Ecological Impact Assessment - Proposed Solar Farm at Wellington Road

Report

Prepared for Energy Farms Ltd
Prepared by Beca Limited

18 May 2022

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Appendix A – Ecological Impact Assessment Guidelines

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Revision History

Revision Nº	Prepared By	Description	Date
1	Jessica Schofield	Draft for Internal Review	22/04/22
2	Jessica Schofield	Draft for Client Comment	28/04/22
3	Jessica Schofield	Draft for approval	18/05/22

Document Acceptance

Action	Name	Signed	Date
Prepared by	Jessica Schofield		18/05/22
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on behalf of	Beca Limited		

Executive Summary

Energy Farms Limited (EFL) is proposing to develop 193 Hectares of land on 1618 Wellington Road in Rangitikei, Manawatū-Whanganui Region for solar farm generation. Beca Limited (Beca) have been commissioned by EFL to prepare an Ecological Impact Assessment (EcIA) to support the resource consent application for the proposed works which include works within, and earthworks within 10 m of, intermittent streams, as well as vegetation clearance.

The property is currently used for dairy farming with paddocks comprised of typical pasture species, and a 0.91 hectare vegetation patch consisting of mature exotic trees at the southern end of the property. The initial site walkover in January 2022 identified a potential wetland in the northern end of the property, adjacent to a watercourse. This area was assessed as having a low likelihood of meeting the definition of a 'natural wetland' under the National Environmental Standards for Freshwater NES-F (2020). During the site investigation in April 2022 this was confirmed to be a non-wetland area under the NES-F (2020).

The property also contains three ephemeral and three intermittent watercourses. Ecological features within the property may provide habitat for native fauna including common native bird species, native skinks, and native bats. Native fish species may also be present at certain times of the year in available aquatic habitat.

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.

Remaining potential construction phase and operational adverse effects as a result of the proposal include:

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

Proposed measures to address these effects include:

- Timing of construction to avoid bird nesting season (Sept – Feb) or pre-clearance nest surveys;
- Completion of a lizard risk assessment prior to the commencement of work and the development and implementation of a lizard management plan if native lizards are present.
- Completion of a bat survey prior to the commencement of work and the development and implementation of a bat management plan if native bats are present;
- Terrestrial and/or riparian planting to increase indigenous dominance of vegetation;
- Implementation of robust erosion and sediment control measures to avoid sediment runoff into the wetland and watercourses;
- Implementation of good practice watercourse and stormwater management.

The overall ecological effect of the proposal is considered to be **Very Low-Low** assuming the recommended mitigation measures are implemented.

1 Introduction

Energy Farms Limited (Energy Farms, EFL) is considering the development of 193 hectares on 1618 Wellington Road, Rangitikei District, Manawatū-Whanganui Region for solar farm generation. The proposed works include installing solar panels and associated infrastructure (i.e roads to facilitate internal access, inverter stations) 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 include works within, and earthworks within 10 m of intermittent streams, and vegetation clearance.

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 19h of January 2022 and the 6th of April 2022.
- A desk-based review of:
  - Information held by Horizons Regional Council and Rangitikei District Council plans and documents with regard to the ecological values of the site; and
  - New Zealand Freshwater Fish Database, Department of Conservation (DOC), New Zealand Herpetological Society Records, 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, 2022a) was prepared for this site to identify areas of high ecological value and 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 15 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 Marton substation, located at 362 Pukepapa Road (some 3.6km from the site). There are a number of options available for the interconnection, with existing 110 kV lines traversing the subject site. 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 formed (where they do not already exist) to facilitate access to the various areas of panels. A 5 m 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. Few existing culverts or fords across intermittent and permanent watercourses are already present on the site. However, there are 18 new

watercourse crossings proposed to be constructed, as indicated in Drawing Number GIS-2867656-06; Beca, 2022c.These are located within both intermittent and ephemeral watercourses. The effects of the installation of these culvert and ford watercourse crossings have been assessed as part of the scope of this report. The effects of the installation of these culverts has 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. A preliminary assessment of earthworks required for this portion of works has shown that the area of disturbed ground could be 10,000m2 with a total volume of 6,400m3 (Beca, 2022b). It is proposed that any overcut will be used to fill two artificial ponds (Ponds 5 and 6, see below for further discussion).

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 earthworks are estimated at approximately 47,300 m^2 (Beca, 2022b).

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 237,000 (+/- 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 within the Rangitikei Ecological District (ED). Rangitikei ED consists of mid altitude (mostly 300 – 600 m asl), hills and valleys with rivers draining to the southwest, and encompasses coastal (Northerly and North-westerly) winds (McEwen, 1987). Since 1896 nearly all the potential farmable land in the Rangitikei catchment has under-gone a significant change in terms of its flora and fauna (Gordon, 2009). Originally, Rangitikei was extensively forested with podocarp and podocarp-hardwood forests, however, only remnants of that cover remain today. Presently, remnants comprise of dense podocarp and podocarp/hardwood forests with Tawa and Kamahi present in some of these vegetation patches, Kōwhai-Houhere forests in drier areas, and significant area of silver beech in the Northwest. Most of the district has been modified to varying degrees of to accommodate farming (McEwen, 1987).

The site itself is located on 1618 Wellington Road in the Rangitikei District (Figure 1). Historically, the site would have been covered with podocarp forest. Retrolens imagery establishes that the site was converted to a farmland well before 1942, with the exception of one patch of exotic pine and eucalyptus vegetation. The landform is predominantly flat with moderately incised watercourses. The watercourses are the predominant depressions in the farmland. The current use is cattle farming, and the main landcover is pasture grasses. Surrounding land-use is primarily agricultural.

Figure 1. Site location within the surrounding landscape.

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), eBird Database, Department of Conservation (DOC) Bat Bioweb Database; and New Zealand Herpetological Society Records;
- Horizon Regional Council geospatial layers;
- Freshwater Ecosystems of New Zealand geospatial layers (Leathwick et al., 2010);
- Google Earth and LINZ aerial imagery;
- Other publicly accessible reports or information.

3.2 Site visit

Site visits undertaken on the 19h of January 2022 and the 6th of April 2022. During the first site visit, high level freshwater and terrestrial habitat assessments were conducted, and the likelihood of natural wetlands being present was assessed at a high level. During the second site visit, more detailed investigations were undertaken, with a focus on areas likely to be affected by works. These investigations are described in more detail below.

Weather during the first site visit was fine and there had been 2.3 mm of rain in the two weeks preceding (Palmerston North; FAR, 2022). Weather during the second site visit was cloudy with periods of rain (totalling around 34.6mm over the three days) and there had been 45.5 mm of rain in the two weeks preceding (Palmerston North; FAR, 2022).

Locations investigated during the two site walkovers and detailed investigations completed during the second site visit are shown in Figure 2.

