Boffa Miskell

Kapuni Green Hydrogen Project

Ecological Impact Assessment: Terrestrial Ecology, Birds, Lizards & Bats

Prepared for Hiringa Energy

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Cover photograph: Bird observation at project site at the location of proposed turbine 2. © BML, 2020

1 Executive Summary

Introduction

- Hiringa Energy is seeking to install four wind turbines on a farm in Taranaki as part of a Green Hydrogen Project.
- Originally, the four turbines proposed were 230m tall three-bladed wind turbines aligned in a north-south direction. The turbines comprise a similar tapered cylindrical tower, a nacelle with three rotor blades and the turbines were spaced approximately 360m apart. The hub height sat at 125m with approximately 80m long rotor blades giving an overall 162 m rotor radius and an overall 230m tip height.
- However, following micro-siting investigations and advice from turbine suppliers, the configuration of turbines on the proposed site were slightly altered and a shorter tower proposed but the same diameter rotor retained resulting in a 24m lower tip height. This is referred to as the 2.5D layout. The four turbines will now have a maximum tip height of 206m and a minimum tip height (ground clearance) of 43m. This report has been revised in light of these changes.
- Also, a new access track will be constructed 5m north of the existing access track to lie outside two wetland buffers, thereby ensuring those wetlands are avoided (previously it was proposed that the existing track would be upgraded).This report has been revised in light of this design change.
- Given the sites flat topography only minor earthworks will be required to provide construction access to the site.

Methods

- Our scope was to carry out an assessment of terrestrial vegetation and habitats, avifauna (birds), herpetofauna (lizards and frogs) and bats. Given almost all vegetation on the site is exotic (native vegetation exists only as small planted corridors of riparian planting) and there are no habitat features such as dunes, lakes, ponds or natural wetlands, the investigation methods were selected to reflect a site lacking in indigenous habitat.
- The main focus of the study was on birds, and specifically sought to determine if the site lay in a flight path for migrant species. To this end, two weeks were spent by an ornithologist on site at the peak of the summer migration movement.
- Our scope of work did not include freshwater assessments. Effects on waterways, wetlands and riparian vegetation are addressed in a separate report by Larkin (2021).

Results

- The site is flat and almost entirely in pasture. There are low boxthorn hedgerows and small waterways that have been fenced and undergone some limited planting but are generally dominated by rank grass.
- The pasture is improved and intensively grazed, with no habitat features that would support native lizards or provide breeding areas for birds. The hedgerows and areas of rank pasture in fenced waterways, provide the only habitat diversity.
- This property lies within an expansive, uniform pastoral landscape which runs from the coast to the forested slopes of Mt Taranaki. The site is not in any way unique and does not contain habitat not found within the many thousands of farms surrounding it.
- We conclude that terrestrial native lizards may be present but if they are, they would be limited to the cover provided by the hedgerows.

- The site lies some 25km west of the nearest known population of bats and no bats were detected during a bat survey conducted on site. We conclude that bats are highly unlikely to utilise the site.
- The resident and local birds that were observed are all species of open country and are habituated to rural activity. They are common and widespread locally and nationally.
- Two migrant bird species were recorded at the site, a single South Island pied oystercatcher, and two calls of pied stilts at night. We conclude this is not a migration route.

Significance

- The plant communities and habitats on the site do not meet the criteria for significance as detailed in the Regional Policy Statement.

Ecological Value

- The plant communities and habitats on the site have low ecological value, primarily providing habitat for the suite of common native birds of open country.

Assessment of Potential Ecological Effects

- During construction, the earthworks on the site will be minimal, and will not impact on the local birdlife which are accustomed to normal farm activities, stock, machinery and vehicle movement. These species are also highly mobile and can move away from any activity that disturbs them. Clearance of small pockets of boxthorn hedgerows and riparian planting (including rank grassland) to enable construction of the access track will result in very small-scale loss of potential, albeit likely marginal, northern grass skink habitat (an indigenous, Not Threatened, protected species). We conclude that effects of this project on this indigenous species will be very low.
- During operation we conclude that any effects of this project on indigenous species will be very low. We expect that there will be some collision mortality with non-threatened species as has been observed at other sites, but these birds including harrier hawk, black-backed gull, and spur- winged plover, are widespread and abundant within this landscape and these mortalities will not have an impact on local or national populations.

Measures to Avoid, Minimise, Remedy and Mitigate

- Once the infrastructure plans have been finalised and the extent and location of hedgerow and riparian planting (including associated rank grassland) loss is confirmed we recommend that a lizard survey is conducted by a suitably conducted ecologist in these affected areas. If lizards are detected, a lizard management plan should be prepared, and a DOC permit obtained to enable lizard salvage and relocation.
- No further remedy or mitigation is required.
- No post-construction monitoring is required.

Conclusion

- Overall, the results of this study suggest this will be a benign windfarm site, ideally suited for the proposed development.
- No natural indigenous vegetation will be affected. A small area of recent riparian plantings will be lost as well as small areas of boxthorn hedgerow. These may provide habitat for common terrestrial birds and lizards.
- Besides a lizard survey, no further remedy or mitigation is required.

2 Contents

Appendices

3 Introduction

3.1 Scope

Hiringa Energy engaged Boffa Miskell to prepare a terrestrial Ecological Impact Assessment (EIA) for a resource consent application to construct and operate a small-scale wind farm (four turbines) in Kapuni, South Taranaki.

The scope for this assessment covered terrestrial vegetation and habitats, birds, bats, and lizards. We have not assessed waterways, wetlands or freshwater fauna; these components have been assessed in a separate report titled "Kapuni Green Hydrogen Project Freshwater Ecological Assessment Wind Turbine Site (Larkin, 2021). We only comment on waterways to the extent that riparian habitat potentially provides corridors for bird movement.

The objectives of this ecological assessment were to:

- Describe the terrestrial ecological environment and features of the area.
- Determine the significance (in terms of section 6(c) of the RMA) and ecological value of that environment and its features.
- Identify the magnitude and overall level of potential adverse effects on the terrestrial ecological values of the area that will be impacted by construction and operation of the wind farm.
- Identify opportunities and methods to avoid, minimise, remedy and mitigate potential adverse terrestrial ecological effects; and
- To address residual terrestrial ecological effects, after the mitigation hierarchy has been applied, through ecological offsetting.

This assessment begins by describing the project and site location (Section 3.2). It then describes the assessment methodology (Section 4) and the results (Section 6). This is followed by an assessment of the ecological significance and values of the site (Sections 6 and 7) and an assessment of effects (Sections 0 and 8.5). The assessment finishes with recommendations to avoid, minimise, remedy and mitigate potential adverse ecological effects (Section 9), and a conclusion (Section 10).

The ecological components covered in this report include terrestrial vegetation, avifauna (birds), herpetofauna (lizards and frogs), bats and terrestrial invertebrates. This report does not assess impacts on freshwater habitats or species present within the project area.

3.2 Site Location and Project Description

The proposed wind farm site is shown in Map 1 (page 7). It is a dairy farm located at 271-369 Kokiri Road, Kapuni, South Taranaki. It is owned by Parininihi ki Waitotara.

Hiringa Energy Limited and Balance Agri-Nutrients proposing to install four wind turbines on the PKW farm located near the Ballance industrial plant at Kapuni. The turbines will be 206 m tall and three-bladed. They will be aligned in a north-south direction. This north-south linear arrangement ensures turbines effectively harness the dominant westerly winds. The turbines comprise a tapered cylindrical tower and a nacelle with three rotor blades. The turbine towers will be spaced approximately 360m apart. The hub height will sit at 125 m with approximately 80 m long rotor blades. The maximum blade tip height will be 206 m and the minimum tip height (ground clearance) will be 43 m (Figure 2, page 9).

The turbines will produce up to 24MW of power, the purpose of which is to supply renewable energy to power the nearby Ballance Plant and supply the electrolysis process to produce 5MW of hydrogen gas. The resulting green hydrogen will be used by the plant and combined with atmospheric nitrogen to produce urea. Water required as part of the electrolysis process will be sourced from Waingongoro Stream, which Ballance already has a consent for. The green hydrogen produced will also provide fuel for the transport sector and support the development of a green hydrogen energy and transport hub for South Taranaki. The four turbines will be connected to the national grid and any excess power during peak electricity production will be fed into the grid.

From the wind data that Hiringa have been collecting at the site since 2019, the expected turbine capacity factors will be equivalent to, if not better than, some of the best onshore wind farms in the world.

Each turbine site will require a reinforced concrete foundation. There will be approximately 21,000 – 25,000 m^3 total volume of material disturbed some of which will be used as backfill and the balance disposed of off-site.

The turbine towers, nacelle and rotors will be all be painted off-white matte finish. In accordance with CAA regulations each turbine will have a red light at each hub. The regulations also require that each turbine has a light in the tower centre (front and back) to allow 360-degree viewing.

A 5 m by 10 m substation and switch rooms (i.e. footprint of 20-foot container) will be built near the base of the third turbine. An underground cable from the turbines will connect to the substation and from there either connect into the existing overhead Powerco lines on Palmer Road or run cross country to connect with the Ballance Plant depending on which route option is ultimately chosen(Appendix A, page 50).

Given the site's flat topography, only minor earthworks will be required to provide construction access to the site. Access for construction of the turbines and transport of the turbine components will be via the existing entry of Kokiri Road near the southern boundary of the PKW farm and a new track will be constructed 5m north of the existing access track to provide a buffer of 10m buffer and ensure two wetland areas are avoided. Access track construction will require culvert upgrades and or new culvert installation which will result in some small-scale loss of riparian plantings and associated rank grassland (mainly in Areas D and E – refer to Appendix A; note that freshwater effects are not addressed in this report but are assessed in the freshwater report; (Larkin, 2021). From there farm races will be used to access each turbine site. The races will be widened with an improved hardstand surface and short sections of hardstand will be constructed between some of the turbines. A small section of hedgerow along Kokiri Road will be removed or altered to enable access to the site, as well as small-scale removal of hedgerow shrubs between the turbines.

