm drains within the project works are not permanently wet, and riparian vegetation consisted of mainly exotic species including pampas, gorse and pine. Mostly all the drains were fenced to ward off stock. The drains are straight and channelised which has therefore limited potential freshwater habitat. Additionally, there is limited connectivity of the farm drains to the other permanent/intermittent streams as such, these drains would not be expected to contain high freshwater fauna diversity. The main purpose of these drain networks is to lower the water table, reduce surface flood risk, reduce contaminant load on waterways, and optimise soil moisture.

The drainage network is deemed to be of **Low to Negligible** ecological value based on very low ratings for all four Matters (Table 6). The proposed solar panel layout plan seeks to avoid the placement of panels over the farm drains.

Table 6: Scoring and justification for assigned ecological value to the rural drainage network within the north and south site.

Matter	Rating	Justification
Representativeness	Very Low	Straightened and channelised - channel modification has reduced habitat heterogeneity. Lack of native riparian vegetation, vegetation mainly consists of exotics.
Rarity/Distinctiveness	Very Low	Not expected to provide habitat for At Risk or Threatened species.
Diversity and Pattern	Very Low	Low diversity and complexity.
Ecological context	Very Low	Important contribution to drainage of farmland. Limited connectivity with permanent/intermittent streams. Little to no high quality instream habitat. Riparian vegetation patchy in places and dominated by weeds. Provides limited shading. Catchment dominated by agricultural land-use. Most drains are fenced from stock.
		Overall value: **Low to Negligible**

5.4 Potential values of permanent and intermittent waterbodies

The NPS-FM 2020 requires that both the current ecological value and potential ecological value of freshwater systems is considered. When considering the potential, it is assumed that the riparian margins of watercourses would be revegetated with indigenous species and exotic weeds will be removed. This would increase shading and shade out some of the macrophyte cover, increase woody debris inputs to the stream and increase habitat heterogeneity over time, as well as improve erosion and scour protection. These actions are expected to increase the representativeness, and ecological context ratings of the of the streams, especially in regard to the permanent unnamed streams, where the potential ecological value can increase from Moderate to High. For the intermittent streams, it is considered that with similar actions, potential ecological value can increase from Low to Moderate.

5.5 Ponds

The north property includes four constructed ponds (see Figure 13 for locations). Two of these ponds, further north (referred to as “Northern Ponds”), are likely duck shooting areas, and the other two are opposite the cow shed (referred to as “Southern Ponds”) (Figure 18).

5.5.1.1 Northern Ponds

Of the northern end ponds, one has been colonised by raupō, rushes, carex and *Persicaria hydropiper*. The margins are lined with blackberry (*Rubus fruticosus*), māhoe (*Melicytus ramiflorus)*, karamū, willows, and karo (Figure 18). It appears that the pond was created in a lower part of the terrain (potentially by impounding the stream channel) on the western side with roads. The second pond (east of the first) has less hydrophytic vegetation although soft rush and *Carex* sp. are present. The banks were sparsely populated with cabbage trees (*Cordyline australis)*, silver ferns, and poplars (*Populus sp*). Avifauna observed near or in the ponds included Canada geese (*Branta canadensis*), paradise shelducks (*Tadorna variegate*), magpie (*Gymnorhina tibicen*), fantail (*Rhipidura fuliginosa*), and pukeko (*Porphyrio melanotus*).

The ponds are artifically constructed, include wetland margins, and have some limited shading from the taller poplars, karamū, and willows. There is some stock access to the ponds, which likely reduces water quality. Although not considered to have formed naturally, these ponds provide potential habitat for waterbirds, eels,and gambusia (a pest fish). As such, the overall ecological value of the Northern ponds are **Moderate**.

5.5.1.2 Southern Ponds

The southern ponds are dominated by including raupō, *Juncus* sp., *Persicaria hydropiper* and *Carex* sp. (Figure 18). Avifauna observed near and within these ponds included mallard duck (*Anas platyrhynchos*).

The ponds are artifically constructed structures and have limited to no shading and likely low water quality due to continous stock access and sediment runoff. Additionally, there is limited connectivity of the ponds to nearby watercourses, therefore are unlikely to provide habitat for native species. As such, the overall ecological value of the Southern ponds are **Low**.

Figure 18: Ponds within the north property. Northern ponds (top left and right) with typical hydrophytic species observed and pond opposite to the cow shed (bottom).

5.6 Terrestrial Vegetation

Vegetation across the site consists mainly of pasture grass species and associated weeds as well as a patch of remnant native vegetation that is now primarily residual kahikatea (*Dacrycarpus dacrydioides*) stems, interspersed with a sparse collection of other individual stems of kānuka (*Kunzea robusta*) rimu (*Dacrydium cupressinum*), and pukatea (*Laurelia novae-zelandiae*) with rātā (*Metrosideros* sp.) and *Astelia* sp. growing on some trees at the northern end of the north site in proximity to the riverine wetland previously described (see Section 5.2.1). There is also established mixed native-exotic vegetation along the riparian margins of intermittent and permanent streams on the south site, shelter belts of planted mature pine as well as along the riparian edge of some permanent streams, and patches of exotic weeds including blackberry, inkweed, bamboo, and pampas (Figure 19). Within the proposed solar panel layout, the patch of remnant kahikatea assembly towards the north of the site has been excluded.

Individual native trees and areas of mixed native-exotic vegetation are assessed as having **Moderate** ecological values based on the dominance of exotic trees and the presence of Threatened – Nationally Vulnerable native species. Mature exotic trees are assessed as having **Negligible** ecological values. Patches of remnant native vegetation, mainly within the north site; and along the riparian margins which occur across both sites, are assessed as having **Moderate** ecological value based on low ratings for representativeness and diversity and pattern, and moderate ratings for rarity/distinctiveness and ecological context (Table 7).

The habitat value of vegetation for birds, bats, and herpetofauna is discussed separately in the below sections.

Table 7: Scoring and justification for assigned ecological value to patches of remnant native vegetation.

Matter	Rating	Justification
Representativeness	Low	Indigenous species dominate No understory due to grazing
Rarity/Distinctiveness	Moderate	Dominant native species onsite are Not Threatened. Rata and kānuka are dispersed in patches and are both Threatened – Nationally Vulnerable species.
Diversity and Pattern	Low	Expected level of natural diversity not present.
Ecological context	Moderate	Small extent and degraded condition Not fenced to exclude stock. Contributes to overall ecological network and provides potential habitat for avifauna and bats Contributes to maintenance of genetic diversity as an indigenous seed source.
		Overall value: **Moderate**

Figure 19: Typical vegetation found onsite – general mix of exotics and natives.

5.7 Fauna

5.7.1 Freshwater fish

Few freshwater fish records are available for the catchment. The only recent records (2012) for the Oaoiti Stream, approximately 4 km upstream of the site, include longfin eel (*Anguilla dieffenbachii* At Risk – Declining), kōura (*Paranephrops* sp.), and freshwater shrimp (*Paratya curvirostris*)[21,22].

During the first site visit three dead eels were observed in watercourses in the southern property. It was unclear what the cause of death was, but it is low water levels, and flow rates and high-water temperatures were typical stressors observed during the site visit.

During the second site visit, un-baited fish traps (gee minnows) were deployed at Oaoiti Stream, 10 m downstream and 20 metres upstream of the road bridge. No live fish we caught in the traps however, one dead (and half eaten) galaxiid was caught. Body conditions indicated that the specimen had likely been dead for more than 24 hours. As galaxiid species are usually predated on by higher trophic groups, this find indicates the presence of longfin and/or shortfin eels. This is supported by eDNA findings, which indicates the presence of kōaro (*Galaxias brevipinnis*) and longfin eel (*Anguilla dieffenbachia*) both of which are At Risk – Declining, shortfin eel (*Anguilla australis*) and redfin bully (*Gobiomorphus huttoni*), which are both Not Threatened, and brown trout (Introduced) [23].

The proposed solar panel layout appears to avoid the permanent and intermittent stream environments, with the exception of the installation of four culverts. Indirect adverse effects can occur from operation activities and the installation of the solar panels.

Due to the likely presence of At Risk – Declining species through eDNA records, the freshwater fish values, associated with the permanent streams within the properties, are assessed as **High**.