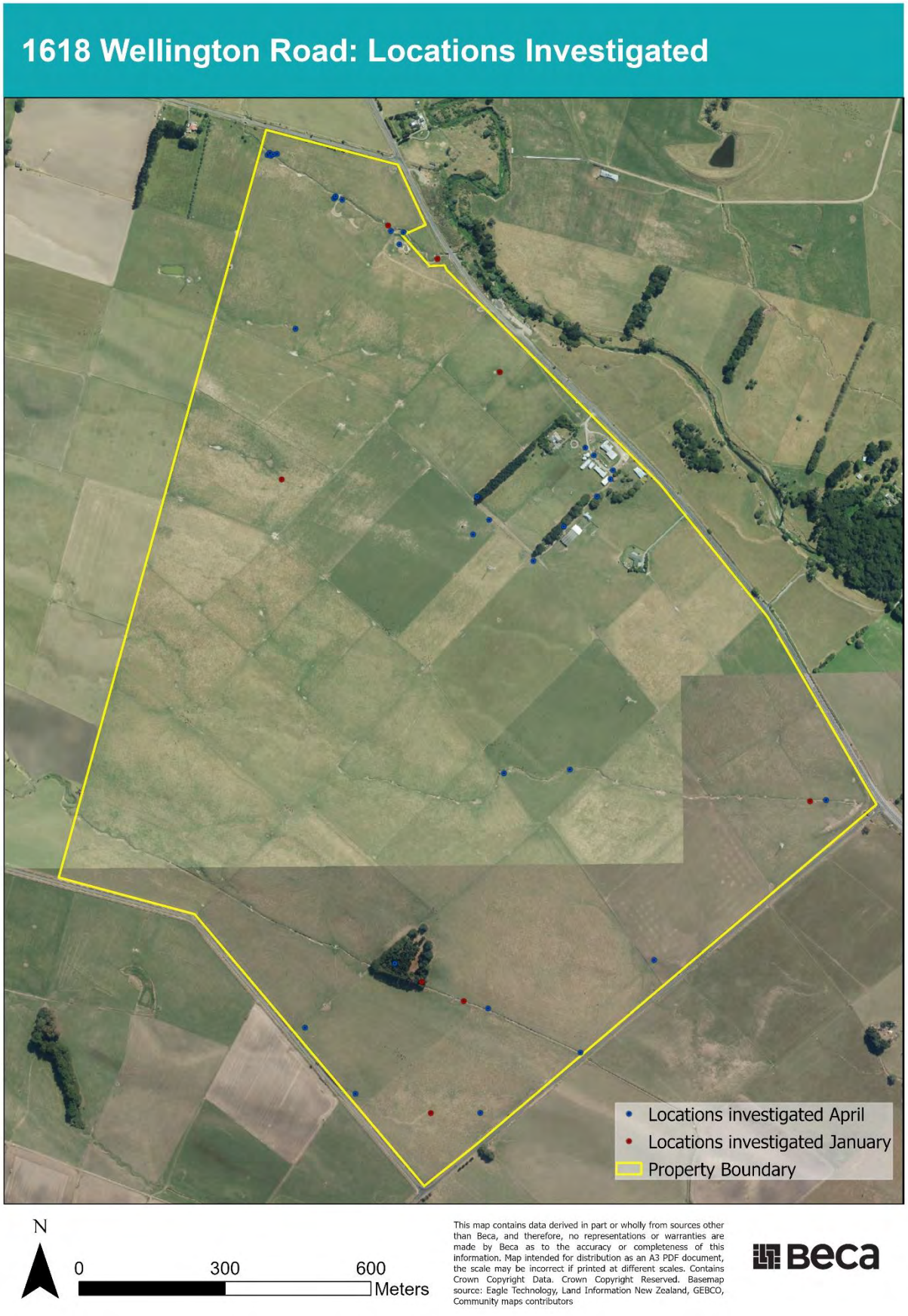

Figure 2: Locations visited during the site visit.

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 2.9.0 desktop geospatial software. GIS data and ecological information were used from the following sources:

- Google Earth and LINZ aerial photography
- Auckland Council geospatial layers
- Retrolens historical imagery
- Manaaki Whenua soil information from S-map (Manaaki Whenua, 2021)
- Freshwater Ecosystems of New Zealand (FENZ) historic wetland typology geospatial layer (Leathwick et al., 2010).

The topography and underlying geology of the site was first examined using contours, modelled overland flow paths and S-Map to understand where ‘wet’ areas might be located. Relevant literature on New Zealand wetlands was referred to, to help understand wetland types that might be associated with the palustrine hydro system within the site (Johnson & Gerbeaux, 2004; Johnson & Rogers, 2003). The site was then 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, recent aerial imagery from Google Earth (2018-2021) and LINZ (2021) were visually inspected for wetland features. The photography 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 also 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 Figure 3) the 19th of January in summer. No high or moderate risk areas (as described below in Table 1) were identified through preliminary design.

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. The potential wetland area with risk classification based on observations during the initial site assessment in January 2022.

3.4 Wetland classification and delineation

During the second site visit, an assessment of the potential wetland area noted during the first January site visit was undertaken. Detailed investigations were undertaken where wetland vegetation covered an area greater than 2m x 2m. The detailed investigations were conducted in general 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 for overview).

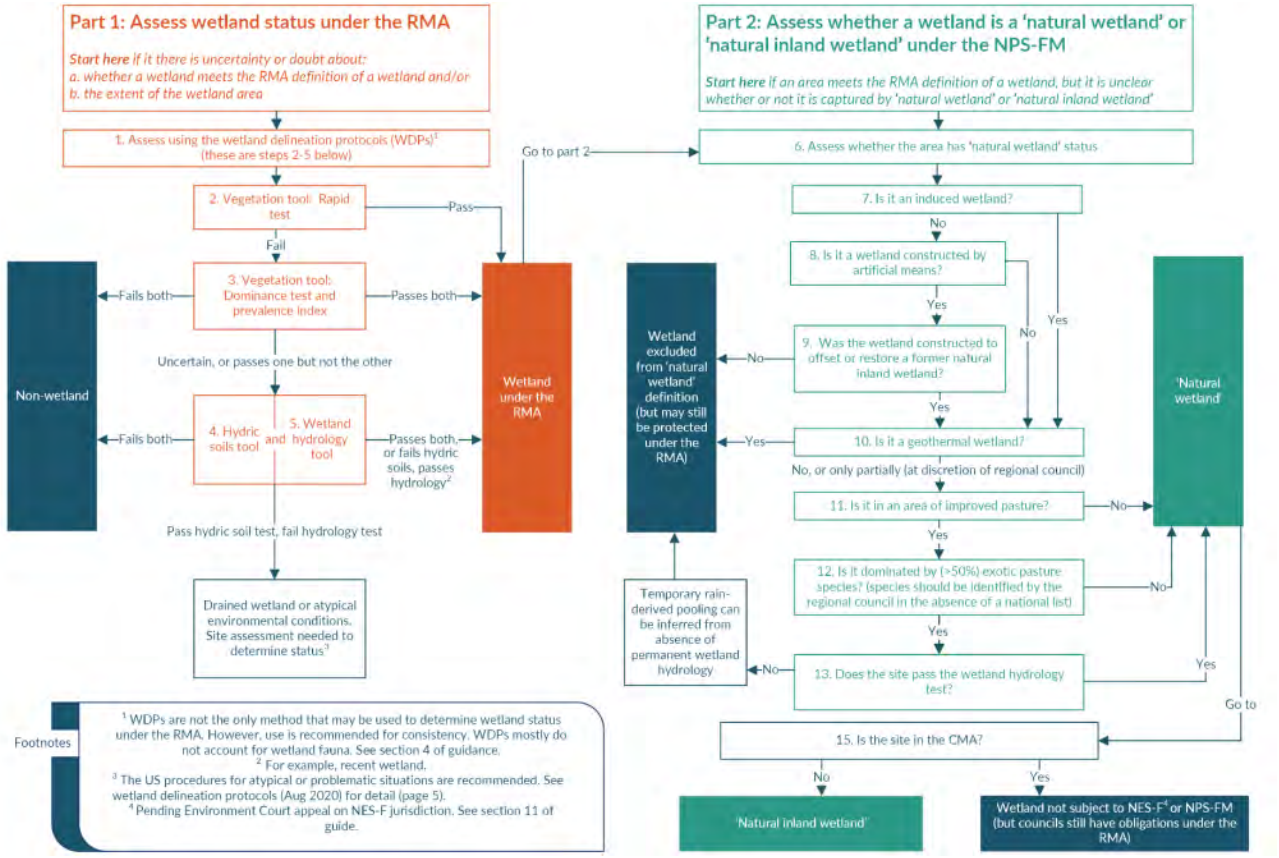

Figure 4. Assessing 'natural wetland' and 'natural inland wetland' status under the NPS-FM (Ministry for the Environment, 2021).