The dairy farming operation on the Site will continue following construction of the turbines with no restrictions on stock access or movement.

3.3 Potential Ecological Effects of Windfarms

3.3.1 Construction and Operational Effects

Earthworks are associated with both the turbine foundations and formation of the access track, which, of necessity must be wide enough to allow the delivery of the oversized components and construction equipment including very large cranes. Sediment management from sites of excavation and disposal is therefore an issue requiring consideration.

Construction also often involves large amounts of heavy machinery and requires storage of fuel and lubricants. Large volumes of concrete also need to be produced on site or trucked to it. Issues of contaminant discharge need to be considered.

Table 1 identifies the main components of windfarm development which can impact on ecological values. We return to this later in this assessment.

Table 1: Checklist of Potential Impacts of Relevance to Nature Conservation

Potential Impact	Construction phase	Operation phase
Main Construction Activities:		
• Earthworks for internal roads / laydown areas / spoil sites / site compounds / maintenance yard	X	X
• Constructing turbine foundations and installing turbines	X	
• Installing meteorological masts	X	X
• Transporting wind farm components from port to the site (road & bridge upgrades)	X	
• Electricity substation and transmission to distribution network.	X	X
Potential vegetation and habitat effects		
• Direct habitat loss (reduced species diversity, reduced habitat, displacement)	X	X
• Indirect habitat effects and associated biological impacts such as:		
- Reduction in habitat extent (e.g. reduced habitat integrity, edge effects)	X	
- Interference with geological / morphological processes (e.g. slope processes).		X
- Interference with hydrological processes (e.g. diversions, drainage, effects on aquifers)		X
- Erosion / sedimentation (effect on freshwater systems, turbidity, siltation).	X	
Potential disturbance to mobile species		
• Noise / construction activity (disturbance of life stages, breeding, feeding)	X	
• Turbine lighting (nocturnal birds, migrants, bats)		X
• Bird / bat collision		X
• Bird / bat displacement from habitat	X	X

3.3.2 Bird Strike & Displacement

There has been over four decades of research into the factors that lead to bird and bat collisions with manmade structures such as wind farms. As a result of this research a number of guidance

documents have been produced to assist in the identification and assessment of potential wind farm sites (Clean Energy Council, 2018; New Zealand Wind Energy Association, 2013; Scottish Natural Heritage, 2014).

Some general themes are now clear which allow likely issues at windfarm sites and necessary site investigations to be identified. These themes include:

- Turbine collisions occur at low rates at most wind farm sites and are typically of common and abundant species. They rarely have population level effects. Much has been learnt from the few windfarms where large numbers of bird deaths, or deaths of threatened species, have been recorded. This has supported guidance on better windfarm siting and design as well as the acknowledgement of key ornithological groups[1,2].
- There are many different factors that combine in different ways to create conditions where windfarms are either safe, or hazardous, to wildlife. These factors operate both temporally and spatially. They involve topography, seasonal weather conditions, the size, number and type of turbines used; the spatial arrangement of turbines; wind farm orientation to valleys or passes; the particular species of bird present at the site, and factors that affect their breeding, feeding, roosting behaviour and movement patterns. For example our assessment of the Brooklyn Turbine site adjacent to Zealandia (Boffa Miskell Ltd, 2012) showed a preferences for almost all species, and particularly weaker flyers, for crossing ridgelines at a saddle.
- Over time, most avian species resident near a windfarm learn to avoid the turbines, adjusting their flight to pass under the rotor sweep or between the turbines. Avoidance rates range from around 95% to 99.99% depending on the species (Bowgen & Cook, 2018; Scottish Natural Heritage, 2018). The species most at risk are those that migrate bi-annually and so are not resident or have a behaviour that over-rides the avoidance response (hunting raptors).
- Because of the very high avoidance rates observed for most species, and other site and species factors that influence the probability of turbine collision, modelling (supported by observation) tells us that for most birds it requires many hundreds or thousands of traverses of a wind farm site before a collision is likely to occur (Boffa Miskell Ltd, 2016). The actual rate depends on the bird or bat species and the specifics of the wind farm.
- Perceived wisdom is that the densities of birds are reduced in close proximity to wind farms, however, this now appears to be relatively uncommon and species specific (Douglas et al., 2011; Pearce-Higgins et al., 2009). Most species, particularly those habituated to a rural environment, will adapt to the presence of a wind farm over time. However, displacement has been observed in international studies for a few species of bird, and can be ecologically significant, particularly if the birds are displaced from breeding territory. It therefore needs to be considered.
- The presence of a threatened species does not necessarily preclude development of a windfarm. However, if a threatened species is present a comprehensive assessment must be undertaken. The behaviour of the birds in question need to be well understood, and the risk factors for collision and displacement must be fully addressed in the design. A reduced windfarm, or habitat modification may be the result.
- Despite improvements in windfarm and turbine siting and design, even a small number of deaths can have a significant effect on a population of birds which, for example, is limited in distribution or has a very low reproductive rate. When assessing a site, factors need to be

[1] https://www.nature.scot/professional-advice/planning-and-development/planning-and-development-advice/renewable-energy/onshore-wind-energy

[2] https://www.audubon.org/news/wind-power-and-birds

considered such as the presence or absence of sensitive bird species, if sensitive birds are present, their feeding, roosting and nesting behaviour at the site; the presence of migratory routes; the quality of habitat on the site, and so on.

The following table identifies specific features of windfarms and wind turbines that have been implicated in bird strike and displacement internationally and we return to this in our later assessment of effects.

Table 2: Risk Factors for Wildlife Collision and Displacement.

Large concentrations of turbines
Closely spaced turbines
Towers in uniform rows across the landscape (barrier)
Turbines within a steep valley, across saddles
Turbines that lie across a migratory route
Turbines in close proximity to habitats where birds congregate (wetlands, lakes, estuary's, staging areas)
Turbines within a site frequented by threatened or at-risk species
Frequent fog and low cloud common (esp. during migration season)
Large prey base (attracting raptors)
Transmission lines perpendicular to prevailing winds
Transmission lines crossing water

As a result of this research a number of guidance documents have been produced to assist in the identification and assessment of potential wind farm sites (Clean Energy Council, 2018; New Zealand Wind Energy Association, 2013; Scottish Natural Heritage, 2014).

3.3.3 The New Zealand Experience

The research and guidance that has built up over the past four decades has led to better predictive tools for safe wind turbine and wind farm placement, further reducing collision risk for susceptible species. Where post construction monitoring has been carried out in New Zealand, the benefits of this research and guidance has been confirmed with no significant mortalities recorded. The results have been published for West Wind wind farm in Wellington (Bull et al., 2013). This is a wind farm in rural landscapes adjacent to the coast. Many of the species present are similar pastoral species found at Kapuni.

At West Wind, over the period of observation, there were mortalities of 17 bird species, of which eleven species were introduced; chaffinch (6), mallard (4), redpoll (4), yellowhammer (3), one or two each of seven other common introduced species, including a number of unidentified finches.

Of the 18 native species recorded on site, there were mortalities of 6 species, harrier (13), paradise shelduck (5), and southern black-backed gull (4), with two tui, and 1 each of spur-winged plover and fairy prion. Of all birds, fairy prion was the only one with a threat status (At Risk – Relict). Occasional mortalities of oceanic species, driven inland during storms, was predicted (Boffa Miskell Ltd, 2005).

Table 3: Avian mortalities recorded during post construction monitoring at West Wind (Bull et al., 2013) wind farm.

Species	Threat Status	West Wind
Australasian Harrier	Native - Not Threatened	12
Paradise shelduck	Native - Not Threatened	5
Southern black-backed gull	Native - Not Threatened	4
Tui	Native - Not Threatened	2
Spur-wing plover	Native - Not Threatened	1
Fairy prion	Native - At Risk	1
Chaffinch	Introduced	6
Mallard	Introduced	4
Redpoll	Introduced	4
Finch sp.	Introduced	3
Yellowhammer	Introduced	3
Skylark	Introduced	2
Blackbird	Introduced	1
Dunnock	Introduced	1
Eastern rosella	Introduced	1
Goldfinch	Introduced	1
Greenfinch	Introduced	1
Song thrush	Introduced	1

3.4 Consultation

Prior to commencement of this assessment early results were provided to the Department of Conservation for their comment (Appendix H). Feedback was provided by the Department, including requests for further explanation of the methods, consideration of the likelihood of bats, and consideration of a range of threatened or at-risk species, not seen on site but present in the North Island. This assessment considers each of the matters raised.

Map 1: Site Map, Mt Taranaki, Taranaki Ring Plain, the proposed wind farm site (Google Earth and infrastructure plan .