5.7.2 Freshwater Macroinvertebrates

5.7.2.1 Oaoiti Stream

MCI Scores for Oaoiti Stream returned an MCI value of 105.0 and a QMCI value of 6.01, which is within the attribute band B and C. This is indicative of mild-moderate organic pollution and nutrient enrichment and is composed of a mix of taxa sensitive and insensitive to organic pollution/nutrient enrichment. Macroinvertebrate diversity was also relatively low (13 taxa) with 42% EPT and 36.5% EPT taxa. Within the data, macroinvertebrate species identified included kōura (*Paranephrops planifrons*), New Zealand dobsonfly (*Archichauliodes diversus*), and the New Zealand Mayfly *(Deleatidium sp.)* (At Risk – Nationally Uncommon).

Oaoiti Stream is considered to have **Moderate** macroinvertebrate values based on the presence of At Risk – Naturally Uncommon species.

A full account of macroinvertebrates can be found in Appendix 5:Table 5.1.

5.7.2.2 Manganui Stream

The Macroinvertebrate Community Index Score (MCI) for Manganui Stream returned an MCI value of 98.18 and a QMCI value of 4.76, which is within attribute band C according to the NPS-FM (2020). This is indicative of moderate organic pollution or nutrient enrichment, although taxa that are sensitive to organic

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[21] Crow, S. (2017). *New Zealand Freshwater Fish Database. Version 1.2*. National Institute of Water and Atmospheric Research (NIWA). https://doi.org/10.15468/ms5iqu

[22] Dunn, N. R., Allibone, R. M., Closs, G. P., Crow, S. K., David, B. O., Goodman, J. M., Griffiths, M., Jack, D. C., Ling, N., Waters, J. M., & Rolfe, J. R. (2018). Conservation status of New Zealand freshwater fishes, 2017. In *New Zealand Threat Classification Series 24* (p. 11). Department of Conservation. www.doc.govt.nz

[23] See 18

pollution/nutrient enrichment were present. Macroinvertebrate diversity was relatively low (11 taxa) with 15% EPT and 36% EPT taxa.

As such, Manganui Stream is considered to have **Low** macroinvertebrate values.

5.7.3 Avifauna

Records on eBird within 5km of the site for 2010 – 2021 include At Risk – Naturally Uncommon black shag and common native and exotic species associated with disturbed agricultural landscapes (refer to Appendix 3 for full list). The aquatic habitat present on site may provide suitable habitat for black shag but none were observed during the site visit. All other avifauna identified are Not Threatened or Introduced.

Species sighted during both sites visit included fantail, yellowhammer (*Emberiza citrinella*), dunnock (*Prunella modularis*), goldfinch (*Carduelis*), harrier (*Circus approximans*), kōtare (*Todiramphus sanctus*), mallards, paradise shelducks, magpies, blackbirds (*Turdus merula*), song thrush (*Turdus philomelos*), pukeko, and canada geese.

Due to the presence of suitable habitat and nearby records of of a Nationally Uncommon species, the potential species value is assessed as **Moderate**.

5.7.4 Herpetofauna

Lizard records for the surrounding area include two goldstripe gecko (*Woodworthia chrysosiretica*; At Risk – Declining) records 4.4 km from the site in 2020, and a copper skink (*Oligosoma aeneum*; At Risk – Declining) record 4.4 km from the site from 1996 (Source: DOC).

The properties do include woody debris, rocky debris, rank grasslands, and scrub/flax that may provide suitable habitat for native skinks and goldstripe geckos. As all native lizards are protected under the Wildlife Act (1953), control measures will be required to mitigate risk of injury and/or mortality to any herpetofauna living within the project site. Due to the presence of suitable habitat and nearby records of At-Risk lizard species, the potential species value is assessed as **High**. It should be noted that this assessment is based on desktop assessment and information available, and no formal surveys were conducted.

5.7.5 Bats

There are no bat records within 25 km of the site however, both long-tailed bats (*Chalinolobus tuberculatus*) and the central lesser short-tailed bats (*Mystacina tuberculate rhyacobi*) (known from the central North Island, Taranaki and East Cape) are known to forage along riparian corridors of adjacent catchments and potentially across farmland in the wider landscape, and have a known typical home range of over 100 km. They are also known to roost within trees that provide suitable refuges under bark and in cavities of nearby foraging areas. Roost tree characteristics are defined as trees with a trunk diameter >15cm that have cavities, cracks, crevices, hollows, epiphyte clumps suitable as refugia (Table 8). The remnant kahikatea patch and the mature pines may provide suitable roosting habitat for bats.

In the absence of survey data, the bat values of the site are potentially **High**. Based on the presence of suitable habitat, it is expected that a bat survey will form a condition of consent, along with the development of a bat management plan, should native bats be found.

Table 8: Criteria for assessing trees for their suitability as bat roosts (adapted from AECOM New Zealand Limited, 2019).

Suitability as a roost	Justification of assessment	Bat survey required?
Low	A tree of at least 15 cm dbh but no roost features visible or with only limited roosting potential i.e. loose bark present, but not sufficient to provide shelter for roosting bats.	No

Moderate	A tree of at least 15 cm dbh with one or more roost features that could be used by individual bats or where it is not clear from theground inspection whether roost features are present or not andtherefore requires further inspection.	Yes
High	A tree of at least 15 cm dbh with one or more roost features which could provide habitat for several bats due to their size and ability to provide sufficient shelter and protection.	Yes

6 Assessment of Ecological Effects

This assessment of ecological effects has been framed by the rule assessment and scope of consideration of rules as provided through planning interpretation of the relevant Rules (see the AEE). The effects assessed are associated with the temporary effects arising from the construction phase as well as the longer-term effects that are related to changes in hydrology and structures proposed to be placed in watercourses once the solar panels and associated infrastructure have been installed/constructed. The assessment of ecological effects has been undertaken in accordance with the EIANZ guidelines[24]. Level of effects are assessed as the product of the **magnitude** (determined according to the duration of effects, the degree of change that will be caused and the extent of potential impact), and the ecological **values** impacted. The key effects assessed, and the associated magnitude are described in detail below.

6.1 Key Ecological Effects Overview

6.1.1 Construction phase effects (temporary) include:

- Potential injury and/or mortality of native fauna;
- Vegetation clearance and loss of terrestrial habitat;
- Erosion and earth disturbance leading to potential deposition of suspended sediments into receiving environments.

6.1.2 Operational phase effects include:

- Increased impervious surface landcover and potential alterations to hydrology;
- Alteration to intermittent and permanent watercourses.
- Loss of potential ecological value

6.2 Construction Phase Effects (temporary)

6.2.1 Potential injury and/or mortality of native terrestrial fauna

Construction activities and clearance of vegetation have the potential to cause direct injury or mortality to native wildlife such as birds, bats and lizards. These activities may also result in indirect mortality via displacement and habitat loss.

6.2.1.1 Avifauna

Avifauna at the site consists of common indigenous and exotic species typical of modified agricultural landscapes. Adults are expected to disperse to other suitable habitat, but it is possible that vegetation clearance will result in the direct loss of eggs and/or juveniles.

It is expected that the proposal will have a minor magnitude of effect on local avifauna populations that utilise the site thus is assessed as a **Low** unmitigated magnitude of effect.

Nevertheless, as native bird species present at the site are protected under the Wildlife Act 1953 (with the exception of pukeko and paradise shelducks which are declared game during the open season for game specified under the Second Schedule of the Wildlife Act), and management of these impacts is recommended, particularly during breeding season where the risk of impact on eggs or juveniles that are not able to flee construction works.

6.2.1.2 Herpetofauna

[24] See 8

Vegetation clearance and clearance of woody debris has the potential to cause injury and/or mortality of native skink and/or gecko, as there is potential herpetofauna habitat present onsite. Disruption to remnant native vegetation is not anticipated as this habitat is outside of the area of proposed works; although there will be some limited disturbance of exotic vegetation, rank and pasture grass.

The magnitude of this effect is not able to be assessed in the absence of survey data. Nevertheless, as all native fauna is protected under the Wildlife Act, measures to avoid injury/mortality are required even at low magnitudes of effect and recommendations for management and mitigation have been made to address these issues and ensure the overall level of effect is Low.

6.2.1.3 Bats

Clearance of high-risk roost trees could potentially lead to injury and/or mortality of individual and/or colonies of bats by crushing them during tree felling, causing lethal levels of stress, or forcing them out of their roost and exposing them to diurnal predators. The majority of vegetation on the site does not constitute high-risk roost habitat, although some of the shelter belts will. Bat habitat may also become further fragmented, disrupting corridors of bat activity and resulting in displacement.