3.5 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 two site visits to capture the species composition and ecological value of terrestrial 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 methodology was developed in mind for application in the Auckland Region, the methodology provides a good high-level methodology for collecting environmental data for stream attributes and can be applied across New Zealand. Data collected included: channel condition and morphology, bank and channel modification, stream bank erosion, standing water characteristics, channel shade and riparian vegetation.

3.6 Watercourse classification

A preliminary, high level watercourse classification was completed based on the below Horizons 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)".*

And states the following definitions of ephemeral, intermittent, and permanent watercourses:

Ephemeral watercourse - *"is an area of land with no defined waterbed which is above the water table at all times. It only flows during, and shortly after, rain events. Ephemeral waterways are not covered by the regulations".*

Permanent watercourse – *"is the continually flowing reaches of any river or stream".*

Intermittent watercourse – *"stream reaches that cease to flow for some periods of the year because the bed can be above the water table at times".*

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 April) and professional judgement applied.

3.7 Assessment of ecological effects

A desktop assessment of ecological effects was undertaken in accordance with Ecological Impact Assessment (EcIA) EIANZ guidelines for use in New Zealand: terrestrial and freshwater ecosystems (Roper-Lindsay et al., 2018).

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 assigning 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/project 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 assessed (Table 1.6).

4 Wetland Classification and Delineation

4.1 Extent of potential wetland

Little wetland vegetation is distinguishable in aerial imagery from 1942 and the site during this period in Figure 5 shows similar agricultural landcover to the present day (Retrolens; refer Appendix B). The site is predominantly pastureland, however, the initial site walkover in January 2022 identified an area in the northern end of the property, adjacent to Watercourse 6 that was assessed as having a 'low' likelihood of meeting the definition of a 'natural wetland' under the National Environmental Standards for Freshwater NES-F (2020) on the basis of scattered hydric vegetation (predominantly *Persicaria hydropiper*) at the time of the initial site visit. During the second site visit in April 2022, a wetland classification was completed at the location which appeared most representative of wetland hydric vegetation and confirmed this to be a **non-wetland** area under the NES-F (2020). Further details regarding this classification are given below.

Figure 5: Historic aerial image from 1942 with site boundary (refer Appendix B for further detail).

Figure 6. Photos taken of the potential wetland area during the initial site visit on the 19th January, 2022.

Figure 7: Photo of the potential wetland area (left of image) on 6th April 2022.

4.1.1 Soils

The site consists of several soils of the Pouakai Group. Underlying most of the site is Marton alluvial terrace deposits (Q6a) of weathered, poorly to moderately sorted gravel with minor sand and silt (Townsend et al., 2008; Figure 9). There is a small area of Ohakea alluvial terrace deposits (Q2a) of poorly to moderately sorted gravel with minor sand and silt at the northern most edge of the site, and beach deposits (Q5b) of shallow marine conglomerate, shell beds, dune sand, and peat at the south eastern most margin of the site.The nearest soil investigation – 3.3 km north of the site undertaken by Beca in 1979 comprised of 6 boreholes to depths between 3 and 10 m below ground level within the alluvial terrace deposits (Townsend et al., 2008). These investigations indicated the soil profile is comprised of stiff clay and silts with a layer of dense gravel material at depth of about 4 m bgl. This is consistent with the soils observed at the bank of watercourse 6 on site, with an organic topsoil layer below which a layer of alluvial rock deposits of gravel and cobbles (50-200mm), with some boulders (>200mm) (Figure 8). This soil at the potential wetland location is classified as Ohakea alluvial terrace deposits of gravel. Photographs taken along and adjacent to watercourse channels indicate the near surface soils contain

Soil was investigated within the one 2x2 m plot of putative wetland area to a depth of 15 cm to refusal (see Figure 8). Cobbles hampered efforts to dig deeper into the soil, however the eroded bank profile also provides an indication of soil profile (Figure 8). There was no evidence of soil moisture.

Soils were not considered typically hydric.

Figure 8: Soils in the 2x2 m plot within the potential wetland area (left) and evidence of soils with gravel and boulder substrates (right).

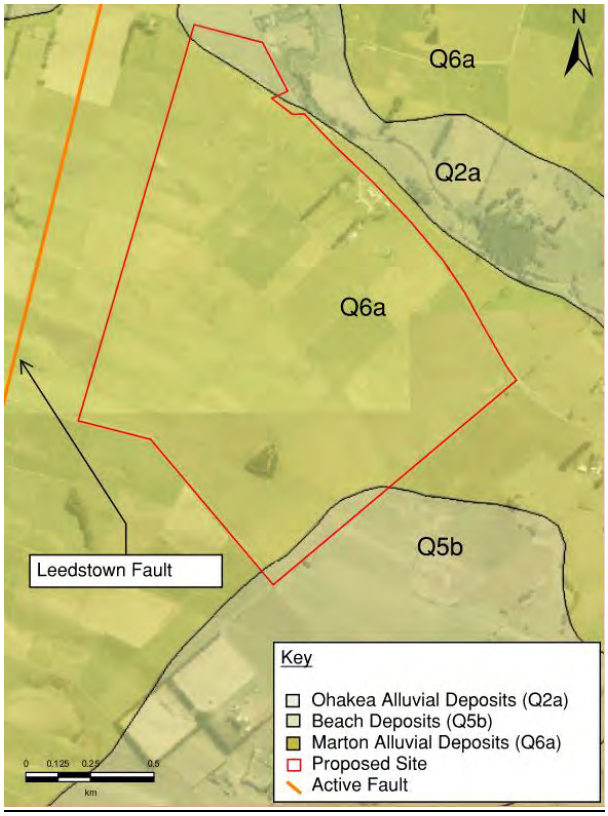

Figure 9: Soil geology underlying the site (Townsend et al., 2008).

4.1.2 Vegetation

During the initial site visit, only one facultative wetland (FACW) species, *Persicaria hydropiper*, was present within the area. During the second site visit, a 2x2 m plot was completed in the location which appeared most representative of wetland hydric vegetation and identified the species present in Table 2. No wetland species of Obligate indicator status were identified and *Persicaria hydropiper* was again the only species of facultative wetland indicator status identified.

Table 2: Vegetation plot results collected 6th April 2022.

Species	Cover (%)	Dominant Species?	Indicator Status	Pasture Species?
Persicaria hydropiper	25	Yes	FACW	No
Rumex obtusifolius	2	No	FAC	No
Trifolium repens	5	No	FACU	Yes
Lolium perenne	60	Yes	FACU	Yes
Plantago major	2	No	FACU	No

Figure 10: Vegetation at the potential wetland area.

4.1.3 Hydrology

The property has a broad drainage pattern of flows from west where there is slightly higher topography to east, as tributaries of the Tutaenui Stream in the direction of the Rangitikei River.