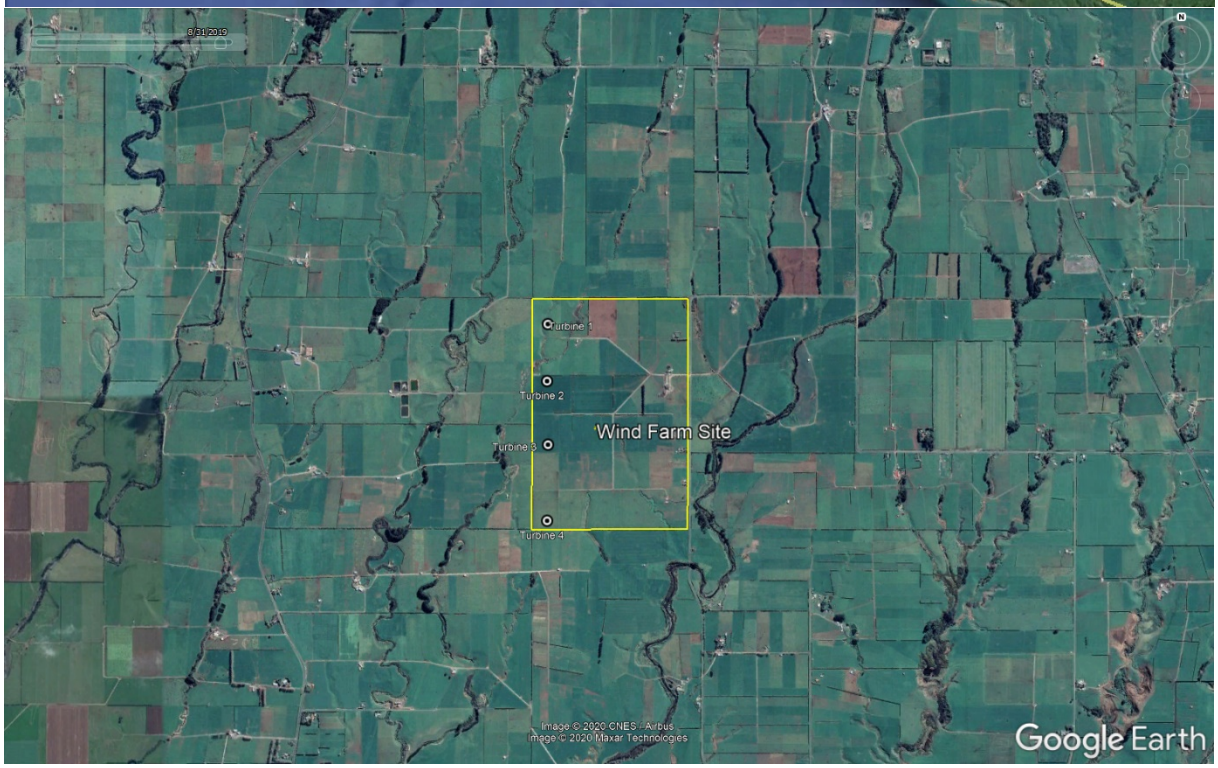
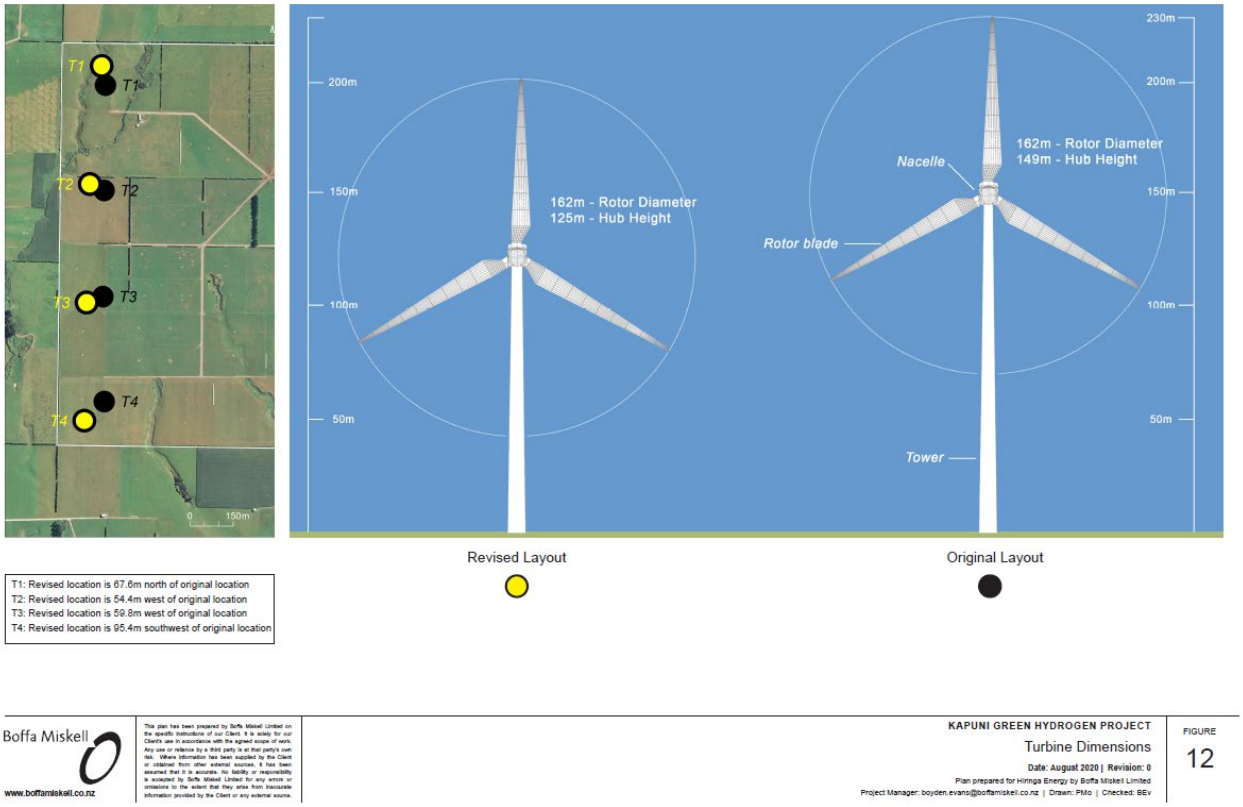


Figure 1: Simulation of the turbines installed (BML 2020).

Figure 2: Turbine Dimensions (BML 2021)



4 Methodology

4.1 Vegetation & Habitats

4.1.1 Desktop

The desktop investigation included a review of scientific literature (published and unpublished) including the PNAP investigations for this ecological district, the District and Regional Plans including protected and unprotected SNA sites, and relevant websites. Ecological databases were also accessed including the LENZ Threatened Environments Classification.

4.1.2 Site Investigations

Once on site it was clear that the majority of the site was in improved pasture with shelterbelts formed from exotic trees species, and with no indigenous vegetation other than some areas of recent riparian planting.

It was concluded that no quantitative surveys were required. No species lists were compiled. A breakdown of the areas of exotic communities was produced from aerial photography and site observation.

4.2 Terrestrial Fauna - Lizards

4.2.1 Desktop

Lizard records from the DOC-administered herpetofauna distribution database (BioWeb)[3] were requested and subsequently provided by DOC on 20 October 2020.

4.2.2 Site Investigations

Once on site it was clear that within the improved pasture there were no habitat features that would support terrestrial lizard populations in the presence of dairy farming and stock movements. It is possible terrestrial lizards are present in the hedgerows and riparian planting areas (including associated rank grassland), however this is likely to be marginal habitat given the intensity of grazing. Only small pockets of hedgerow shrubs and riparian planting and grassland will be affected by the project.

It was concluded that quantitative surveys were not required.

4.3 Bats

4.3.1 Desktop

The desktop investigation included a review of scientific literature (published and unpublished), and relevant databases, including the DOC bat database. Aerial maps and relevant literature were examined to obtain a “wider area” overview of potential bat habitat between the site and other known bat populations.

[3] The BioWeb database was accessed on 26 October 2020.

There are two species of endemic bats in New Zealand; short-tailed bats (Threatened – Nationally Vulnerable) and long-tailed bats (Threatened – Nationally Critical) (O'Donnell et al., 2018). It is highly unlikely central short-tailed bats (*Mystacina tuberculata rhyacodia*) would be present given their habitat requirements and known scarcity in this Ecological Region. The focus of this study was long-tailed bats (*Chalinolobus tuberculatus*).

4.3.2 Site Investigations

Bats emit echolocation calls that are outside the range of human hearing and because they are very mobile and difficult to both see and hear, survey methods that involve active searching for bats (e.g. trapping, etc) are logistically difficult and time consuming. Consequently, accepted practise for detecting the presence of bats is via bioacoustic surveys using acoustic recorders (ARs) manufactured by Wildlife Acoustics. These recorders passively record both long-tailed bat (40 kHz) and lesser short-tailed bat (28 kHz) echolocation calls on two concurrently operating frequency channels. They operate remotely by recording and storing each echolocation call (bat pass), along with the date and time of occurrence.

One bioacoustic bat survey was conducted over 29 consecutive nights (except for two ARs, one of which stopped recordings after 22 nights (AR at location 2) and the other after 26 nights (AR at location 5). The survey was conducted between 12 October to 9 November 2020. Ten ARs were deployed across the site targeting habitat features preferred by long-tailed bats. The locations of the ARs are presented in Appendix I.

Bat activity is influenced by overnight weather conditions with minimum temperatures above 10°C in the first four hours after sunset being ideal for bat emergence from roosts. Furthermore, rainfall above 2.5 mm/h in the first two hours after dusk and strong winds exceeding an average overnight windspeed of 20 km/h or wind gusts in excess of 60 km/h will reduce bat activity and emergence from roosts (O'Donnell, 2000). Hourly weather data was sourced from the nearest weather station available in New Zealand's National Climate database (www.cliflo.niwa.nz) and included temperature, rainfall, and wind speed. Weather data were analysed to ensure conditions during the survey period were suitable for bats to be active and therefore bats had been detectable via acoustic recordings for at least 10 survey nights. These nights are henceforth referred to as "fine weather nights". Bat activity can also be influenced by moonlight (Ciechanowski et al., 2007), consequently the targeted survey period was chosen to avoid surveying full moon and one night before and after the full moon.

All bat recorders were set to have the same date and time settings and were programmed to monitor from one hour before sunset[4] to one hour after sunrise during the survey period. Acoustic data from all fine weather nights were analysed using BatSearch version 3.12, a programme designed by the Department of Conservation for use with their ARs. This software program converts the bat echolocation calls (passes) into spectrograms that are visually analysed.

4.4 Avifauna

4.4.1 Best Practice

This assessment follows the accepted process for wind farm assessments (See NZWEA 2013).

[4] Sunset and sunrise times were taken from the closest available location on the LINZ Sunrise/Sunset tables, see https://www.linz.govt.nz/sea/nautical-information/astronomical-information).