The magnitude of this effect is not able to be assessed in the absence of survey data. Nevertheless, as all native fauna is protected under the Wildlife Act, measures to avoid injury/mortality are required even at low magnitudes of effect and recommendations for management and mitigation have been made to address these issues and ensure the overall level of effect is Low.

6.2.1.4 Freshwater fish

Adverse effects on freshwater fish have been avoided by retaining 10+ m buffers around intermittent and permanent watercourses where feasible. Limited construction activities are required within intermittent watercourses, and two new culverts are proposed to be installed within permanent watercourses, therefore habitat where native freshwater fish are most likely to be present in high abundance will likely be disturbed however, disturbance will be minimal and temporary in nature.

As there are limited in-stream works occurring within intermittent and permanent watercourses anticipated through design, this effect is assessed to have low magnitude of effect with an overall **Low** unmitigated magnitude of effect. Nevertheless, measures to avoid injury/mortality are recommended even at low magnitudes of effect should there be works undertaken in intermittent streams while standing water is present.

6.2.2 Erosion and earth disturbance via trenching and installation of panels

Bulk earthworks and a substantial area of trenching (300 – 500 mm wide and 1.0 m deep along each solar panel line) is required for the laying of power cables connecting solar panels to the inverters and subsequently to the switch yard. Trenches are proposed to be dug by hydraulic excavator with cables being progressively installed and the trench immediately backfilled. Trenching may result in increased surface soil exposure during power cable implementation and therefore increases the risk of erosion and sediment release in times of rainfall during the work. If not appropriately managed, this may cause a degradation of landcover and runoff into watercourses and/or wetlands within the property which may impact habitat value and ecosystem functioning disruption.

Installation of the solar panels could indirectly impact the series of natural wetlands and permanent, intermittent, and ephemeral watercourses throughout the property due to soil exposure from earthworks resulting in sedimentation. If not appropriately managed, this may cause a degradation of habitat quality and ecosystem function.

6.2.2.1 Natural wetlands

Sediment runoff into wetlands may decrease wetland volume, decrease the duration wetlands retain water, and change plant community structure. Wetlands across the north site are already receiving environments for (and sources of) sediment due to stock access exposing soil and entering wetlands during wet conditions.

As such, the potential unmitigated magnitude of effect of wetlands is assessed as **Low** resulting in no more than a minor shift from existing baseline conditions. Any adverse effects can be minimised with erosion and sediment control measures during the construction period.

6.2.2.2 Permanent and intermittent watercourses

Uncontrolled sediment discharge into permanent and intermittent watercourses during earthworks could result in degradation of the existing water quality conditions and alteration of substrate composition. Suspended sediments increase water turbidity and can directly lead to fish mortality through clogging of the gills. Increases in suspended sediments can also negatively impact the photosynthetic activity of aquatic plants through reduced light attenuation, lowering dissolved oxygen levels in the system.

Water quality could be degraded through increased turbidity and siltation from soil exposure and runoff, and streambank erosion due to construction pressures. Contaminant runoff from installation and construction materials may also adversely affect the water quality in watercourses across the property[25]. To minimise these effects, a 10m buffer distance from earthworks has been maintained, and it is expected that best practice erosion and sediment control will be implemented.

In the absence of effects management measures, the potential magnitude of effect of proposed works is expected to be **Moderate** for permanent streams and **Low** for intermittent streams.

6.2.3 Vegetation clearance and potential loss of habitat

It is expected that vegetation clearance within the site will be minimal, and mainly restricted to mature exotic trees, to allow for solar panel installation. Early estimates indicate that any such required vegetation clearance could amount to ~ 5,128 m^2 over the site.

Exotic vegetation present onsite includes large (8-20m) poplars, mature pine (~20m), and bamboo stands (~3-5m). Exotic (and native) vegetation present within 10m of the riparian zone, will not be cleared. Although botanical values of exotic species are negligible, mature exotic vegetation does provide some potential habitat for native bats in the form of roost trees, and potential roosting/nesting habitat for birds. As the extent of clearance is small in the context of wider available roosting/nesting habitat for bats and birds, clearance is assessed as a **Low** unmitigated magnitude of effect.

According to the proposed panel layout, there are limited areas of vegetation onsite which is subject to clearance. Additionally, vegetation clearance is mainly limited to exotic species. There are good opportunities to undertake planting of indigenous species (particularly in riparian and wetland margins) to uplift existing values and increase ecological values within the site.

6.3 Operational Phase Effects

6.3.1 Increased impervious surface landcover and potential alterations to hydrology

The proposed solar panel layout is expected to cover approximately 138 ha across the two properties.

Although the solar panel coverage is expected to locally shield some areas from direct rainfall recharge, runoff through the proposed buffer areas (around streams and wetlands) and pasture retained beneath panels is expected to provide enough surface for maintaining a close-to-natural recharge to the nearest

[25] U.s. Department of Energy National Energy Technology Laboratory. (2011). *Final Environmental Assessment West Tennessee Solar Farm Porject Haywood County, Tennessee*.

down-gradient streams and wetlands and ultimately avoid the risk of depletion, assuming that the panels themselves are installed so that direct runoff from them is not redirected to another catchment. Potential impacts to groundwater recharge or streams (permanent and intermittent) flow rates are unlikely.

Natural wetlands within the north site which are located slightly lower gradient areas of the paddocks are unlikely to be impacted by a potential recharge reduction due to panel coverage. Due to the lower-lying nature of the wetlands (especially the palustrine marsh wetlands) which are located in old depression areas formed by river alignments, water from rainfall will likely divert beneath adjacent panels and still runoff into these areas. The overall risk to the identified wetlands remains low and thus, this is assessed as a **Low** unmitigated magnitude of effect.

6.3.2 Alteration to permanent watercourses

For installation, construction, and continued site access and maintenance activities, alterations to intermittent and permanent watercourses within the property may be required. Because of the permanent and intermittent nature of the many watercourses on this site the number of watercourse crossings has been limited, with access to solar panel areas being from the all-weather spine road to each solar panel area/ paddock being via tractor access around its perimeter, and between rows, without crossing the watercourses between areas/paddocks.

As per the proposed solar panel outlay, five new culverts will be placed across the site. Of these five culverts, two will be placed within the permanent streams. One culvert will be placed within Watercourse 1, and a second culvert will be placed at the eastern end of Manganui stream on the south site property border. The installation of these culverts will be undertaken with reference to fish passage guidelines[26, 27], with design considerations to ensure minimal disruption to in-stream habitat to allow continued longitudinal connectivity for aquatic fauna. Alteration of the natural stream channel gradient and alignment should be avoided or minimised where possible.

In the absence of appropriate effects management measures, the potential magnitude of effect from the installation of culverts is expected to be **Moderate**. The changes arising from culvert installation can potentially result in partial changes in the underlying character and attributes of the existing watercourse.

6.3.3 Loss of potential ecological value

The NPS-FM (2020) requires that consideration be given to the loss of potential value of rivers/streams and wetlands.

As detailed in Section 5.2 and 5.3, when considering the potential value of the wetlands and watercourses, it is assumed that planting of indigenous wetland species alongside the riparian margins of permanent and intermittent streams and removal of exotic weeds. The proposed works are expected to result in a **Negligible** loss of potential value for the wetlands and streams. Works will not prohibit these actions being undertaken in the future, nor impede any improvements in water quality.

[26] Franklin, P., Gee, E., Baker, C., & Bowie, S. (2018). New Zealand Fish Passage Guidelines: For structures up to 4 metres. In *NIWA Client Report 2018019HN*. NIWA. https://www.niwa.co.nz/static/web/freshwater-and-estuaries/NZ-FishPassageGuidelines-upto4m-NIWA-DOC-NZFPAG.pdf

[27] National Environmental Standards for Freshwater Management. 2020.

7 Ecological Effects Management

The ecological effects of installing solar panels and associated infrastructure (i.e. roads to facilitate internal access, inverter stations) on the site have been avoided in the first instance by conducting a preliminary ecological constraints assessment[28] and ensuring wetland reclamation, stream diversion, additional culverting of intermittent and permanent streams, and loss of high value vegetation is avoided through design.