The initial site visit was completed in the middle of summer during an extended period of low rainfall; the soil was dry with no ponding or surface water was observed across the site. The second site visit was at the end of summer, after a period of 45.5 mm rain in the two weeks prior and at the time despite evidence of pugging by the stock during wetter periods, there was no ponded or evident surface water in the potential wetland area (Figure 11). The following primary and secondary hydrology indicators (Ministry for the Environment, 2021) were present during both site visits:

Primary

- 2F: Surface soil cracks evident within the watercourse and adjacent to the channel banks. This is likely a result of the locality of this area within a riverine hydrosystem, where a cycle of fine sediment deposition is likely to occur as this area is within the watercourse floodplain and may be subject to pooling after periods of heavy rainfall.

Secondary

- 2L: drainage patterns evident as “Watercourse 6” is an intermittent stream;
- 4B: presence of localised geomorphology that indicates water accumulation potential (small depression).

This putative wetland area displays the above hydrological indicators, and is considered to have hydrology that is capable of supporting a wetland as the result of its position within the margins of a riverine hydrosystem.

Figure 11: Broader putative wetland area at the true left bank of Watercourse 6.

4.1.4 Summary of 'natural wetland' delineation (confirmed not a wetland)

There are no areas within the property that meet the NPS-FM 2020 definition of a 'natural wetland'. The putative wetland area investigated has been classified as a non-wetland based on the failure of the rapid and prevalence tests and the lack of hydric soils. Hydrological indicators are present, however are associated primarily with the functioning riverine hydrosystem of the intermittent stream; Watercourse 6. The results of the wetland delineation in the 'low risk' classified wetland area from the January 2022 site visit is detailed in Table 3 below.

Given the confirmed status as not a 'natural wetland' no broader consideration has been given to this location on the site (although values have been determined associated with the intermittent stream).

Table 3: Wetland Delineation results summary.

Plot	Pasture Test	Rapid Test	Dominance Test	Prevalence Index	Vegetation tests	Soils	Classification	Justification
1	Yes	No	Yes	3.4	Fail	Non-hydric	Non-wetland	Fails rapid test, prevalence index value high, non-hydric soils, however hydrological indicators are present.

5 Ecological Features and Values

5.1 Overview

The property has a predominantly flat topography. While site-specific detailed contours are not available, NZ Topo50 indicates that the site falls gradually from east to west by about 10m in elevation from one side to the other of the property. It is presently grazed by cattle. A patch of exotic vegetation consisting of pine (*Pinus* sp.), *Eucalyptus* sp., and cypress (*Cupressus* sp.) trees is present adjacent to the southern property boundary. Six watercourses traverse the property. Watercourses 1, 4, and 5 are ephemeral, whilst watercourses 2, 3, and 6 are intermittent (Figure 12). A number of site photographs and records have been collected during the ecological surveys undertaken in January and April – 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 12: Overview of ecological features mapped within the site following the 6th April site visit.

5.2 Watercourses

The three intermittent and three ephemeral watercourses that run through the property are shown in Figure 13. Intermittent watercourses comprise a length of 3.4 km and ephemeral 2.4 km. At the time of both site visits, most ephemeral watercourse channels were dry and had no water flow, with common pasture species rye grass (*Lolium perenne),* clover *(Triofolium repens),* and buttercup (*Ranunculus repens)* interspersed across the channel. At all six watercourses, thistle (*Cirsium spp.)* is scattered along the channel banks. At watercourse 6, the channel banks and beds are dominated by *Persicaria hydropiper* and rye grass (Figure 19). The channel for all watercourses on site, except Watercourse 4, are well defined and in some places incised; although the channel forming processes for the ephemeral watercourses (watercourses 1, 4, and 5) in particular were unclear at the time of both site visits.

All watercourses are subject to extensive disturbance due to stock access. No watercourse on the site had notable riparian margins or shading. The watercourses or general areas of longitudinal depression have had some degree of anthropogenic modification, although the majority of the channels appear to follow landform and contour, and are apparent on historic aerial imagery, including at Watercourse 6, which appears to be a tributary to a nearby larger river system (refer historic aerials Appendix B). Watercourse 6 has also had some modification and appears to have been used as a stock access track and underpass under the local road. A small section of the bed includes cobbled substrate underlying the topsoil and grass cover. There is an area of ponded water at Watercourse 6 (Figure 20). Works in watercourses for new culvert and ford construction are anticipated at both the intermittent and ephemeral streams.

The watercourses are assessed as having **Negligible** current ecological value based on a low rating for representativeness, and very low ratings for rarity/distinctiveness, diversity and pattern, and ecological context (Table 4). The habitat value of these streams are highly affected by seasonality, and the surrounding farming land use. Additionally, the NPS-FM 2020 requires that both the current ecological value and the potential ecological value of freshwater systems are considered. When considering potential, it is assumed that the riparian margins of watercourses would be revegetated with indigenous species, culverts would allow for fish passage, and watercourses would be fenced to exclude stock. These actions would increase shading, increase woody debris inputs to the watercourses and associated habitat heterogeneity over time, and improve erosion and scour protection. However, as grazing of the land will continue, some land use pressures would remain. These actions are expected to increase the representativeness, and ecological context ratings of the watercourses to Moderate and thus, the potential ecological value of the watercourses is **Moderate**.

Table 4. Scoring and justification for current assigned ecological value to intermittent and ephemeral Watercourses.

Matter	Rating	Justification
Representativeness	Low	Natural channel habitat – some incised, some minimal depth. Water quality expected to be poor – flowing through farm paddocks. No associated riparian vegetation at most watercourses. Extreme seasonality – water present only in certain seasons do not provide consistent habitat.
Rarity/Distinctiveness	Very Low	Unlikely to provide suitable habitat for Threatened or At Risk species, nor valuable habitat for common native species as water is only present seasonally.
Diversity and Pattern	Very Low	Very low diversity and pattern.
Ecological context	Very Low	Very low-quality freshwater habitat. Very limited connectivity for freshwater fish, highly seasonally affected. Ongoing land use pressures, stock access and trampling.
		Overall value: Negligible