Table 4. Avifauna assessment staging for wind farms (New Zealand Wind Energy Association, 2013).

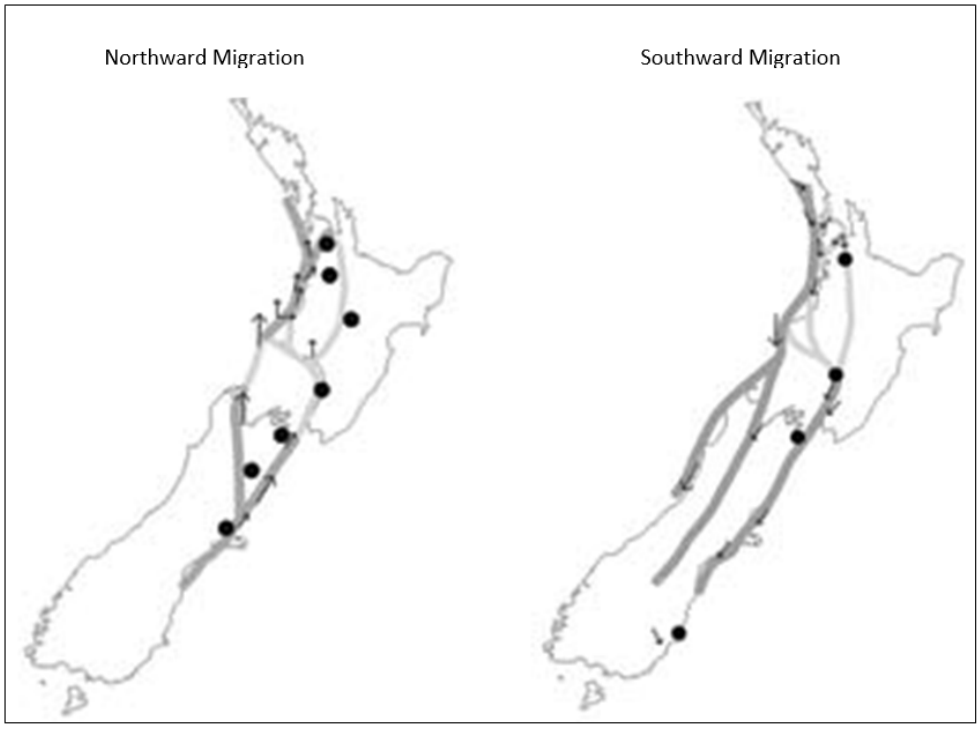
Investigation Level	Methods May Include
Level 1: Preliminary site evaluation and site sensitivity analysis	Preliminary site evaluation and initial assessment of potential risk to indigenous flora and fauna from construction and/or operation of the proposed wind farm. this stage calls upon sources of existing information and reconnaissance surveys to determine the sensitivity of the site and of the wildlife known to be present. if the level of risk is estimated to be low or can be reduced to that level through mitigation measures, design reviews, or siting alterations, no further investigations may be needed. Otherwise, level 2 investigations may need to be undertaken.
Level 2: Site-wide investigation	Site-wide investigation to refine the risk assessment from Level 1 investigation using more intensive methods. This requires a reasonably clear turbine layout so that effects can be accurately assessed. If the level of risk is estimated to be low or can be reduced to that level through mitigation measures, design reviews or siting alterations, no further investigations may be required. Otherwise, Level 3 investigations may need to be undertaken.
Level 3: Population-level studies	Level 3 investigations may be initiated if the results of the Level 2 investigation indicate a greater than low level of residual risk of significant bird impacts from the operation of the proposed wind farm. Research design may seek to answer questions on fatality pathways, the quantification of risk to populations, and the evaluation of risk reduction management practices. These studies should establish both the scale of risk (i.e. probability x impact) and the scale of mitigation needed to fully compensate this risk.
Level 4: Post-construction monitoring	Post-construction monitoring to test the pre-operational predictions and to confirm the success of mitigation measures where they are necessary. this enables validation and refinement of prediction methods, allows regulatory compliance monitoring (e.g. whether a project is fulfilling the terms of its approval by planning authorities), and permits proponents to monitor their own environmental performance.

4.4.2 Desktop Evaluation (Level 1)

The desktop investigation included a review of scientific literature (published and unpublished), and relevant websites. Base data for likely bird occupation of the site was collated from the Atlas of Bird Distribution in New Zealand (grid square (260, 618)) which encompasses the project site (Ornithological Society of New Zealand, 2002). We reviewed the PNAP investigations for this ecological district and protected and unprotected SNA sites listed in the District and Regional Plans for insights into bird habitats and notable populations.

We also looked at the location of the site in relation to possible migratory pathways (Southey, 2009), referencing again the OSNZ Atlas, and experiences from other wind farm work (e.g. Te Apiti, West Wind, Taharoa, Te Uku, and Waverley/Waipipi) to get an understanding of the sensitivity of the site.

Figure 3. Predicted migration routes for national migrants from Southey 2009.



Upon completion of this Level 1 study we concluded that there were unlikely to be any resident or local bird species with a threat status, with the likely exception of NZ pipit which are widespread on pastoral landscapes.

It was also considered unlikely that the site would lie on a flight path for domestic migrants because:

- The site lies too far inland from the coast (8km) to be affected by coastal movements which typically follow distinctive features, the surf, beach, coastal escarpment, and coastal dunes,
- The site lies some distance east of a possible shortcut movement across land from near Hawera to New Plymouth (Southey, 2009) in the vicinity of Waingongoro River (8.5km) and SH3 (10km to the east), and
- The site lies in the "shadow" of Mt Taranaki and so is unlikely to lie in the path for any likely southward movement.

However, for the avoidance of doubt it was recommended that observations be carried out during the peak northward movement of South Island Pied Oystercatcher (SIPO) in 2020. If significant numbers of migrants were observed, we would then move to more comprehensive migrant monitoring.

Note, for the reasons stated above we have assumed if the site was not clearly a migrant pathway during this period, it would also not be a flyway for southward movements.

4.4.3 Site Investigations (Level 2)

The primary objective of these surveys was to determine if the site was traversed by migrant waders. The surveys were accordingly conducted over 10 consecutive days between 8 and 17 January 2020 at the peak period of movement for South Island Pied Oystercatcher (*Haematopus finschi*) which is the most abundant, visible and audible of New Zealand's migratory bird species.

Four methods were used to gather data on bird's resident or vagrant to the site:

Five-minute bird counts

Between 8 and 17 January 2020, five-minute bird counts were conducted daily at each of the four proposed wind turbine sites. The counts were conducted using the methodology described in Dawson and Bull (1975) and were conducted between 6-10 am.

For each count, data were collected on the species (both native and exotic) and number of birds seen and heard during the five-minute period. Weather variables were also recorded including temperature, wind, minutes of sun during the survey, precipitation type and precipitation value.

Fixed point, fixed period surveys

Following each five-minute count, 45-minute fixed point, fixed period counts were conducted. The observers surveyed an 180^0 zone out to 200 metres from the fixed survey point. For each count all native avifauna species seen and heard during the count period were recorded (exotic bird species were not recorded).

Data collected included species and number of birds, time observed, distance of the bird/s from the observer, direction of the bird/s from the observer when first seen, direction of bird movement, maximum height flown, minimum height flown, behaviour, the habitat they were observed in, and any other notes of interest[5].

The order in which the turbines were surveyed was altered daily to catch any temporal variation in bird activity across the sites.

Incidental observations

Bird species not recorded during the formal surveys, but incidentally observed while on site, were also recorded (both native and exotic).

Bioacoustic monitoring

Eight bioacoustic recorders were deployed on fenceposts in close proximity to the proposed turbine locations, including two areas of riparian planting (Figure 4, Page 18). The recorders were set to record from 8pm to 6am to pick up any birds potentially migrating across the site at night. The recordings were analysed by a sub-contractor with expertise in the field of bioacoustics though RavenPro™ to search for the calls of wetland and migratory birds.

Consideration of species not recorded

Finally, we assess a number of native bird species which have a threat status, but which were not seen during the summer 2020 survey, or recorded as part of the OSNZ bird atlas project (Robertson et al., 2007). We consider their habitat preferences and general behaviours against the habitat present at the proposed wind farm site, and its location within the wider landscape to determine the likelihood of seasonal presence or vagrant movements.

4.4.4 Population-level studies (Level 3)

At the completion of the Level 2 study and analysis of data collected (Section 5.6), we considered whether there was a need for further site investigation, including the possible use of radar which is recommended at sites with high use of important species. We concluded that:

- The site does not lie in a flyway for migrant birds, which are more likely to follow the coast around Taranaki or cross the Taranaki bite to the east of the site. The likelihood of occasional migrant birds crossing the site is not zero, but we consider that these will be stochastic events

[5] Note that the birds that were recorded included all observations to the extent of visibility, not just those that crossed the site.

that cannot be predicted or modelled and will not be in numbers sufficient to be considered a risk for these species.

- There was no habitat on the site that would attract or support individuals or populations of threatened or at-risk species other than those observed.
- The native birds that were present were common and widespread and we have a good understanding of the risk of collision for these species from other projects.

No further field investigations were considered necessary.

4.5 Assessing Ecological Significance

A requirement of an ecological impact assessment is to carry out an assessment of significance under Section 6(c) of the Resource Management Act (RMA). The terrestrial values on site have been assessed against the criteria in Policy 4 (Identifying Significant Biodiversity Values) of the Taranaki Regional Policy Statement (Taranaki Regional Council, 2010). Table 5 outlines those criteria. Under Policy 4, indigenous vegetation and habitats of indigenous fauna of a site are considered significant if they meet one or more of the criteria (a, b or c) and are sustainable (criterion d) which takes into account the quality of the area, its naturalness and inherent ecological viability (Table 5).