Where effects have not been able to be avoided, effects have been minimised by retaining 10 m buffers around intermittent and permanent streams where feasible and ensuring robust erosion and sediment controls will be place.

Other potential adverse ecological effects can be minimised or managed through best practice environmental management and construction methodology as detailed below.

7.1 Fauna Management

7.1.1 Avifauna

The clearance of vegetation will directly remove some habitat for native birds. Due to their highly mobile nature, it is likely that direct impacts on adult forest birds on-site will be largely avoided as they are expected to disperse to other habitat during vegetation clearance. Potential impacts on nesting adult native birds, and both their eggs and unfledged chicks should be avoided by timing vegetation clearance to avoid nesting season (September to February for most species). Avoiding the nesting season can however be challenging as it coincides with earthworks season when rainfall and runoff is at its lowest. If vegetation clearance during the peak of the bird breeding season is unavoidable, then those areas should be checked by a suitably qualified ecologist and/or arborist for nesting birds immediately prior to vegetation removal and, if any active nests (i.e. one or more viable eggs or live chicks are present) are detected, vegetation clearance in the immediate vicinity of the nest (e.g., within a 10m radius) should be delayed until a suitably qualified ecologist confirms that any nests present are no longer active.

In regard to the potential of injury and/or mortality of avifauna colliding with solar panels. It is recommended that a suitable monitoring plan be put in place that assesses bird mortality that may occur onsite within proximity of the solar panels.

7.1.2 Herpetofauna

Native herpetofauna are protected under the Wildlife Act 1953 and the construction stage activities may disrupt herpetofauna species, if present.

It is recommended an initial risk assessment survey for lizards be undertaken by a suitably qualified herpetologist to assess the risk and likelihood of lizard presence/absence within the area of construction at the property prior to the commencement of works.

If native herpetofauna are found to reside within the site, lizard management will be required. A Lizard Management Plan will need to be developed and implemented by a DOC-permitted herpetologist ecologist, and prior to the start of works, adverse effects on native herpetofauna present at the site will need to be mitigated by relocating them to protected, suitable habitat. Although considered unlikely in this instance (due to the low likelihood of their presence), should lizard salvage and relocation be determined to be required, typical actions are expected to be the capture and release by an experienced herpetologist, outside of winter

[28] Beca. 2022. Ecological Constraints Assessment – Proposed Solar Farm at Upper Kina Road. Prepared for Energy Farms Limited.

months and in accordance with Department of Conservation Wildlife Authority requirements. A lizard release site will need to be secured and should be under pest control both prior to and following relocation. The release site should also be monitored for lizard presence, abundance and habitat suitability outside of winter months.

7.1.3 Bats

The site includes a (low) potential foraging and roosting habitat for native bats. It is recommended that a bat survey is conducted by an appropriately qualified ecologist prior to the commencement of works.

If any bat activity is detected at this time, a bat management plan should be developed and implemented. The bat management plan will outline roost tree management, tree felling protocol, and appropriate mitigation for loss of roost trees. Should lighting be installed across the site, it is recommended that directional lighting is used to minimise operational disturbance of long-tailed bats.

7.1.4 Freshwater Fish

Where habitat disturbance and/or dewatering cannot be avoided, protocols to avoid injury/mortality of native fish should include fish rescue and relocation in areas where standing water is present prior to the commencement of works. It is recommended that impacted habitat be isolated (using stop-nets), and fish present be caught and translocated to a suitable aquatic habitat outside of the works footprint. This will likely involve a combination of trapping, slow dewatering and sorting through dewatered materials to capture and relocate fish outside of the works zone. The stop-nets should be retained within the stream until the works are completed, to ensure that no fish re-colonise.

7.2 Erosion and Sediment Controls

Sediment controls will be put in place to prevent sediment laden runoff entering watercourses in accordance with industry best practice guidelines following the Waikato Regional Council Guidelines for Soil Disturbing Activities (which applies to the Taranaki Region). These will comprise of silt fencing, vegetation filter strips, decanting earth bunds, diversion cut-off drains to direct runoff away from earthwork areas, stabilising earthwork areas with gravel progressively and grassing any exposed bare areas as soon as possible. It is recommended the works are carried out, as far as practicable, during the appropriate earthworks season.

As an additional erosion and sediment control measure, it is recommended that pasture or other vegetation is maintained throughout the site, including underneath the panels, and where evidence of scour or soil erosion is identified the area is revegetated.

7.3 Watercourse Management and Stormwater Design

By utilising existing farm access roads that are already culverted, it envisaged that is only five new culverts will be required, and those are necessary to access some of the panel sites isolated from the access roads by a watercourse. Setbacks of at least 10 m have been provided from identified watercourses to provide for riparian margins and access.

It is recommended all new tracks, all-access roads, and any other formed areas are drained to vegetated areas or best practice stormwater management design is implemented (e.g., planted swales to nearby watercourses) to reduce the risk of erosion and scour, and consideration given during that process to make sure that impacts on ‘natural wetlands’ are avoided.

Any in-stream works are required to be undertaken with consideration of good environmental management practices, including erosion and sediment control, consideration of fish passage guidelines and with design considerations to ensure minimal disruption to in-stream habitat or aquatic fauna. It is generally recommended that riparian margin plantings and measures to prevent stock entering watercourses are implemented, to minimise potential for stream bank erosion and runoff effects and enhance the biodiversity within the property.

7.4 Wetland Management, Restoration, and Riparian Planting

The NES-F (2020) sets out a strong imperative to avoid wetland loss and degradation. The natural wetlands confirmed to be present within the property require reclamation or alteration to the hydrology of these features to be avoided. Solar panel layout design has been refined to ensure all confirmed wetlands identified during the March 2022 site visit are located outside of the proposed works area.

It is generally recommended that indigenous plantings within and around natural wetlands take place within the site, and wetlands are fenced to exclude stock. Wetland areas of key ecological value could be identified to focus enhancements efforts on, as a practicable measure to increase the ecological integrity and ecosystem services value of wetlands within the property.

Table 9: Summary of potential ecological effects on ecological values including magnitude, level of effects, and recommended mitigation measures.

Potential ecological effect	Ecological component	Ecological Value	Potential Ecological Value	Magnitude of Effect (unmitigated)	Overall Level of Effect (unmitigated)	Mitigation measure	Overall Level of Effect (mitigated)
Construction phase effects (temporary)							
Potential injury and/or mortality of avifauna	Avifauna	Moderate	NA	Low	Low	Fauna management	Low
Potential injury and/or mortality of herpetofauna	Herpetofauna	High	NA	TBC	NA	Fauna management	Low
Potential injury and/or mortality of bats	Bats	High	NA	TBC	NA	Fauna management	Low
Potential injury and/or mortality of native freshwater fish	Freshwater Fish	High	NA	Low	Very Low	Fauna management	Low
Vegetation clearance and loss of terrestrial habitat	Remnant native vegetation	Moderate	NA	Low	Low	Terrestrial revegetation planting	Low
Erosion and earth disturbance via trenching and installation of panels	Wetlands	Low	Moderate	Low	Very Low	Erosion and Sediment Controls	Very Low
	Permanent Streams	Moderate to High	High	Moderate	Low	Erosion and Sediment Controls	Low
	Intermittent Streams	Low	Moderate	Low	Low	Erosion and Sediment Controls	Very Low
Runoff and deposition of suspended sediments to receiving natural wetlands	Wetlands	Low	Moderate	Low	Very Low	Wetland management, restoration, and riparian planting	Very Low
Runoff and deposition of suspended sediments to receiving watercourses	Permanent Streams	Moderate to High	Moderate	Moderate	High	Watercourse management and stormwater design	Low
	Intermittent Streams	Low	Moderate	Moderate	Low	Erosion and Sediment Controls	Very Low
Operational Phase Effects							
Increased impervious surface landcover	Watercourses, Wetlands	Moderate to High, Low	Moderate	Low	Low	Watercourse management and stormwater design	Very Low
Alteration to permanent watercourses	Permanent Streams	High	NA	Moderate	High	Watercourse management, stormwater design, and culvert designs in accordance with appropriate fish passage guidelines.	Low
Loss of potential ecological value	Watercourses, Wetlands	Moderate to High, Low	NA	Negligible	Very Low	None required	Very Low

8 Conclusions and Recommendations

A desktop review of ecological features and species records was completed to identify potential ecological constraints on 189 hectares of land on Upper Kina Road, Ōpunake. The review was followed by a site walkover in January 2022 and a detailed field investigation in March 2022. The implementation of the solar farm within the site may result in adverse ecological impacts identified in this report. To manage the impact of the construction and operation of the solar farm the implementation of the following effects management measures have been proposed:

- Fauna management;
- Terrestrial revegetation planting;
- Erosion and Sediment Controls;
- Watercourse management and stormwater design;
- Wetland management, restoration, and riparian planting.