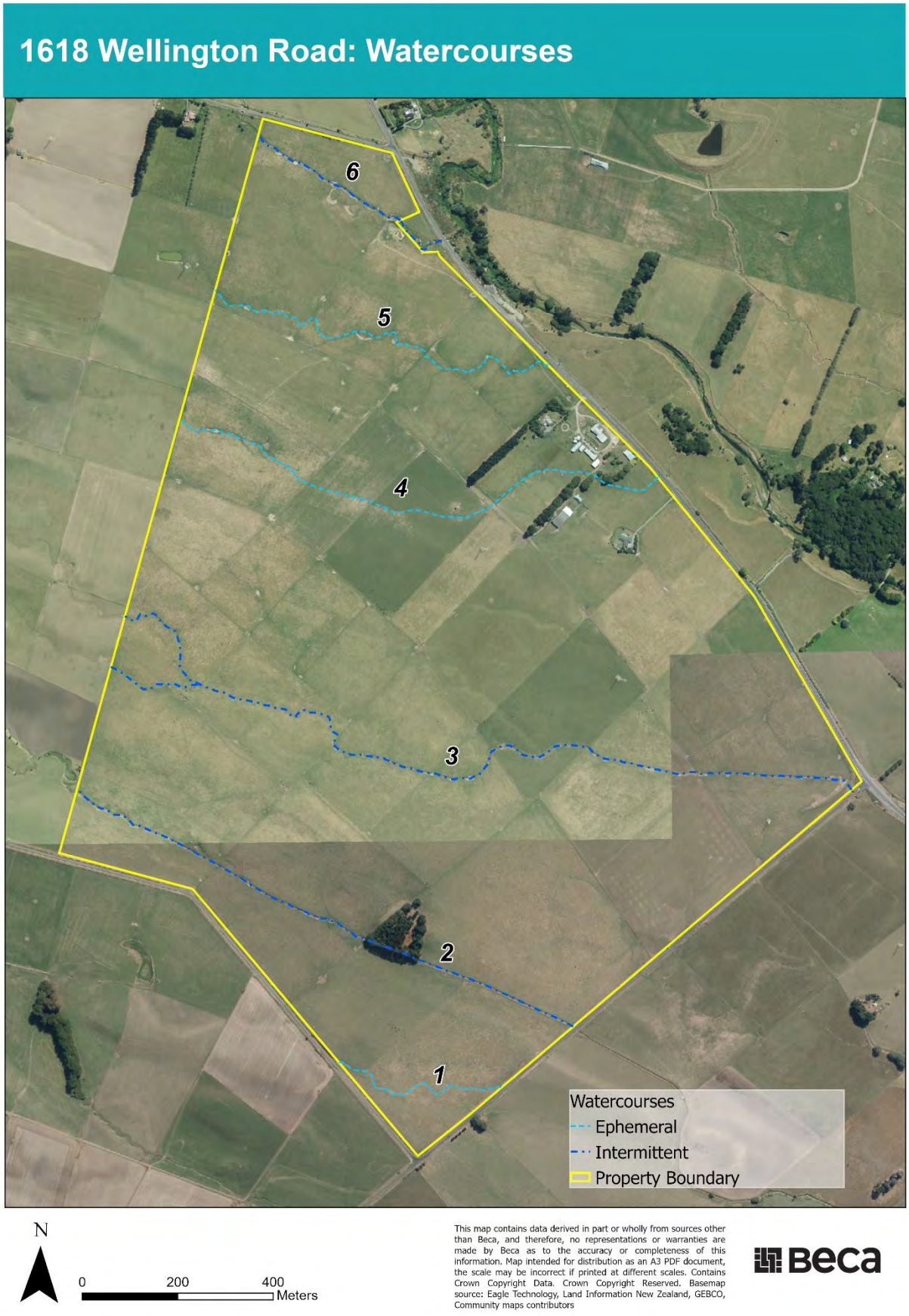

Figure 13: Watercourses within the property.

Figure 14:Watercourse 1 present on site is ephemeral with pugging evident during both January and April 2022 site visits.

Figure 15: Watercourse 2 present on site appears straightened as it runs along a main fence line. Outside of the property, meanders are observed upstream indicating the natural functionality of this watercourse.

Figure 16: Watercourse 3 present on site displays meanders through the property and is present on aerial imagery upstream.

Figure 17: Watercourse 4 present on site is ephemeral with limited topography supporting a clear overland flow path.

Figure 18:Watercourse 5 present on site is ephemeral.

Figure 19: Watercourse 6 present on site is intermittent. It contains a large, perched concrete culvert approximately 3 m long with an additional 8 m of concrete lined channel in the watercourse bed. The watercourse is approximately 2 m wide at this point. There are a range of gravel and rock substrates in this watercourse outside of this area, with unstable banks subject to mass wasting.

Figure 20: Area of ponded water connected to Watercourse 6.

5.3 Terrestrial Vegetation

Areas of vegetation are mapped below (Figure 21); they comprise exotic species. The large exotic vegetation patch to the south of the site is 0.85 hectares and consists of a canopy of mature eucalyptus, pine, and cypress trees. The canopy is moderately patchy, with no understory. The second area situated around the farm buildings is 0.52 ha and consists of large exotic pine trees and poplars at the entrance of the site, adjacent to the dwellings (Figure 22) and were likely planted as a shelterbelt. The easternmost shelterbelt visible in aerial imagery was removed between the January and April 2022 site visits. Both of these areas are partially fenced and have evidence of stock recently being present. A single cabbage tree (*Cordyline australis*) was also recorded on the channel bank of Watercourse 6. Mature exotic trees and patches of exotic vegetation at the site are assessed as having **Low** ecological value based on the presence of only exotic species, however, may provide some limited habitat contribution within the agriculture landscape dominated by pasture.

Table 5. Scoring and justification for assigned ecological value to patches of exotic vegetation.

Matter	Rating	Justification
Representativeness	Very Low	Exotic species dominate. No understory
Rarity/Distinctiveness	Very Low	Common exotic species only.
Diversity and Pattern	Very Low	Expected level of natural diversity not present.
Ecological context	Low	Small extent and degraded condition. Evidence of stock access. Contributes to overall ecological networks as stepping stone habitat.
		Overall value: Low

Figure 21: Terrestrial Vegetation within the property. The easternmost shelterbelt visible in aerial imagery was removed between the January and April 2022 site visits.

Figure 22: Terrestrial vegetation observed on Site at the mature vegetation patch in the south. Last image shows pine trees forming one of the shelter belts near the buildings recently cut down during site visit on 6th April 2022.

5.4 Fauna

5.4.1 Bats

Long Tailed Bats (*Chalinolobus tuberculatus* – Threatened/Nationally Critical) are present throughout the North Island mainland and are recorded to be present within the Region within 20 km of the site. Long Tailed Bats have a large home range and are highly mobile so may use the site as a flyway, as foraging habitat, or a roost site where mature vegetation (diameter at breast height/DBH > 15cm) is available. Several exotic mature trees were noted as having cavities or flaky bark suitable for bat roosts (such as within Pine and Eucalyptus spp. stand), considered Low and Moderate risk bat roost trees (Table 6). While no specific data exists for this site, it is considered possible that these trees have the potential to support bat roosting habitat.

In the absence of survey data, the bat values of the site are potentially **High**.

Table 6: 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 the ground inspection whether roost features are present or not and therefore 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

5.4.2 Herpetofauna

Herpetofauna records for the surrounding area include native skink records;

- Northern Grass Skink (*Oligosoma polychroma* – Not Threatened) 4.6km from the site in 2002;
- Glossy Brown Skink (*Oligosoma zelandicum* – At Risk/Declining) records 1.8km from the site in 1995 (Department of Conservation, 2021).

Northern grass skinks are known to prefer grasslands (especially tall grass species or rank grass), scrublands and vinelands rather than forests. They are known to inhabit dry, open areas with abundant basking areas coupled with cover. Glossy brown skinks occur in a wide range of habitats including coastal areas near the high tide mark, in coastal pebble banks, grassland, wetland, dense scrubland, mature forest with dappled sunlight. Glossy brown skinks show a preference for somewhat damper microhabitats than other species such as northern grass skinks.

The property includes a number of habitat features that may be suitable for native skinks. Some fallen logs in the stand of pines and eucalyptus and the cut down trees near the farm buildings along with building debris could be suitable for lizards, although given the landscape context of the site and long history of modification, low abundance (if present) would be expected. While there are some small areas of taller vegetation available, given the disconnected nature of these fragments and species composition, it is considered highly unlikely that arboreal geckos will be present on the site.

In the absence of survey data, the herpetofauna values of the site are potentially **Moderate** based on availability of marginal, possibly suitable habitat and nearby records. Native lizards are protected under the Wildlife Act 1953 and it is expected that a survey of areas of suitable habitat subject to clearance will form a

condition of consent, along with the development of a lizard management plan, should native lizards be found.