Table 5. Policy 4 of the Taranaki Regional Policy Statement – Identifying Significant Biodiversity Values (Taranaki Regional Council, 2010).

Significance Criterion:	Explanation:
Rarity and Distinctiveness	This criterion refers to the presence of threatened indigenous flora and fauna species or the presence of species distinctive because they are at their national distributional limit, only occur in Taranaki, or, although common elsewhere, are particularly uncommon in Taranaki.
Representativeness	This criterion refers to an area being significant because it supports ecosystems that are now much reduced in relation to their former extent.
Ecological Context	This criterion refers to an area being significant because it enhances connectivity between fragmented indigenous habitats; buffers or similarly enhances the ecological values of a specific site of value; or provides seasonal or core habitat for specific indigenous species.
If one of these criteria (A-C) are met, the sustainability of the area to continue to be significant in future is considered to decide what management response (if any) should be taken to protect the values of the area.	
Sustainability	This criterion considers the size and shape of the area and its degree of isolation; the type of ecosystems, habitats and species present and their ecological requirements; the presence of threats or disturbance to the area; and the conservation management required to achieve self-sustainability.

4.6 Evaluation of the Level of Ecological Effects

The methodology for assessing the level of terrestrial ecological effects associated with the proposed wind farm follows that in the EIANZ Ecological Impact Assessment Guidelines (Roper-Lindsay et al., 2018). This is considered to represent the best practise approach in New Zealand. In summary, this method requires:

- An assessment of the values of the terrestrial communities, habitats and ecosystems,
- An assessment of the magnitude of the effects on these values based on criteria listed in (Table 7);

- The application of a matrix (Table 8) which determines the level of effect based on the ecological value of the site or species present.

4.7 Assigning Value

4.7.1 Vegetation and habitat

For the terrestrial communities we apply the same criteria as used for a significance assessment in the Policy 4 of the Taranaki Regional Policy Statement (*Rarity and Distinctiveness, Representativeness, Ecological Context, Sustainability*). Each of the four criteria are scored "High", "Moderate", "Low" or "Negligible" based on the assessor's experience and observations of the site. The four scores are then combined to provide a single score for that community from "Very High" to "Negligible".

4.7.2 New Zealand Biota (Individual Species)

New Zealand biota have been assessed by the Department of Conservation (DOC) for their threat from extinction against a standard set of criteria, which is described in (Townsend et al. 2008), and its associated lists published for each taxonomic group[6]. This provides a consistent basis to assign ecological value for individual species (Table 6).

Table 6. Factors to consider when assigning value to terrestrial species (Roper-Lindsay et al., 2018).

Ecological Value:	Determining Factors:
Very High	• Nationally Threatened species found in the ZOI (zone of influence) either permanently or seasonally.
High	• Species listed as At Risk – Declining, found in the ZOI, either permanently or seasonally.
Moderate	• Locally (Ecological District) uncommon or distinctive species; or • Species listed as any other category of At Risk, found in the ZOI either permanently or seasonally.
Low	• Nationally and locally common indigenous species.
Negligible	• Exotic species, including pests, species having recreational value.

4.7.3 Assessing Magnitude of Impact

Once the value of the ecosystem components has been determined, the magnitude of the impact is assessed. Magnitude of Effect is a measure of the extent or scale of the impact, its duration, and the degree of change that it will cause. A typical scale of magnitude ranges from very high to negligible as outlined in (Table 7).

[6] Classifications as listed in: (Robertson et al., 2017) for birds; (de Lange et al., 2018) for vascular plants; (Hitchmough et al., 2016) for lizards; and (O'Donnell et al., 2018) for bats.

Table 7. Criteria for describing magnitude of effect (Roper-Lindsay et al., 2018).

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

4.7.4 Assessing Level of Impact

The overall level of the effect is determined by applying the following matrix (Table 8), which combines the ecological value, and the magnitude of the effect.

Table 8. Criteria for describing the level of effect (Roper-Lindsay et al., 2018).

MAGNITUDE	Very High	High	Moderate	Low	Negligible
Very High	Very High	Very High	High	Moderate	Low
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

Figure 4. The project site including the location of the four turbines (at which the 5-minute bird count and point-count surveys were conducted) and the locations at which the bioacoustic recorders were deployed. The red circles represent the diameter of the swept area of the blades (80m radius).

5 Results – Existing Environment

This section combines the results of the desktop and field investigations to describe the existing environment within the proposed project site.

5.1 Site Context

The proposed wind farm site is located on a dairy farm in the Taranaki region within the South Taranaki District. The land is flat with some undulations and is within the Taranaki ring plain. Ecologically the site is located in the Egmont Ecological District (ED 25.01). Potential vegetation (Landcare Research Informatics Team, 2018) suggests the landscape within which the site lies would have historically been dominated in kahikatea-pukatea / tawa forest.

The lowlands of the Egmont ED (in which the proposal site is located) are described as being largely modified for farming (mostly intensive dairying) with very few areas of indigenous vegetation remaining (McEwen, 1987).

We note that the Taranaki Ring Plain from the west coast to SH3 in the east (and not including Mt Taranaki, or urban areas) contains an area of over 165,000 ha of continuous and largely identical pastoral land. The site (PKW Farm) is approximately 130ha in area with the four proposed turbines located along one margin.

5.2 Significant Natural Areas

With respect to the terrestrial Schedules of the South Taranaki District Plan, the project site does not contain any Significant Natural Areas (Schedule 2) or Notable Trees (Schedule 4) (South Taranaki District Council, 2015).

The closest SNA to the site is SNA 8/Rowan Road which is approximately 7 km from the project site. This SNA is a 1.7 ha lowland tawa forest with pukatea and mahoe on Opunake Formation Appendix B, page 52).

No areas identified in the Protected Natural Areas Programme (PNAP) are present at or close to the site (Appendix C, page 53); the majority of the sites identified are north of Mount Taranaki (Bayfield & Benson, 1986).

5.2.1 Naturally Uncommon Ecosystems

To date, 72 types of naturally uncommon ecosystems have been identified as occurring in New Zealand (Holdaway et al., 2012; Williams et al., 2007; Wiser et al., 2013).

There are no naturally uncommon ecosystems within the project site.

5.2.2 National Priority Environments

The Ministry for the Environment has produced a list of national priority environments for protecting rare and threatened biodiversity of private land (Ministry for the Environment & Department of Conservation, 2007). Note that this is not a statutory document. The priorities are:

- National Priority 1: To protect indigenous vegetation associated with land environments (defined by Land Environments of New Zealand at Level IV) that have 20 per cent or less remaining in indigenous cover.

- National Priority 2: To protect indigenous vegetation associated with sand dunes and wetlands; ecosystem types that have become uncommon due to human activity.
- National Priority 3: To protect indigenous vegetation associated with 'originally rare' terrestrial ecosystem types not already covered by priorities 1 and 2.
- National Priority 4: To protect habitats of acutely and chronically threatened indigenous species.

There are no national priority environments within the project site.

5.2.3 Threatened Environments

Table 9 shows the 2007 version of categories of the Land Environments of New Zealand (LENZ) threat classification (Walker et al., 2007) which forms part of the assessment for significance in the Taranaki Regional Policy Statement. There are six categories, the first five environments are considered to be Threatened. The sixth is considered to be secure.

Table 9: Threatened Environment Classification 2007.

Category	Criteria	Name
1	<10% indigenous vegetation left	Acutely Threatened
2	10–20% indigenous vegetation left	Chronically Threatened
3	20–30% indigenous vegetation left	At Risk
4	>30% left and <10% protected	Critically under protected
5	>30% left and 10-20% protected	Under protected
6	>30% left and >20% protected	Less Reduced and Better protected

The site is located within a land environment F5.2A; flat to gently undulating ring-plain (Taranaki) and coastal plains. Under this classification, this land environment is described as '1' Acutely Threatened. (defined as *"Environments with < 10 % indigenous cover left. In these environments, the loss of habitats for indigenous species has been greatest in the past. Little indigenous biodiversity remains in these environments"*).

5.3 Terrestrial Vegetation

The Land Cover Database classifies the vegetation within the project area as exotic grassland. This was verified while on site as the dominant vegetation type present. The site is a dairy farm and all pasture is improved and intensively grazed (See Figure 5 & Figure 6, and Site Photos (page 46).

Within the part of the site where the turbines would be located all hedgerows are of boxthorn (See Photo 1). The only large trees near the turbines are a cluster of large pines on the neighbouring property approximately 270m west of the nearest proposed turbine, Turbine 3 (See Photo 2 & Photo 3.

Two tributaries of a small stream (Waiokura Stream) traverse the north-western corner of the site near Turbine 1. These have been fenced and retired from farming and the riparian margins in some areas have been planted (See Figure 6 & Photo 6). The main planted species were flax (*Phormium tenax*) and toetoe (*Austroderia toetoe*), with occasional cabbage trees (*Cordyline australis*), shining coprosma (*Coprosma lucida*) and hebe (*Veronica stricta*). Rank grassland is common in these areas as well as patches of blackberry and *Convolvulus, cress and buttercup* (See Photo 5).

Figure 5. Showing turbine locations 1 & 2. Turbine 1 lies close to the west branch of Waiokura Stream (Photo 5).