The overall level of ecological effects of the proposed construction works are **Very Low** to **Low**, assuming the implementation of the recommended effects management measures. This means that effects will be discernible, but the underlying character, composition, and attributes of the existing baseline condition will be similar to pre-development circumstances over a short to medium term time scale.

Overall, if watercourse and wetland management is implemented as recommended there may be a net gain in ecological value due to increased indigenous dominance and improved habitat value for native fauna over a medium to long term time scale.

1

Appendix 1– Ecological Impact Assessment (EIANZ Methodology)

Appendix 1: Ecological Impact Assessment Guidelines

Assigning Ecological Value

Freshwater and terrestrial habitat

The ecological values of freshwater and terrestrial systems (riparian vegetation, habitats and species present) potentially impacted by the works were assessed against the following attributes:

- Representativeness;
- Rarity or distinctiveness;
- Diversity or pattern; and
- Ecological context.

These attributes are described in Table 1.1 and Table 1.2 below.

Table 1.1. Matters that may be considered when assigning ecological value to a freshwater site or area.

Matters	Attributes to be assessed
Representativeness	Extent to which site/catchment is typical or characteristic Stream order Permanent, intermittent or ephemeral waterway Catchment size Standing water characteristics
Rarity/distinctiveness	Supporting nationally or locally threatened, at risk or uncommon species National distribution limits Endemism Distinctive ecological features Type of lake/pond/wetland/spring
Diversity and pattern	Level of natural diversity Diversity metrics Complexity of community Biogeographical considerations - pattern, complexity, size, shape
Ecological context	Stream order Instream habitat Riparian habitat Local environmental conditions and influences, site history and development Intactness, health and resilience of populations and communities Contribution to ecological networks, linkages, pathways Role in ecosystem functioning – high level, proxies

Table 1.2. Attributes to be considered when assigning ecological value or importance to a site or area of vegetation/ habitat/community.

Matters	Attributes to be assessed
Representativeness	Criteria for representative vegetation and aquatic habitats: Typical structure and composition Indigenous species dominate Expected species and tiers are present Thresholds may need to be lowered where all examples of a type are strongly modified Criteria for representative species and species assemblages: Species assemblages that are typical of the habitat Indigenous species that occur in most of the guilds expected of the habitat type
Rarity/distinctiveness	Criteria for rare/ distinctive vegetation and habitats: Naturally uncommon, or induced scarcity Amount of habitat or vegetation remaining Distinctive ecological features National priority for protection Criteria for rare/ distinctive species or species assemblages: Habitat supporting nationally Threatened or At-Risk species, or locally uncommon species Regional or national distribution limits of species or communities Unusual species or assemblages Endemism
Diversity and pattern	Level of natural diversity, abundance, and distribution Biodiversity reflecting underlying diversity Biogeographical considerations, considerations of lifecycles, daily or seasonal cycles of habitat availability and utilisation
Ecological context	Site history, and local environmental conditions which have influenced the development of habitats and communities The essential characteristics that determine an ecosystem's integrity, form, functioning, and resilience (form "intrinsic value" as defined in RMA) Size, shape and buffering Condition and sensitivity to change Contribution of the site to ecological networks, linkages, pathways and the protection and exchange of genetic material Species role in ecosystem functioning – high level, key species identification, habitat as proxy

The freshwater habitat features were assessed considering each of the attributes in Table 1.1, and terrestrial habitat features were assessed considering attributes in Table 1.2. Features of interest were subjectively given a rating on a scale of ‘Very Low’ to ‘High’ for each attribute and assigned a value in accordance with the description provided in Table 1.3.

Table 1.3. Rating system for assessing ecological value of terrestrial and freshwater systems (Roper-Lindsay et al. 2018)

Value	Description
Negligible	Feature rates Very Low for at least three assessment attributes and Low to Moderate for the remaining attribute(s).
Low	Feature rates Very Low to Low for most assessment attributes and moderate for one. Limited ecological value other than providing habitat for introduced or tolerant indigenous species.
Moderate	Feature rates High for one assessment attribute and Low to Moderate for the remainder, <u>OR</u> the project area rates Moderate for at least two attributes and Very Low to Low for the rest. Likely to be important at the level of the Ecological District.
High	Feature rates High for at least two assessment attributes and Low to Moderate for the remainder, OR the project area rates High for one attribute and Moderate for the rest. Likely to be regionally important.
Very High	Feature rates High for at least three assessment attributes. Likely to be nationally important.

Species

The EIANZ provides a method for assigning value (Table 1.4) to species for the purposes of assessing actual and potential effects of activities.

Table 1.4. Criteria for assigning ecological values to species

Ecological Value	Species
Very High	Threatened (Nationally Critical, Nationally Endangered, Nationally Vulnerable)
High	At Risk (Declining)
Moderate	At Risk – Recovering and At Risk – Naturally Uncommon
Low	Nationally and locally common indigenous species

Assigning Magnitude of Impacts

The magnitude of impacts is determined by the scale (temporal and spatial) of potential impacts identified and the degree of ecological change that is expected to occur as a result of the proposed activity (Roper-Lindsay *et al*. 2018).

Based on the assessor’s knowledge and experience, the magnitude of identified impacts on the ecological values within the project area and zone of influence were assessed and rated on a scale of ‘Very High’ to ‘Negligible’ based on the description provided in Table 1.5.

Table 1.5. Criteria for describing the magnitude of effects (Roper-Lindsay et al. 2018)

Magnitude	Description
Very high	Total loss or very major alteration to key features of existing conditions, such that the post-development attributes will be fundamentally changed and may be lost altogether; and/or loss of a very high proportion of the known population or range of the feature.
High	Major loss or alteration of key features of existing conditions, such that post-development attributes will be fundamentally changed; and/or loss of a high proportion of the known population or range of the feature.
Moderate	Loss or alteration to one or more key features of the existing condition, such that post-development attributes will be partially changed; and/or loss of a moderate proportion of the known population or range of the feature.
Low	Minor shift away from existing conditions. Change arising from the loss/alteration will be discernible, but underlying attributes will be similar to pre-development circumstances; and/or having a minor effect on the known population or range of the feature.
Negligible	Very slight change from existing conditions. Change barely distinguishable, approximating "no change"; and/or having negligible effect on the known population or range of the feature.

Assessment also considered the temporal scale at which potential impacts were likely to occur:

- Permanent (>25 years).
- Long-term (15-25 years).
- Medium-term (5-15 years).
- Short-term (0-5 years).
- Temporary (during construction)

Assessing the Level of Effects

The overall level of effect on each ecological feature identified within the zone of influence were determined by considering the magnitude of impacts and the values of impacted ecological features (Roper-Lindsay *et al*. 2018).

Results from the assessment of ecological value and the magnitude of identified impacts were used to determine the level or extent of the overall impacts on identified ecological features within the project area and zone of influence using the matrix described in Table 1.6.

Table 1.6. Matrix combining magnitude and value for determining the level of ecological impacts (Roper-Lindsay et al. 2018).

Effect Level		Ecological and/or Conservation Value				
		Very High	**High**	**Moderate**	**Low**	**Negligible**
	Very High	Very High	Very High	High	Moderate	Low
Magnitude	**High**	Very High	Very High	Moderate	Low	Very Low
	Moderate	High	High	Moderate	Low	Very Low
	Low	Moderate	Low	Low	Very Low	Very Low
	Negligible	Low	Very Low	Very Low	Very Low	Very Low
	Positive	Net Gain	Net Gain	Net Gain	Net Gain	Net Gain

Results from the matrix were used to determine the type of responses that may be required to mitigate potential direct and indirect impacts within the project area and within the zone of influence, considering the following guidelines (Roper-Lindsay *et al*. 2018):

- A ‘Low’ or ‘Very Low’ level of impact is not normally of concern, though design should take measures to minimise potential effects.
- A ‘Moderate’ to ‘High’ level of impact indicates a level of impact that qualifies careful assessment on a case-by-case basis. Such activities could be managed through avoidance (revised design) or appropriate mitigation. Where avoidance is not possible, no net loss of biodiversity values would be appropriate.