5.4.3 Avifauna

New Zealand eBird records within a broader 8 km radius of the site for 2010 - 2021 establish sightings of common native and exotic species (Table 7). Magpies were observed during the site visit. Other exotic bird calls were observed during the site visit within the pine tree patch, however they were not able to be identified. Given the nature of the site and the long-term land use for agricultural purposes, it is expected that typical terrestrial avifauna species are likely to be present at the site and may utilise the broader site area for roosting, foraging or migratory purposes and the mature vegetation patches for nesting.

The site is assessed as having **Low** avifauna values based on the presence of common native species.

Table 7: Bird species recorded within a 8 km radius of the site between 2010-2021 (eBird, 2021). Conservation status assigned according to Global IUCN (2020).

Common Name	Scientific Name	Conservation status
Rock Pigeon	*Columba livia*	Introduced and Naturalised
Welcome Swallow	*Hirundo neoxena*	Not Threatened
Common Starling	*Sturnus vulgaris*	Introduced and Naturalised
House Sparrow	*Passer domesticus*	Introduced and Naturalised
Silvereye	*Zosterops lateralis*	Not Threatened
European Goldfinch	*Carduelis carduelis*	Introduced and Naturalised
Swamp Harrier	*Circus approximans*	Not Threatened
Rook	*Corvus frugilegus*	Introduced and Naturalised

5.4.4 Freshwater Fauna

No freshwater fish records are available for the site itself but records from the Rangitikei River within 14 km of the site are listed below in Table 8. This includes At Risk – Declining Longfin Eel, Torrentfish, and Inanga. In the context of the site, the Rangitikei River is around 4 km east of the site at its closest point and an order of magnitude larger than the watercourses within the property.

Table 8: Fish records from within 14 km of the site from the New Zealand Freshwater Fish Database (Crow, 2017). Threat status assigned according to (Dunn et al., 2017) and (Grainger et al. 2013).

Distance from site (km)	Year of observation	Common Name	Scientific Name	Conservation Status
7 km north	2000	Longfin Eel	*Anguilla dieffenbachii*	At Risk - Declining
		Eel	*Anguilla spp.*	Not Threatened
		Torrentfish	*Cheimarrichthys fosteri*	At Risk - Declining
		Redfin bully	*Gobiomorphus huttoni*	Not Threatened
		Upland bully	*Gobiomorphus breviceps*	Not Threatened
		Redfin bully	*Gobiomorphus huttoni*	Not Threatened
7.8 km north	2010	Longfin Eel	*Anguilla dieffenbachii*	At Risk - Declining
		Torrentfish	*Cheimarrichthys fosteri*	At Risk - Declining
		Eel	*Anguilla spp.*	Not Threatened
13.8 km south	2003	Inanga	*Galaxias maculatus*	At Risk - Declining
		Eel	*Anguilla spp.*	Not Threatened
		Freshwater shrimp	*Paratya curvirostris*	Not Threatened

Given the typology and hydrological characteristics of the watercourses on site, it is considered highly unlikely that freshwater fauna would be present for most of the year in the ephemeral waterbodies identified; and unlikely that the intermittent waterbodies would support significant freshwater fauna except in winter supported by elevated water levels due to due to rainfall. Therefore, this site is assessed as having **Low** freshwater fauna values.

6 Assessment of Ecological Effects

Ecological effects are associated with the temporary effects arising from the construction phase as well as operational effects 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 (Roper-Lindsay et al., 2018). 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 fauna;
- Vegetation clearance and loss of terrestrial habitat;
- Earthworks leading to potential deposition of suspended sediments into watercourses.

6.1.2 Operational phase effects include:

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

6.2 Construction phase effects (temporary)

6.2.1 Potential injury and/or mortality of fauna

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

6.2.1.1 Avifauna

Avifauna is expected to consist 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.

Nevertheless, as native bird species present at the site are protected under the Wildlife Act 1953 (with the exception of Silvereye and Swamp Harrier which are partially protected under the Wildlife Act), and management of these impacts is recommended, particularly during breeding season where there is risk of impact on eggs or juveniles that are not able to flee construction or clearance.

It is expected that the proposal will have an effect on local avifauna populations that utilise the site especially due to the limited habitat availability, although there is similar habitat available in the wider landscape, thus is assessed as a **Low** magnitude of effect.

6.2.1.2 Bats

Clearance of low and moderate-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 magnitude of this effect is not able to be assessed in the absence of survey data. Nevertheless, as all native bat fauna is protected under the Wildlife Act, measures to avoid injury/mortality are required and recommendations for management and mitigation have been made to address the risk of harm.

6.2.1.3 Lizards

Vegetation clearance and clearance of woody debris has the potential to cause injury and/or mortality of the lizard species noted in the area Northern Grass Skink (Not Threatened) which inhabit grasslands, or Glossy Brown Skink (At Risk/Declining) which inhabit diverse habitats most relevant of which are grassland and mature forest.

The magnitude of this effect is not able to be assessed in the absence of survey data. Nevertheless, as all native lizard fauna is protected under the Wildlife Act, measures to avoid injury/mortality are required and recommendations for management and mitigation have been made to address the risk of harm.

6.2.1.4 Freshwater fish

Effects to freshwater fish have been avoided by retaining 10 m buffers around intermittent watercourses. Some construction activities are required within intermittent watercourses, with 11 new culverts and seven fords to be constructed over the three intermittent streams across the property. Native freshwater fish and other fauna are not expected to be present in high abundance and will not be substantively disrupted, particularly if works take place over summer months when streams are typically dry.

As the intermittent watercourses are expected to provide very limited habitat to freshwater fish, this effect is assessed to have **Negligible** magnitude of effect. Nevertheless, measures to avoid injury/mortality are recommended regardless and in the case of this site that may be achievable by undertaking necessary stream works when the streams are not flowing (i.e. in summer).

6.2.2 Vegetation clearance and loss of terrestrial habitat

Mature exotic trees will be cleared to allow solar panel installation.

Exotic vegetation includes large poplars (10-15 m), mature pine (~20 m), mature eucalyptus (~20 m), and cypress (~10-15 m). Approximately 1.43 hectares (ha) of exotic vegetation will be cleared from the site (0.85 ha of mature pine, eucalyptus, and cypress trees, 0.51 Ha of pine shelterbelt, and 0.07 Ha of poplars). Although botanical values are negligible, mature exotic vegetation does provide some potential habitat for native bats in the form of roost trees, several of which were identified as Low or Moderate risk roost habitat and potential roosting/nesting habitat for birds. Whilst the result is clearance of most trees across the site, the patchy, exotic trees do not currently provide substantial habitat or ecological value. This results in a minor loss of baseline attributes where underlying attributes will be similar to pre-development circumstances, clearance is assessed as a **Low** magnitude of effect to exotic vegetation.

6.2.3 Earthworks leading to potential deposition of suspended sediments into watercourses

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.

Whilst input into design has resulted in the ability to avoid activities in close proximity to watercourses, trenching may result in increased surface soil exposure during power cable laying and therefore increases the risk of erosion and sediment release especially in times of rainfall during the work. As minimal access roads are currently present across the site, the creation of new all-weather gravel access roads (4 m minimum width) throughout the property will also require earthworks and resulting substantial land disturbance and possible discharge to watercourses.

If not appropriately managed, effects to watercourses may cause habitat value disruption and degradation (including effects beyond the boundary of the site), therefore assessed as having **Moderate** magnitude.