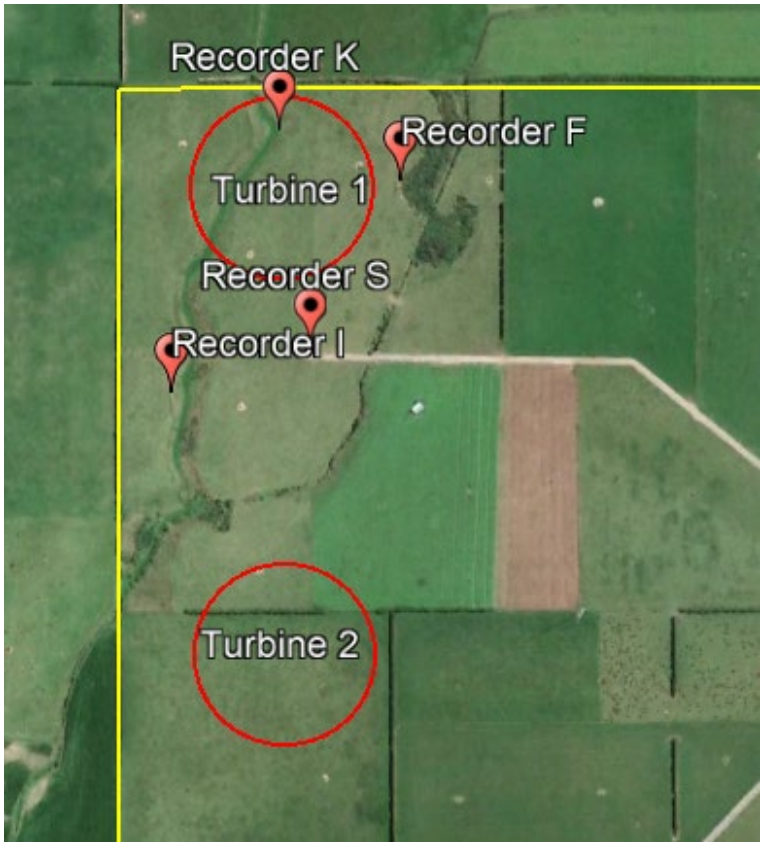
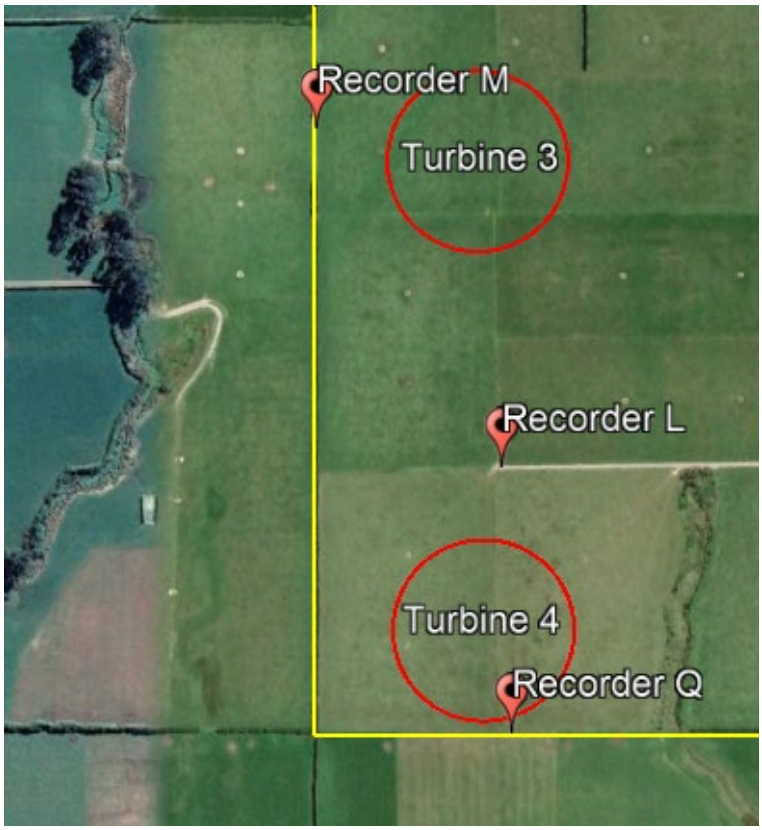


Figure 6. Showing turbine locations 3 & 4, in open pasture. The large pines are the only old growth trees near the turbines (Photo 2).



5.4 Herpetofauna

5.4.1 Desktop

The DOC BioWeb herpetofauna database has records for one species of lizard and one frog species within 10 km of the site during the last 30 years (1990-2020). Older records are considered to be out-of-date and have been omitted. The records are of plague skink (*Lampropholis delicata*) and the brown tree frog (*Litoria ewingii*). These species are both introduced and not considered further in this assessment (Hitchmough et al., 2016).

Five native lizard species have been recorded in the wider south Taranaki area (>10 km from the site). They are:

- goldstripe gecko *(Woodworthia chrysosiretica*; At Risk - Relict),
- copper skink *(Oligosoma aeneum*; Not Threatened),
- ornate skink (*Oligosoma ornatum;* At Risk - Declining),
- brown skink (*Oligosoma zelandicum*), and
- common skink / northern grass skink (*Oligosoma polychroma*; Not Threatened).

These species are typically found in habitats that are not present within the project site. Those habitats include native forest, beaches, coastal flaxlands, and/or woody/rocky debris including debris found in urban areas (Van Winkel et al., 2018).

Of these five species, northern grass skink is considered the most likely to be present, although, if present, it will be confined to small areas of habitat on the margins of the paddocks and within the rank grassland amongst the riparian plantings, but not within the pasture itself.

5.4.2 Site Investigation

The project site is a dairy farm that is intensively grazed and does not contain any remnant or regenerating native vegetation or have any connection to such areas. The riparian planting areas are also isolated and not connected to areas of native vegetation. The pasture does not contain any habitat features such as boulderfields, logs, woody debris, rubbish piles or weedlands.

It is possible that lizards are present in the narrow boxthorn hedgerows and riparian planting where there is some rank grass and debris for shelter, however, these habitats are considered marginal.

Outside of the turbine locations is a row of old growth pine trees that may provide some habitat for lizards (See Photo 2 & Photo 3, page 47) but these are located several hundred metres from the potential turbine pads and access road.

We conclude that the only potential habitat for native terrestrial or arboreal lizards (skinks and geckos) that will be affected by this project, are small areas of boxthorn hedgerow, and small areas of recent riparian planting within rank grass. In both cases the vegetation provides marginal habitat for lizards.

5.5 Bats

5.5.1 Desktop

The DOC bat database was searched (October 2020) for all records of long-tailed bats (*Chalinolobus tuberculatus*, *Threatened – Nationally Critical* (O'Donnell et al., 2018)) and central

lesser short-tailed bats (*Mystacina tuberculata rhyacodia*, *Threatened – Nationally Vulnerable* (O'Donnell et al., 2018)).

In addition, four[7] summer seasons of bat surveys have been conducted in the Taranaki area by Dave Bell (2015-16 summer to 2019-20 summer). These surveys involved the use of automatic bat monitors (ABMs) to detect bat passes. During these surveys, which in total spanned 3,971 survey nights, short- and long-tailed bats were detected in forested areas in northern and eastern Taranaki at some distance from the project site (Appendix D, page 54). During these surveys, a total of 55,978 long-tailed bat passes were detected and 2,653 short-tailed bat passes[8]. No bats were detected on Mount Taranaki (Egmont National Park) despite extensive survey work and it was concluded that it is very doubtful that that they are present in this National Park (Bell, 2016, 2017, 2018, 2019, 2020).

Short-tailed bats

Based on data on the DOC bat database and Native Birds Taranaki, the closest site to the project area where short-tailed bats have been detected is approximately 83 km to the north east, near Tahora. This species will not be present at the proposed wind farm site.

Long-tailed bats

The closest site to the project area where long tailed bats have been detected is approximately 25 km to the east in forest that forms part of the Matemateonga Range on the western fringe of the Whanganui National Park.

No bat surveys have been conducted on the pastoral-dominated landscape of the ring plain. There is some potential small-scale connection between the forests where bats have been detected and scattered shelterbelts within this pastoral landscape and so this landscape is data deficient.

5.5.2 Site Investigation

Fine weather nights that were suitable for bat monitoring (as defined in the methodology in Section 4.3.2) occurred on 13 out of 29 nights during the survey period (Appendices I to J). There were nine and 12 suitable nights for AR locations 2 and 5 respectively (the ARs that stopped working before completion of the survey). The remaining nights were not deemed suitable for automated bat monitoring (based on the guidelines for bat monitoring described in Section 4.3.2) due to adverse weather and moon conditions. Twelve nights dropped below 10°C within the first four hours after dusk and three nights exceeded 5.0 mm within the first two hours after dusk. There was also a full moon on 1 November 2020 (Appendices J and K).

No bat passes were recorded at any of the monitoring locations during either survey (Appendix L).

[7] Three prior summer surveys were conducted however there were unreliable detections during these surveys due to issues with the automatic bat monitors as such the results of these surveys are not considered.

[8] It should be noted that the number of passes is not indicative of the number of bats present in the area, given that the same bat may make multiple passes during a survey. ABM surveys provide an indication of presence and potential relative abundance.

5.6 Avifauna

5.6.1 Combined Results

Thirty-eight avifauna species have been recorded in the OSNZ square that encompass the project site. Based on the vegetation communities present on site, the project area provides potential habitat for 32 of these species. During the surveys conducted on (5-minute bird counts, fixed period counts, bioacoustic monitoring and incidental observations) 24 of these species were recorded within, or traversing, the proposed wind turbine site during the survey period (a total of 2051 birds were recorded). Two species were observed during this study that were not recorded in the OSNZ report, South Island pied oystercatcher and rock pigeon. The 32 species include 15 native species and 17 exotic species (Table 10).

Three of the native species have a national threat status of "At Risk" (Robertson et al., 2017), South Island pied oystercatcher (SIPO), New Zealand pipit and black shag. The other 12 native species that were recorded are classified as "Not Threatened" and therefore would only be considered of conservation concern under unusual circumstances. An unidentified shag was also observed.

Table 10. All species (native and exotic) observed during the ten days of survey (all methods combined) conducted at the proposed wind turbine locations in Kapuni between 8 and 17 January 2020. Nat. Unc. stands for naturally uncommon.