A ‘Very High’ level of impact is unlikely to be acceptable on ecological grounds alone and should be avoided. Where avoidance is not possible, a net gain in biodiversity values would be appropriate.

2

Appendix 2 – Wetland Delineation Results

2 Wetland Delineation Results

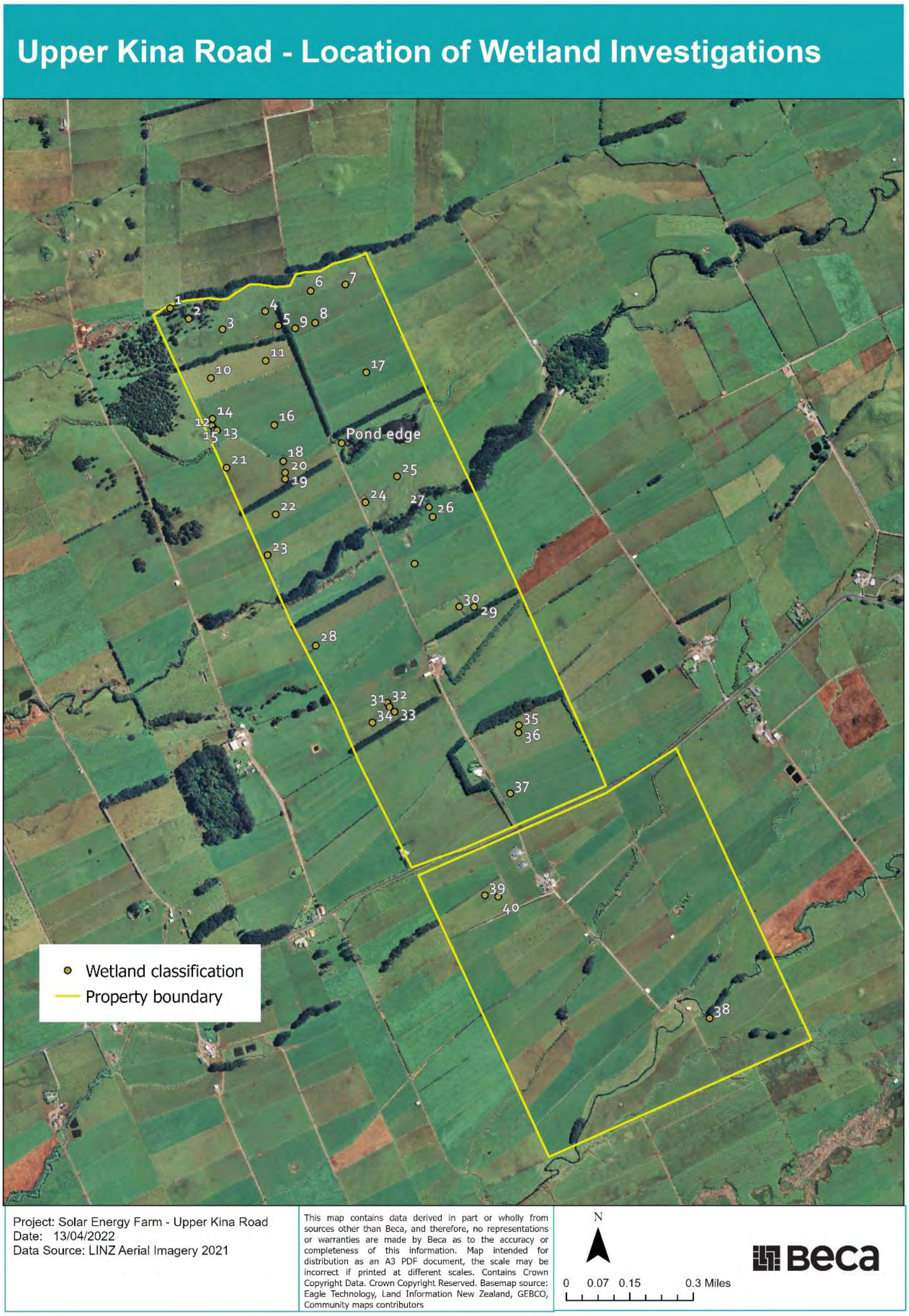

Figure 2.1. Location of wetland delineations within north and south sites.

Table 2.1. Results of wetland investigations and justification for classification.

Plot	Rapid Test	Pasture test	Dominance Test	Prevalence test	Vegetation tests	Soils	Classification	Justification
1	Fail	Fail	Pass	2.6	Pass	Not hydric	Wetland	Passes both prevalence and dominance test and occurs near stream. Is confirmed as Wetland 1.
2	Fail	Fail	Pass	3.4	Uncertain	Not hydric	Non- wetland	Uncertain vegetation test results. Non-hydric soils. Profession judgement applied – marginal vegetation and non-hydric soils
3	Fail	Fail	Pass	3.2	Uncertain	Not hydric	Non-wetland	Uncertain vegetation test results and soils. Professional judge applied – marginal vegetation and non-hydric soils
4	Fail	Pass	Fail	3.5	Fail	-	Non-wetland	Passes pasture test and fails both vegetation tests
5	Fail	Fail	Pass	3	Uncertain	Not hydric	Non-wetland	Dominated by *Persicaria sp.* but no other wetland / landscape that would be determinative of a wetland. As per conversatior the farmers, these zones appear to also occur where there is reason to amalgamate (e.g., near farm gates). This location r both these elements. Professional judgement has been appli classify this as non-wetland.
6	Fail	Fail	Pass	2.7	Uncertain	Not hydric	Non-wetland	Landscape features would not indicate that the WDP should a this area (apart from the soil mapping previously undertaken). Uncertain vegetation test results and soils. Professional judge applied – marginal vegetation and non-hydric soils. No hydrol features observed.
7	Fail	Fail	Fail	3.4	Fail	-	Non-wetland	Fails both vegetation tests.
8	Fail	Pass	Pass	3.3	Fail	Not hydric	Non-wetland	Passes pasture test and passes dominance but fails prevalen Soils are clearly not hydric.
9	Fail	Fail	Pass	3.3	Uncertain	Not hydric	Non-wetland	Uncertain vegetation test results and soils. Professional judge applied – marginal vegetation and non-hydric soils
10	Fail	Fail	Fail	3.9	Fail	-	Non-wetland	Fails both vegetation tests.
11	Fail	Fail	Pass	2.7	Uncertain	Not hydric	Non-wetland	Landscape features would not indicate that the WDP should a this area (apart from the soil mapping previously undertaken). Uncertain vegetation test results. Professional judgement app marginal vegetation and non-hydric soils. No hydrology featur observed

Sensitivity: General

12	Fail	Fail	Pass	2.9	Uncertain	Not hydric	Wetland	Uncertain vegetation results and non-hydric soils observed. Professional judgement applied- very clear area of hydric veg compared to rest of paddock, with clear pathway of *Persicaria maculosa* and *Juncus effusus* moving from north to south. Ma Wetland 2.
13	Fail	Fail	Fail	3.4	Fail	-	Non-wetland	Forms the edge of Wetland 2.
14	Fail	Fail	Pass	3.2	Uncertain	Not hydric	Wetland	Uncertain vegetation results and non-hydric soils observed. Professional judgement applied- very clear area of hydric veg compared to rest of paddock, with clear pathway of *Persicaria maculosa* and *Juncus effusus* moving from north to south. Ma Wetland 2.
15	Fail	Fail	Fail	3.2	Fail	-	Non-wetland	Fails both vegetation tests.
16	Fail	Fail	Fail	3	Fail		Non-wetland	Fails both vegetation tests.
17	Fail	Fail	Pass	2.8	Uncertain	Not hydric	Non-wetland	Landscape features would not indicate that the WDP should a this area (apart from the soil mapping previously undertaken). Uncertain vegetation test results. Professional judgement app marginal vegetation and non-hydric soils
18	Fail	Fail	Fail	3.4	Fail	-	Non-wetland	Fails both vegetation tests.
19	Fail	Fail	Fail	3.1	Fail	-	Non-wetland	Fails both vegetation tests.
20	Fail	Fail	Fail	3.9	Fail	-	Non-wetland	Fails both vegetation tests.
21	Fail	Pass	Fail	3.5	Fail	-	Non-wetland	Fails both vegetation tests and passes pasture test.
22	Fail	Fail	Fail	3.5	Fail	-	Non-wetland	Fails both vegetation tests.
23	Fail	Fail	Pass	2.2	Pass	Not hydric	Non-wetland	Plot passes both vegetation tests – professional judgement is which indicates marginal hydrophytic vegetation. In broader c the landscape and adjoining pasture (including that offsite), th appears to be in a slightly lower point which may have been r improved historically. A very limited extent with a minor lands depression and no hydric soils – professional judgement appli
24	Fail	Fail	Fail	3.3	Fail	-	Non-wetland	Fails both vegetation tests.
25	Fail	Fail	Fail	3.8	Fail	-	Non-wetland	Fails both vegetation tests.