6.3 Operational phase effects:

6.3.1 Increased impervious surface landcover and potential alterations to watercourse ecology and hydrology

Solar panels may cover the majority of land area of the property (when the panels are horizontal), similar to the impervious coverage of an urban catchment (Beca, 2022b). This may result in increased stormwater runoff and 'flashiness' that could exacerbate runoff and bank erosion effects to watercourses. Although as the panels are elevated above the ground, runoff is likely to be diverted beneath adjacent panels, where infiltration occurs and may not greatly increase the volume of runoff (Cook & McCuen, 2013). There is potential for flow to concentrate and channelise locally as it discharges from panels or from access tracks, that could lead to local soil erosion. No significant change to rates of runoff from the site is anticipated, therefore limited additional effect to streams from the operational presence of solar panels. Potential impacts to groundwater recharge or streams (permanent and intermittent) flow rates are unlikely.

Assuming pasture beneath panels is maintained for livestock grazing, this effect is assessed to have **Low** magnitude.

6.3.2 Alteration to intermittent watercourses

Activities in intermittent watercourses included in the current design involve the construction of 11 new culverts and seven fords across the property. Generally, the all-weather access crossings will require culverts where they do not currently exist, while the grassed access strips will use fords where the watercourse are narrow, and short culverts (10 -12 m long) where the watercourse is incised. Any installation or remediation of culverts will be undertaken with reference to fish passage guidelines (Franklin et al., 2018), with design considerations to ensure minimal disruption to in-stream habitat to allow continued longitudinal connectivity for any freshwater fauna. Alterations are not anticipated to disrupt the value of the watercourses as the value of these across the property is Negligible, therefore this effect is assessed to have **Low** magnitude. The change arising from the culvert will be discernible, but the underlying character and attributes of the existing watercourse will be similar to pre-development circumstances.

6.3.3 Loss of potential 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, when considering the potential value of the watercourses, it is assumed that fencing would be undertaken in conjunction with planting of indigenous species and removal of exotic weeds. The proposed works are expected to result in a loss of **Negligible** magnitude of potential value for the watercourses. Works will not prohibit these actions being undertaken in the future, nor impede any improvements in water quality.

7 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 (Beca, 2022a) and ensuring stream diversion and reclamation is avoided through design.

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

Finally, where the loss of patches of mature exotic vegetation are unable to be avoided, they will be remediated by terrestrial and riparian planting to enhance native habitat provision.

Other potential adverse ecological effects can 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 1.43 ha of exotic vegetation will directly remove potential habitat for exotic and 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 are detected (i.e. one or more viable eggs or live chicks are present), vegetation clearance in the immediate vicinity of the nest (e.g. within a 10 m radius) should be delayed until a suitably qualified ecologist confirms that any nests present are no longer active.

7.1.2 Herpetofauna

Due to the lack of available information on herpetofauna species at the site, it is recommended a habitat risk assessment and survey for lizards be undertaken by a suitably qualified herpetologist to identify high risk habitat within construction areas 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, 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 suitable protected habitat. Although considered unlikely in this instance (due to the low likelihood of their presence), should lizard salvage and relocation could be determined to be required; typical actions associated with this are expected to be the capture and release by an experienced herpetologist outside of winter months and in accordance with Department of Conservation Wildlife Authority requirements.

7.1.3 Bats

The site includes habitat potentially suitable for native bats, including low and moderate risk roost trees and flyway/foraging habitat. 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.

7.2 Terrestrial and/or riparian planting

To offset the clearance of exotic vegetation, planting should be undertaken using suitable species for the site. Native species typical of and suitable for the site's climatic condition are proposed, to improve ecological value. Planting should take place in suitable areas of the property that will not impact the function of the solar panels following the landscape plan, with the aim of establishing riparian shading along intermittent streams and enhancing native habitat provision.

7.3 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. These will comprise grass filter strips and silt fences, decanting earth bunds, diversion cut-off drains to direct runoff away from earthwork areas, stabilising earthworked areas with gravel progressively and grassing any exposed bare areas as soon as possible. In the event that it is necessary to keep parts of the trench open or rain occurs before the trench is backfilled then the contractor will be required to cover the remaining excavated material with polythene to restrict runoff. It is recommended the works are carried out, as far as practicable, during the earthworks season.

As an additional erosion and sediment control approach, 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 re-vegetated.

7.4 Watercourse management and stormwater design

The construction of several culverts and fords are required to access some of the panel sites isolated from the access roads by a watercourse. To protect intermittent watercourses, 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, access roads, and any other formed areas are drained to vegetated areas or stormwater management design is implemented, (e.g. planted swales to nearby watercourses) to reduce risk of erosion and scour and enhance treatment of stormwater. It is recommended the installation of culverts is undertaken in summer conditions when there is no flow in the ephemeral or intermittent streams.

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 freshwater fauna. It is generally recommended that measures to prevent stock entering watercourses are implemented, to minimise potential for stream bank erosion and runoff effects.

7.5 Overall Level of Effects

Table 9. Summary of potential water quality and 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)	Magnitude of effect (mitigated)	Mitigation measure	Overall Level of Effect (mitigated)
Construction phase effects (temporary)							
Potential injury and/or mortality of fauna	Avifauna	Low	NA	Low	Very Low	Fauna management	Very Low
	Herpetofauna	Moderate	NA	TBC	Negligible		Low
	Bats	High	NA	TBC	Negligible		Low
	Freshwater Fauna	Low	NA	Negligible	Negligible		Very Low
Vegetation clearance and loss of terrestrial habitat	Terrestrial vegetation	Low	NA	Low	Negligible	Terrestrial and/or riparian planting	Very Low
Earth disturbance resulting in runoff and deposition of suspended sediments to watercourses	Watercourses	Negligible	Moderate	Moderate	Low	Erosion and Sediment Controls	Very Low
Operational phase effects							
Increased impervious surface landcover and potential alterations to hydrology	Watercourses	Negligible	Moderate	Low	Low	Watercourse management and stormwater design	Very Low
Alteration to intermittent watercourses	Watercourses	Negligible	Moderate	Low	Low	Watercourse management and stormwater design	Very Low

8 Conclusions and recommendations

A desktop review of ecological features and species records was completed to identify potential ecological constraints on 193 Hectares of land on 1618 Wellington Road in Rangitikei, Manawatū-Whanganui Region The review was followed by a site walkover in January 2022 and a detailed field investigation in April 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 and/or riparian planting;
- Erosion and Sediment Controls;
- Watercourse management and stormwater design.

The overall level of ecological effects of the proposed construction works are **Very Low-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 at the site will be similar to pre-development circumstances over a short to medium term time scale.

Overall, if terrestrial and/or riparian planting is implemented as recommended there may be a net gain in ecological value due to increased indigenous dominance, habitat, and ecosystem services provision.

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10 Limitations

This report has been prepared by Beca Ltd solely for Energy Farms Limited (the client). This report is prepared solely for the purpose of the assessment of potential ecological effects of the proposed works (Scope). The report has been prepared to support a resource consent application and may be used by the Client and others in subsequent processes to consider the application to which the assessment pertains. The contents of this report may not be used by the Client for any purpose other than in accordance with the stated Scope.

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This report should be read in full, having regard to all stated assumptions, limitations and disclaimers.

A

Appendix A – Ecological Impact Assessment Guidelines

Appendix A: 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. Attributes that may be considered when assigning ecological value to a freshwater site or area (adapted from Roper-Lindsay et al., 2018).