Species	Conservation Status	Observation Method				OSNZ Square for Project Site	Total Observations During Survey Period (All Methods)
		5-Minute Bird Count	Fixed Point – Fixed Period Survey	Incidental Observation	Bioacoustic Monitoring		
S.I. pied oystercatcher	At Risk - Declining		✓	✓			37
Black shag	At Risk – Nat. Unc.	✓	✓			✓	8
New Zealand pipit	At Risk - Declining					✓	-
Australasian pied stilt	Not Threatened				✓	✓	2
Australasian harrier	Not Threatened	✓	✓	✓		✓	159
Black-backed gull	Not Threatened	✓	✓	✓		✓	262
New Zealand fantail	Not Threatened	✓				✓	1
Paradise shelduck	Not Threatened		✓	✓		✓	2
Pukeko	Not Threatened	✓	✓	✓	✓	✓	39
Spur-winged plover	Not Threatened	✓	✓	✓		✓	237
Welcome swallow	Not Threatened	✓	✓	✓		✓	25
White-faced heron	Not Threatened	✓	✓	✓		✓	9
New Zealand kingfisher	Not Threatened					✓	-
Silvereye	Not Threatened					✓	-
Grey warbler	Not Threatened					✓	-
Australian magpie	Exotic	✓		✓		✓	130
Blackbird	Exotic	✓		✓		✓	26
Chaffinch	Exotic			✓		✓	-
Goldfinch	Exotic	✓		✓		✓	2

Species	Conservation Status	Observation Method				OSNZ Square for Project Site	Total Observations During Survey Period (All Methods)
		5-Minute Bird Count	Fixed Point – Fixed Period Survey	Incidental Observation	Bioacoustic Monitoring		
Greenfinch	Exotic	✓		✓		✓	21
House sparrow	Exotic	✓		✓		✓	24
Mallard duck	Exotic	✓				✓	1
Peacock	Exotic	✓				✓	5
Ring-necked pheasant	Exotic	✓				✓	3
Rock pigeon	Exotic	✓					13
Skylark	Exotic	✓		✓		✓	689
Song thrush	Exotic	✓		✓		✓	2
Starling	Exotic	✓		✓		✓	327
Yellowhammer	Exotic	✓		✓		✓	20
Feral goose	Exotic					✓	-
California quail	Exotic					✓	-
Dunnock	Exotic					✓	-
Total Observations							2,051

5.6.2 Five-Minute Bird Counts

Five-minute bird counts were used to record all birds seen or heard on site, both native and introduced species. The distribution and abundance of all birds helps to understand the habitat values of the site.

In total, 40 five-minute bird counts were conducted over ten days, ten at each of the proposed wind turbine locations (total of 3 hours and 20 minutes). A total of 1,463 bird observations were made, of which 875 birds were seen, and 588 birds were heard (not seen).

Eight native bird species were observed and 13 exotic bird species (Table 10). With one exception, all the native species recorded were Not Threatened.

There were seven observations of black shags (At Risk – Declining), all were traversing the site. There is no habitat for them to utilise within the site.

Overall, the most abundant birds observed were exotic species: skylarks (n=689), starlings (n=327) and magpies (n=130). The most abundant native bird species observed were spur-winged plover and black-backed gull, with a total of 76 and 46 observations made respectively.

5.6.3 Fixed Point, Fixed Period Surveys

Fixed point-fixed period surveys were used to describe the behaviour and activity of all native species potentially affected by the project so that any risk can be assessed. Over the ten days of observation, 40 fixed point-fixed period surveys were conducted, ten at each of the proposed wind turbine locations. The total observation effort was 30 hours.

In total, 588 observations of nine native bird species were recorded, including two species with a national threat status of At Risk, the South Island pied oystercatcher (SIPO) and the black shag. An unidentified shag was also observed but was too far from the observer to determine its species (Table 11). The three most abundant native bird species observed, making up 85% of all observations, were black-backed gulls, spur-winged plovers and harrier hawks. None of these are threatened species.

Table 11. Native birds observed during the summer fixed point-fixed period surveys at the proposed wind turbine locations in Kapuni between 8 and 17 January 2020 (sorted by relative abundance).

Species	Conservation Status	Count	Proportion (%)
Black-backed gull	Not Threatened	216	36.7%
Spur-winged plover	Not Threatened	161	27.4%
Harrier hawk	Not Threatened	127	21.6%
Welcome swallow	Not Threatened	15	2.6%
Pukeko	Not Threatened	14	2.4%
White-faced heron	Not Threatened	8	1.4%
Black shag	At Risk – Naturally Uncommon	7	1.2%
Paradise shelduck	Not Threatened	2	0.3%
S.I. pied oystercatcher	At Risk - Declining	1	0.2%
Unidentified shag species	-	1	0.2%
Total		588	100.0%

(Note these numbers are likely to represent multiple counts of the same bird/s over several visits)

The South Island pied oystercatcher was the only migratory bird species recorded. A single individual crossed the site, flying directly above the observer, travelling north.

5.6.4 Incidental Observations

The only incidental observations of note were of South Island pied oystercatcher. One bird was recorded crossing the site during a fixed-point, fixed-period surveys (See Table 11). A further 36 birds were observed in three flocks heading north from the coast toward New Plymouth. A distant flock of birds (greater than 2,000 m away) was assumed to be SIPO but this was not confirmed and are not included. The distances to the three confirmed flocks from the turbine sites were estimated to be between 400 m and greater than 2,200 m away. All confirmed flocks were heading north. All other incidental observations were of species which do not have a threat status, or which are introduced.

Table 12. Incidental observations for South Island Pied Oystercatcher (including point count observation of a single bird from 14 Jan 2020)

Date	Time	#Birds	Observer Distance (m)	Direction from Observer	Movement Direction	Max Height (m)	Min Height (m)	Behaviour
8/01/2020	09:40:00	10	approx. 1,500	E	N	250	150	Traverse
10/01/2020	07:57:00	6	400	ENE	N	80	80	Traverse
12/01/2020	07:09:00	20	approx. 2,200	W	N	50	50	Traverse
14/01/2020	07:12:00	1	100	W	N	80	60	Traverse

5.6.5 Bioacoustic Monitoring

In total, 80 hours of recordings were collected at 8 locations. Analysis of the recordings using RavenPro™ detected two calls of Australasian pied stilt on 14 January 2020. Besides pukeko, no other wetland or migratory bird calls were recorded.

5.6.1 Flight Height

Table 13 presents the results for bird flight height in relation to the zone within which the turbine rotors move. This zone is typically called the Rotor Swept Area (RSA). For this application consent is being sought for a wind turbine with a lower blade tip of no less than 43m above ground, and an upper blade tip sweep of no more than 206 m above ground, giving a maximum rotor diameter of 160m.

Typically for analysis of flight risk this zone is widened slightly to account for observer inaccuracies when estimating flight heights. For this project we have considered any birds observed flying between 35m and 230m to be at risk.

Table 13. Native bird observations in relation to the rotor swept area (widened to 35-230 m to account for observer inaccuracies when estimating flight heights) during the summer fixed point-fixed period surveys at the proposed wind farm locations in Kapuni between 8 and 17 January 2020.

Species	Conservation Status	Total Count	Total Count Within RSA	Proportion Within RSA (%)
Black-backed gull	Not Threatened	216	120	56
Spur-winged plover	Not Threatened	161	3	2
Harrier hawk	Not Threatened	127	24	19
S.I. pied oystercatcher [1]	At Risk - Declining	1	1	100
Welcome swallow	Not Threatened	15	0	0
Pukeko	Not Threatened	14	0	0
White-faced heron	Not Threatened	8	1	13
Black shag	At Risk – Naturally Uncommon	7	1	14
Paradise shelduck	Not Threatened	2	0	0
Unidentified shag species	Unknown	1	1	100

[1] A single SIPO was observed within the site travelling at between 60m and 80m. A further 36 SIPO were observed at between 400 and 2.2km from the site. All appeared to be flying within the RSA but at these distances flight height estimation is difficult, and these birds may have been flying above RSA.

5.6.2 Birds not seen

The site investigations have indicated that there is no habitat for native bird's other those which are habituated to a pastoral landscape. Even native birds that we would expect to be present in rural landscapes where there are areas of taller trees (New Zealand kingfisher, Silvereye & Grey warbler) were not seen or heard. The NZ fantail was the only forest passerine recorded. However, while not seen during this study or recorded in the OSNZ Bird Atlas for this map grid (Robertson et al., 2007), there are a number of threatened and at risk bird species found within the North Island of New Zealand and for the avoidance of doubt, we consider these species as follows:

Table 14. Consideration of At Risk and Threatened bird species that occur in the North Island but were not seen during this study,