26	Fail	Fail	Pass	2.4	Pass	Not hydric	Non-wetland	Dominated by *Persicaria sp.* but no other wetland / landscape that would be determinative of a wetland. As per conversation the farmers, certain zones appear to also occur where there is or reason to amalgamate (e.g., near farm gates). This locatio not meet either element but the pasture itself does illustrate s patches of this type of vegetation assembly without any other landscape features. Professional judgement has been applie classify this as non-wetland.
27	Fail	Fail	Fail	3.7	Fail	-	Non-wetland	Fails both vegetation tests.
28	Fail	Fail	Fail	3.2	Uncertain	Not hydric	Non-wetland	Uncertain vegetation test results. Professional judgement app marginal vegetation and non-hydric soils
29	Fail	Fail	Fail	3	Uncertain	Very moist soils	Wetland	Uncertain vegetation test results. Landscape position indicate and likely potential for a wetland (upland edge) to be present. Professional judgement applied – marginal vegetation and ve soils and above ground water. Makes up Wetland 5.
30	Fail	Fail	Pass	2.7	Uncertain	Very moist soils	Wetland	Uncertain vegetation test results. Landscape position indicate and likely potential for a wetland (downgradient of plot 29) Pro judgement applied – marginal vegetation and very moist soils above ground water. Makes up Wetland 5.
31	Fail	Fail	Fail	3.6	Fail	-	Wetland edge	Fails both vegetation tests, however, makes up the edge of W
32	Fail	Fail	Pass	2.9	Uncertain	Wet soils	Wetland	Uncertain vegetation test results. Professional judgement app marginal vegetation and very moist soils and above ground w Makes up Wetland 6. Located at the edge of the landscape fe that would delineate the boundary of this wetland.
33	Fail	Fail	Pass	2.5	Pass	Wet soil	Wetland	Passes both vegetation tests and displays wet soils and abov water. Makes up Wetland 6.
34	Fail	Fail	Pass	2.3	Pass	Wet soil	Wetland	Passes both vegetation tests and displays wet soils and abov water. Makes up Wetland 6.
35	Fail	Fail	Pass	2.5	Pass	Not hydric	Non-wetland	Plot passes both vegetation tests – professional judgement is which indicates marginal hydrophytic vegetation. Area is more ephemeral waterway / overland flow path that would be subje temporary rain-derived pooling in the middle of this pastural s

36	Fail	Fail	Pass	2.8	Pass	Not hydric	Non-wetland	Uncertain vegetation tests – professional judgement is applied indicates marginal hydrophytic vegetation. Area is more likely ephemeral waterway. Area is more likely an ephemeral water overland flow path that would be subject to temporary rain-de pooling in the middle of this pastural setting.
37	Fail	Fail	Pass	3.1	Uncertain	Not hydric	Non-wetland	Uncertain vegetation test results. Professional judgement app marginal vegetation and non-hydric soils. No hydrology featur observed
38	Fail	Fail	Fail	2.6	Uncertain	Not hydric	Non-wetland	Large abouts of *P. decipiens* observed in the paddock. Comm with farmer confirms this paddock is used for irrigation purpos hence facilitating the growth of a hydrophytic species.
39	Fail	Fail	Pass	2.8	Uncertain	Not hydric	Non-wetland	Uncertain vegetation test results, dominated by *Persicaria* spe Professional judgement applied – marginal vegetation and no soils. No hydrology features observed. Communication with fa confirms this paddock is used for irrigation purposes, hence fa the growth of a hydrophytic species.
40	Fail	Fail	Fail	3.8	Fail	-	Non-wetland	Fails both vegetation tests.
Pond Edge	Pass	NA	NA	NA	NA	NA	Wetland	Passes rapid vegetation test due to presence of obligate wetla species. Makes up Wetland 3.

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Appendix 3 – Supplementary Avifauna Records

3 Avifauna records

Table 3.1. Bird species recorded within a 5km radius of the site between 2010-2021 (eBird, 2021). Conservation status assigned according to Robertson et al., (2016).

Common name	Māori Name	Scientific Name	Conservation Status
Black shag	Kawau	*Phalacrocorax carbo*	At Risk – Naturally Uncommon
NZ Scaup	Pāpango	*Aythya novaeseelandiae*	Not Threatened
Swamp harrier	Kērangi	*Circus approximans*	Not Threatened
Black swan	Wāna	*Cygnus atratus*	Not Threatened
White-faced heron	Matuku moana	*Egretta novaehollandiae*	Not Threatened
Grey warbler	Riroriro	*Gerygone igata*	Not Threatened
Welcome swallow	Warou	*Hirundo neoxena*	Not Threatened
Black-backed gull	Karoro	*Larus dominicanus*	Not Threatened
Pukeko	Pūkeko	*Porphyrio melanotus*	Not Threatened
Tūī	Tūī	*Prosthemadera novaeseelandiae*	Not Threatened
Fantail	Pīwakawaka	*Rhipidura fuliginosa*	Not Threatened
Starling	Tāringi	*Sturnus vulgaris*	Not Threatened
Paradise shelduck	Pūtangitangi	*Tadorna variegata*	Not Threatened
Sacred Kingfisher	Kōtare	*Todiramphus sanctus*	Not Threatened
Spur-winged plover	NA	*Vanellus miles*	Not Threatened
Silvereye	Pihipihi	*Zosterops lateralis*	Not Threatened
Myna	Maina	*Acridotheres tristis*	Introduced and Naturalised
Skylark	Kaireka	*Alauda arvensis*	Introduced and Naturalised
Mallard	Rakiraki	*Anas platyrhynchos*	Introduced and Naturalised
Goldfinch	NA	*Carduelis*	Introduced and Naturalised
European greenfinch	NA	*Chloris*	Introduced and Naturalised
Yellowhammer	Mōhua	*Emberiza citrinella*	Introduced and Naturalised
Chaffinch	Pahirini	*Fringilla coelebs*	Introduced and Naturalised
Australian magpie	Makipai	*Gymnorhina tibicen*	Introduced and Naturalised
House sparrow	Tiu	*Passer domesticus*	Introduced and Naturalised
Eastern rosella	NA	*Platycercus eximius*	Introduced and Naturalised
Blackbird	Manu pango	*Turdus merula*	Introduced and Naturalised
Song thrush	NA	*Turdus philomelos*	Introduced and Naturalised

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Appendix 4 – Supplementary eDNA results from Wilderlab

Table 4.1. eDNA results from Wilderlab Ltd for Oaoiti Stream.