Value	Explanation	Characteristics
Very High	A reference quality watercourse in condition close to its pre-human condition with the expected assemblages of flora and fauna and no contributions of contaminants from human induced activities including agriculture. Negligible degradation e.g., stream within a native forest catchment	Benthic invertebrate community typically has high diversity, species richness and abundance. Benthic invertebrate community contains many taxa that are sensitive to organic enrichment and settled sediments. Benthic community typically with no single dominant species or group of species. MCI scores typically 120 or greater. EPT richness and proportion of overall benthic invertebrate community typically high. SEV scores high, typically >0.8. Fish communities typically diverse and abundant. Riparian vegetation typically with a well-established closed canopy. Stream channel and morphology natural. Stream banks natural typically with limited erosion. Habitat natural and unmodified.
High	A watercourse with high ecological or conservation value but which has been modified through loss of riparian vegetation, fish barriers, and stock access or similar, to the extent it is no longer reference quality. Slight to moderate degradation e.g., exotic forest or mixed forest/agriculture catchment.	Benthic invertebrate community typically has high diversity, species richness and abundance. Benthic invertebrate community contains many taxa that are sensitive to organic enrichment and settled sediments. Benthic community typically with no single dominant species or group of species. MCI scores typically 80-100 or greater. EPT richness and proportion of overall benthic invertebrate community typically moderate to high. SEV scores moderate to high, typically 0.6-0.8. Fish communities typically diverse and abundant. Riparian vegetation typically with a well-established closed canopy. No pest or invasive fish (excluding trout and salmon) species present.

Value	Explanation	Characteristics
		Stream channel and morphology natural. Stream banks natural typically with limited erosion. Habitat largely unmodified.
Moderate	A watercourse which contains fragments of its former values but has a high proportion of tolerant fauna, obvious water quality issues and/or sedimentation issues. Moderate to high degradation e.g., high-intensity agriculture catchment.	Benthic invertebrate community typically has low diversity, species richness and abundance. Benthic invertebrate community dominated by taxa that are not sensitive to organic enrichment and settled sediments. Benthic community typically with dominant species or group of species. MCI scores typically 40-80. EPT richness and proportion of overall benthic invertebrate community typically low. SEV scores moderate, typically 0.4-0.6. Fish communities typically moderate diversity of only 3-4 species. Pest or invasive fish species (excluding trout and salmon) may be present. Stream channel and morphology typically modified (e.g., channelised) Stream banks may be modified or managed and may be highly engineered and/or evidence of significant erosion. Riparian vegetation may have a well-established closed canopy. Habitat modified.
Low	A highly modified watercourse with poor diversity and abundance of aquatic fauna and significant water quality issues. Very high degradation e.g., modified urban stream	Benthic invertebrate community typically has low diversity, species richness and abundance. Benthic invertebrate community dominated by taxa that are not sensitive to organic enrichment and settled sediments. Benthic community typically with dominant species or group of species. MCI scores typically 60 or lower. EPT richness and proportion of overall benthic invertebrate community typically low or zero. SEV scores low to moderate, typically less than 0.4. Fish communities typically low diversity of only 1-2 species. Pest or invasive fish (excluding trout and salmon) species present. Stream channel and morphology typically modified (e.g. channelised). Stream banks often highly modified or managed and maybe highly engineered and/or evidence of significant erosion. Riparian vegetation typically without a well-established closed canopy. Habitat highly modified.

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, OR 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	Nationally Threatened species found in zone of influence, either permanently or seasonally
High	At Risk – Declining species found in the zone of influence, either permanently or seasonally
Moderate	Species listed as any other category of At Risk found in the zone of influence, either permanently or seasonally. Locally (ED) uncommon or distinctive species found in the zone of influence, either permanently or seasonally
Low	Nationally and locally common indigenous species
Negligible	Exotic species, including pests, species having recreational value.

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 WWTP discharge (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 are 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.

B

Appendix B – Historic Aerial Imagery

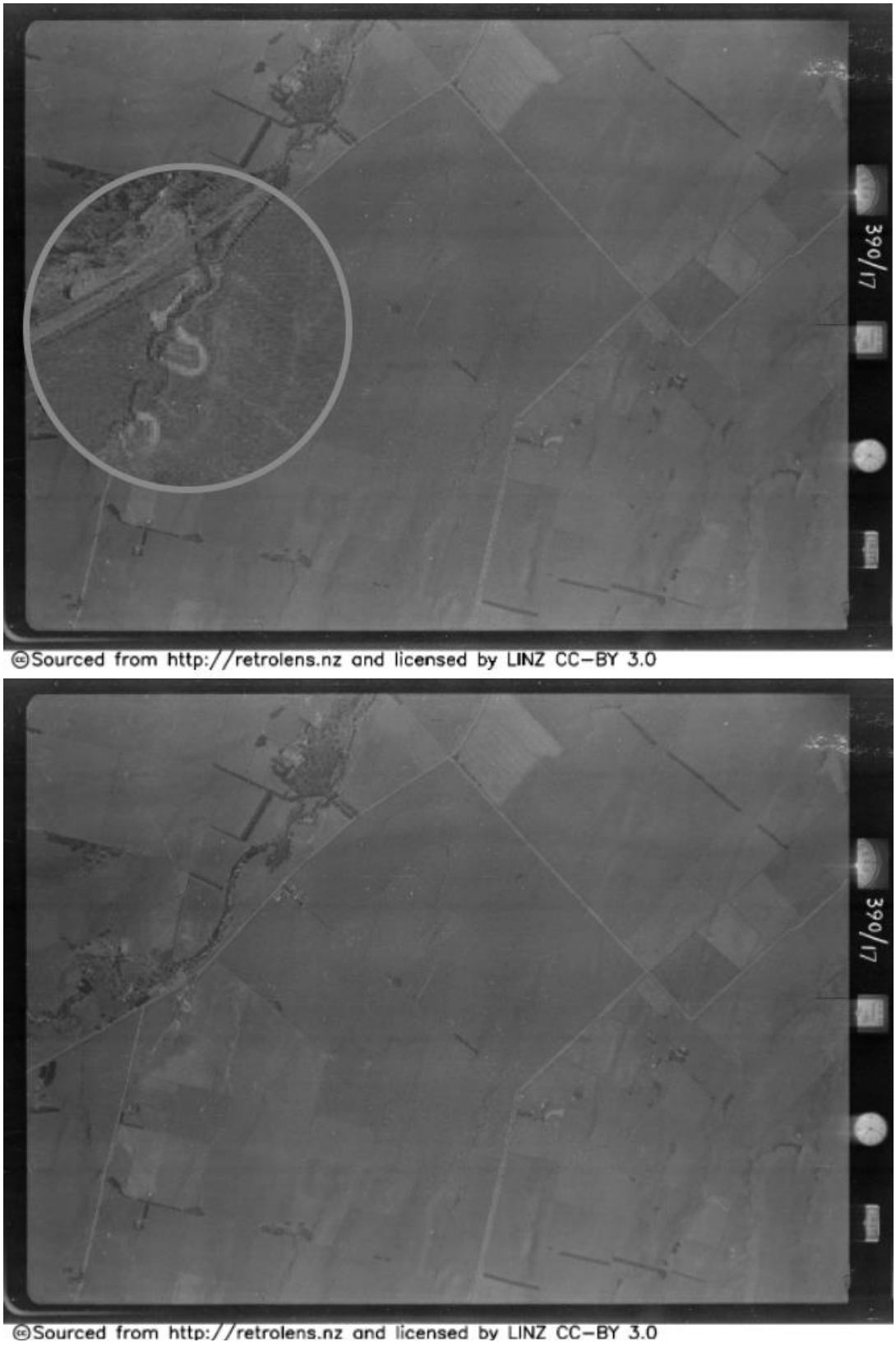

Figure 2.1: Historic aerial images of the site in 1942 from Retrolens.