Scientific Name	Rank	Common Name	Group	Ōpunake eDNA 1
Chaetogaster diaphanus	species	Oligochaete worm	Worms	3772
Anas platyrhynchos	species	Mallard duck	Birds	2041
Anguilla dieffenbachii	species	Longfin eel	Fish	1797
Bos taurus	species	Cattle	Mammals	1159
Turdus philomelos	species	Song thrush	Birds	756
Salmo trutta	species	Brown trout	Fish	684
Craspedacusta sowerbii	species	Freshwater jellyfish	Cnidarians	575
Turdus merula	species	Blackbird	Birds	409
Zosterops lateralis	species	Silvereye	Birds	339
Chaetogaster diastrophus	species	Oligochaete worm	Worms	339
Oxyethira albiceps	species	Micro caddisfly	Insects	190
Homo sapiens	species	Human	Mammals	186
Trichosurus vulpecula	species	Common brushtail possum	Mammals	182
Coloburiscus humeralis	species	NZ spinygilled mayfly	Insects	178
Anguilla australis	species	Shortfin eel	Fish	167
Aoteapsyche colonica	species	Endemic NZ caddisfly	Insects	90
Austrosimulium australense	species	Sandfly	Insects	89
Ectopsocus briggsi	species	Psocopteran fly	Insects	84
Todiramphus sanctus vagans	subspecies	Sacred kingfisher	Birds	78
Erinaceus europaeus	species	European hedgehog	Mammals	76
Hydra vulgaris	species	Hydra	Cnidarians	66
Nesameletus ornatus	species	Small swimming mayfly	Insects	64
Orthonychiurus folsomi	species	Springtail	Springtails	62
Fringilla coelebs	species	Common chaffinch	Birds	57
Eiseniella tetraedra	species	Squaretail worm	Worms	52
Rattus rattus	species	Black Rat	Mammals	49
Galaxias brevipinnis	species	Koaro	Fish	49
Gobiomorphus huttoni	species	Redfin bully	Fish	49
Lumbriculus variegatus	species	Blackworm; California blackworm	Worms	45
Aporrectodea longa	species		Worms	43
Prostoma eilhardi	species	Freshwater ribbon worm	Other	38
Carduelis carduelis	species	Goldfinch	Birds	36
Limnodrilus hoffmeisteri	species	Redworm	Worms	36
Paranephrops planifrons	species	Freshwater crayfish	Crustaceans	36
Henicops maculatus	species		Centipedes	35
Gymnorhina tibicen	species	Magpie	Birds	34
Megascolex laingii	species		Worms	34
Archichauliodes diversus	species	Endemic NZ dobsonfly	Insects	31
Hypogastrura assimilis	species		Springtails	30
Chaetogaster cf. diastrophus MK-2019	species	Oligochaete worm	Worms	29
Tubifex tubifex	species	Sludge worm	Worms	28
Hydrobiosis copis	species	NZ caddisfly	Insects	27
Ceratophysella gibbosa	species		Springtails	26
Acyrthosiphon pisum	species	Pea aphid	Insects	21
Bimastos rubidus	species		Worms	21
Trichopsocus sp. KY322	species		Insects	20

Rhopalosiphum padi	species	Bird cherry-oat aphid	Insects	18
Cyclotella cryptica	species	Brackish-water diatom	Diatoms	16
Porcellio scaber	species	Woodlouse; Slater	Crustaceans	15
Dysaphis aucupariae	species		Insects	15
Lumbricus rubellus	species	Red earthworm	Worms	14
Octolasion cyaneum	species		Worms	14
Inopus rubriceps	species	Sugarcane soldier fly; Australian soldier fly	Insects	14
Psychodidae sp. BOLD:AAU4648	species		Insects	11
Deroceras reticulatum	species	Grey field slug; Grey garden slug	Molluscs	10
Rattus norvegicus	species	Norway Rat	Mammals	8
Octolasion lacteum	species		Worms	8
Nitzschia acidoclinata	species	Diatom	Diatoms	7
Paracyclops fimbriatus	species	Copepod	Crustaceans	7
Bryophaenocladius sp. 8ES	species	Non-biting midge	Insects	7
Rotaria rotatoria	species	Rotifer	Rotifers	6
Tanytarsus sp. EJD-2015	species	Non-biting midge	Insects	6
Trioxys sunnysidensis	species	Parasitoid wasp	Insects	6
Ceratophysella aff. denticulata L3	species	Mushroom springtail	Springtails	6
Bothrioneurum vejdovskyanum	species		Worms	5
Costachorema xanthopterum	species		Insects	5
Potamothrix bavaricus	species	Aquatic oligochaete worm	Worms	5
Capitophorus elaeagni	species	Artichoke aphid	Insects	4
Corynoneura scutellata	species	Non-biting midge	Insects	4
Eriophora pustulosa	species	Garden orb weaver spider	Spiders	4
Nais	genus	Sludgeworm	Worms	5035
Anguilla	genus	Eels	Fish	2113
Potamopyrgus	genus	Mud snails	Molluscs	244
Pristina	genus		Worms	241
Turdus	genus	Thrush	Birds	194
Galaxias	genus	Galaxiids	Fish	135
Aporrectodea	genus		Worms	110
Deleatidium	genus	NZ mayfly	Insects	101
Triplectides	genus	NZ caddisfly	Insects	94
Ctenopseustis	genus	Brownheaded leafroller moth	Insects	56
Pycnocentrodes	genus	Stony cased caddisfly	Insects	56
Planotortrix	genus	Blacklegged leafroller moth	Insects	40
Hydropsyche	genus	Netspinning caddisfly	Insects	29
Chaetogaster	genus	Oligochaete worm	Worms	16
Acyrthosiphon	genus		Insects	12
Nothocladus	genus	Freshwater red alga	Red algae	10
Plumatella	genus	Plumatella	Bryozoans	9
Protaphorura	genus		Springtails	8
Limnophyes	genus	Non-biting midge	Insects	8
Ectopsocus	genus	Psocopteran fly	Insects	7
Cochliopodium	genus	Amoeba	Amoebae	7
Brachycaudus	genus		Insects	6
Amischa	genus		Insects	5

Chamaedrilus	genus		Worms	5
Octolasion	genus		Worms	4
Naidinae	subfamily	Sludgeworms	Worms	1144
Tateidae	family	Aquatic snails	Molluscs	55
Anatidae	family	Ducks/Geese/Swan	Birds	44
Tubificinae	subfamily		Worms	40
Hydropsychinae	subfamily		Insects	34
Aphidinae	subfamily		Insects	16
Leptophlebiidae	family	Pronggill mayflies	Insects	12
Tetrastemmatidae	family		Other	6
Zelandoperlinae	subfamily		Insects	5
Lumbricidae	family		Worms	4
Metazoa	kingdom	Metazoans	Other	3264
root	no rank		Other	2883
Insecta	class	Insects	Other	1650
Arthropoda	phylum	Arthropods	Other	1304
Diptera	order	Flies	Insects	495
Bilateria	clade		Other	53
Clitellata	class		Worms	38
Aves	class	Birds	Other	33
Gastropoda	class	Gastropods	Molluscs	24
Chordata	phylum	Chordates	Other	19
Lepidoptera	order	Butterflies and moths	Insects	15
Endopterygota	cohort		Insects	15
Pancrustacea	clade		Other	11
unclassified Hemisotoma	no rank		Springtails	8
Eurotatoria	class		Rotifers	6

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Appendix 5 – Supplementary Macroinvertebrate Community Index Results

Table 5.1. Macroinvertebrate community indices for Manganui Stream and Oaoiti Stream on the south site. Macroinvertebrate samples were processed by EIA Ltd.

Taxa	MCI Score	MCI -sb score	Manganui Stream Count	Oaoiti Stream Count
Mayfly Atalophlebioides	9	4.4		2
Mayfly Austroclima	9	6.5	5	1
Mayfly Coloburiscus	9	8.1		1
Mayfly Deleatidium	8	5.6		62
Mayfly Nesameletus	9	8.6		6
Mayfly	7	8.8		1
Caddisfly Aoteapsyche	4	6	3	
Caddisfly Hydrobiosis	5	6.7		9
Caddisfly Oxyethira	2	1.2		8
Caddisfly Pycnocentria	7	6.8	7	
Caddisfly Pycnocentrodes	5	3.8	16	4
Caddisfly Triplectides	5	5.7		1
Dobsonfly Archichauliodes	7	7.3	3	1
Beetle Elmidae	6	7.2	52	11
True Fly Aphrophila	5	5.6		4
True Fly Austrosimulium	3	3.9	7	1
True Fly Chironomus	1	3.4		1
True Fly Muscidae	3	1.6		4
True Fly Orthocladiinae	2	3.2		12
Crustacea Ostracoda	3	1.9	1	
Crustacea Paracalliope	5	0.0	13	1
Mollusc Potamopyrgus	4	2.1	86	15
Oligochaete	1	3.8	9	1
Number of Taxa			11	20
EPT Value			4	8
Number of individuals			202	146
% EPT			15.35	59.59
% EPT Taxa			36.36	45.0
Sum of recorded scores			54	105
QMCI – sb Value			3.96	4.92
QMCI Value			**4.76**	**6.01**
MCI Value			**98.18**	**105**