Species	Threat Status	Preferred habitat and consideration in assessment of collision risk
Coastal Species For the eight coastal species with a threat status that occur in the North Island, and that were not observed at this site, we note that the site is 8km inland of the coastal environment and therefore is not an area where "coastal processes, influences or qualities are significant, including coastal lakes, lagoons, tidal estuaries, saltmarshes, coastal wetlands, and the margins of these the coast and is outside of the coastal environment or any coastal influence". Some of these birds can also occupy freshwater/wetlands habitats, but at the Kapuni site the streams are densely vegetated, and there are no ponds, pools or ephemeral wetlands that these species would utilise. Therefore, the site is not considered to provide core or seasonal habitat for the following:		
Black-fronted tern	Threatened – Nationally Endangered	Primary habitat used is freshwater/wetlands, secondary habitat used is coastal/estuarine and farmland/open country (Heather & Robertson, 2015). While pasture can also be used as habitat none were observed during the 11-day survey period. This species is not recorded in the OSNZ Atlas for this grid square.
Black-billed gull	Threatened – Nationally Critical	Primary habitat used is freshwater/wetlands, secondary habitat used is coastal/estuarine and farmland/open country (Heather & Robertson, 2015). While pasture can also be used as habitat none were observed during the 11-day survey period. This species is not recorded in the OSNZ Atlas for this grid square.
Red-billed gull	At Risk – Declining	Primary habitat used is coastal/estuarine, secondary habitats used are freshwater/wetlands and farmland/open country (Heather & Robertson, 2015). While pasture can also be used as habitat none were observed during the 11-day survey period. This species has been recorded in the OSNZ Atlas for this grid square, noting the grid square approaches the coast at one corner.
Caspian tern	Threatened – Nationally Vulnerable	Primary habitat used is coastal/estuarine, secondary habitat used is freshwater/wetlands (Heather & Robertson, 2015). This species is not recorded in the OSNZ Atlas for this grid square.
Royal spoonbill	At Risk – Naturally Uncommon	Primary habitat used is coastal/estuary, secondary habitat is freshwater/wetlands (Heather & Robertson, 2015). This species has been recorded in the OSNZ Atlas for this grid square, noting the grid square approaches the coast at one corner.
Northern New Zealand dotterel	At Risk – Recovering	Primary habitat used is coastal/estuarine, secondary habitat used is freshwater/wetlands (Heather & Robertson, 2015). The Kapuni site is not coastal and contains only tiny areas of poor-quality freshwater habitat that would not be used by this species. While pasture can also be used as habitat none were observed during the 11-day survey period. This species has been recorded in the OSNZ Atlas for this grid square.
White-fronted tern	At Risk – Declining	Primary habitat used is coastal/estuary (Heather & Robertson, 2015). The Kapuni site is not coastal and contains only tiny areas of poor-quality freshwater habitat that would not be used by this species. While pasture can also be used as habitat none were observed during the 11-day survey period.

Species	Threat Status	Preferred habitat and consideration in assessment of collision risk
		This species has been recorded in the OSNZ Atlas for this grid square, noting the grid square approaches the coast at one corner.
Variable oystercatcher	At Risk - Recovering	Primary habitat used is coastal/estuarine, secondary habitats used are freshwater/wetlands and farmland/open country (Heather & Robertson, 2015). While pasture can also be used as habitat none were observed during the 11-day survey period. This species has been recorded in the OSNZ Atlas for this grid square, noting the grid square approaches the coast at one corner.
Wetland Birds The freshwater habitat on site does not contain areas of open water, pools, ponds or lagoons and vegetated margins, snags or roost trees. Therefore, for the six species listed below, the site does not provide habitat that would normally be utilised. Therefore, the site is not considered to provide core or seasonal habitat for the following:		
Australasian bittern	Threatened – Nationally Critical	Primary habitat used is freshwater/wetlands, secondary habitat used is coastal/estuarine (Heather & Robertson, 2015). The Kapuni site contains only tiny areas of freshwater habitat, too small to support this species. This species is not recorded in the OSNZ Atlas for this grid square.
Brown teal	At Risk - Recovering	Primary habitat used is freshwater/wetlands, secondary habitat is farmland/open country (Heather & Robertson, 2015). While pasture can also be used as habitat, none were observed during the 11-day survey period. This species is not recorded in the OSNZ Atlas for this grid square.
North Island fernbird	At Risk - Declining	Primary habitat used is freshwater/wetlands, secondary habitat used is coastal/estuarine (Heather & Robertson, 2015). This species is not recorded in the OSNZ Atlas for this grid square.
Little black shag	At Risk – Naturally Uncommon	Primary habitat used is freshwater/wetlands, secondary habitat used is coastal/estuary (Heather & Robertson, 2015). This species is not recorded in the OSNZ Atlas for this grid square.
New Zealand dabchick	At Risk – Recovering	Primary habitat used is freshwater/wetlands (Heather & Robertson, 2015). This species is not recorded in the OSNZ Atlas for this grid square.
Spotless crake	At Risk - Declining	Primary habitat used is freshwater/wetlands, secondary habitat used is coastal/estuarine (Heather & Robertson, 2015). This species is not recorded in the OSNZ Atlas for this grid square.
Migrant Species Most migrant species are waders utilising tidal flats or ephemeral wetlands as habitat. During high tide or during storms they may fly inland to flooded paddocks but would have no reason to fly 8km inland to the Kapuni Site, which is in every way, unremarkable. Nor do we consider the Kapuni site to be on a flyway for migrations. Therefore, the site is not considered to provide core or seasonal habitat for the following:		
Banded dotterel	Threatened – Nationally Vulnerable	Primary habitat used is coastal/estuarine, secondary habitat used is freshwater/wetlands (Heather & Robertson, 2015). This species is not recorded in the OSNZ Atlas for this grid square.
Black stilt	Threatened – Nationally Critical	Primary habitat used is freshwater/wetlands, secondary habitat used is coastal/estuarine. This species is not recorded in the OSNZ Atlas for this grid square.

Species	Threat Status	Preferred habitat and consideration in assessment of collision risk
Eastern bar-tailed godwit	At Risk – Declining	Primary habitat used is coastal/estuary (Heather & Robertson, 2015). This species is not recorded in the OSNZ Atlas for this grid square.
Wrybill	Threatened – Nationally Vulnerable	Primary habitat used is coastal/estuarine, secondary habitat used is freshwater/wetlands (Heather & Robertson, 2015). This species is not recorded in the OSNZ Atlas for this grid square.
Pastoral Species		
New Zealand pipit	At Risk – Declining	Primary habitat used is farmland/open country, secondary habitat is coastal/estuary. This species is recorded in the OSNZ Atlas for this grid square and we would expect it to be present in this landscape. It has a large home range and it is likely that one or more pairs do have a territory that includes part of this site.

5.6.3 Results Summary

In summary, the avifauna species observed during the summer survey period are those expected of the pastoral-dominated landscape of the Taranaki ring plain. These species include a mix of native (predominantly not threatened) and exotic species that utilise open pasture and associated habitat features such as hedgerows and shelter belts.

Two At-Risk species were observed: black shag (At Risk – Naturally Uncommon) and South Island pied oystercatcher (At Risk - Declining), both in low numbers. All South Island pied oystercatcher observations (n=37) were recorded as flying within the Rotor Swept Area (RSA) although all but one observation was at some distance from the project footprint. Finally, one of the black shag observations was within RSA.

Two calls of the Australasian pied stilt (Not Threatened) were captured by Bioacoustic Recorder at night. It is not possible to determine if these were in flight or roosting.

The New Zealand pipit (At Risk - Declining) was not seen on site but has been recorded by OSNZ observers within the general area and we consider it likely that the home ranges of one or two pairs intersect the site.

We have considered a number of other threatened or at risk coastal and wetland species that were not recorded during summer observation or by OSNZ observers. We conclude that there is no habitat for these species that would attract them to this site, but we cannot rule out vagrant movements of some of these species that would lead them to traverse the site from time to time.

6 Ecological Significance

The purpose of Policy 4 of the Taranaki Regional Policy Statement (Table 5) is to provide criteria for the identification and protection of indigenous ecosystems and habitats with significant indigenous biodiversity values as required by Section 6(c) of the RMA. Note that 'significance' is not a measure of ecological value or condition. Ecological value is assessed in Section 7.

The significance criteria are:

Significance Criterion:	Explanation:
Rarity and Distinctiveness	This criterion refers to the presence of threatened indigenous flora and fauna species or the presence of species distinctive because they are at their national distributional limit, only occur in Taranaki, or, although common elsewhere, are particularly uncommon in Taranaki.
Representativeness	This criterion refers to an area being significant because it supports ecosystems that are now much reduced in relation to their former extent.
Ecological Context	This criterion refers to an area being significant because it enhances connectivity between fragmented indigenous habitats; buffers or similarly enhances the ecological values of a specific site of value; or provides seasonal or core habitat for specific indigenous species.

If any 1 criterion is met, the ecosystem component is considered significant.

Pasture and hedgerows

This vegetation is entirely exotic and so we do not consider that it meets the significance criteria for representativeness, rarity and distinctiveness, or context.

The pasture and hedgerows will be providing limited habitat for common and abundant indigenous species but not core or seasonal habitat for threatened or at-risk species.

Riparian habitat

This riparian vegetation is a mix of relatively large areas of rank grass, weeds, and dense cress and buttercup, with smaller areas of native planting. We do not consider these communities meet the significance criteria of representativeness, rarity and distinctiveness, or context.

The planting will, over time, provide increasing benefit in terms of connectivity along this pastoral stream network, but not until planting is complete and provides an unbroken extent of native riparian vegetation and habitat which traverses through multiple properties.

We conclude that none of the plant communities or habitats of indigenous fauna are significant.

7 Ecological Value

Sites which are not considered significant under section 6(c) of the RMA may still have ecological values. An assessment of ecological value is therefore carried out to guide our consideration of site sensitivity to change, the magnitude and importance of ecological effects, and the need for, and quantum, of required mitigation (Roper-Lindsay et al., 2018). We use the same three criteria as for the significance assessment. However, for this analysis we provide a score of ecological value (Very High, High, Moderate, Low, Negligible) against each criterion.

Pasture & hedgerows

The terrestrial vegetation is not representative, rare or distinctive. The only ecological value of the pasture and hedgerows are as potential habitat for indigenous species. The pasture is habitat for a number of common and widespread bird species. The hedgerows provide habitat that can be utilised by small forest passerines (although none were seen) and are potentially habitat for lizards (northern grass skink). We consider that these two exotic communities to have low value for context.

Riparian habitat

The native vegetation found at these locations is planted. It does not yet have representativeness value, or rarity value. In its current incomplete form, it will not be providing connectivity along this pastoral stream network, but this may improve if more planting is carried out on this property and its neighbours. This vegetation will also provide habitat that can be utilised by small forest passerines which were not seen on this study and may provide marginal habitat for northern grass skink (a Not Threatened species). We consider that this planted community has Low value as a corridor within this otherwise entirely exotic environment.

Indigenous species

Three native bird species which have a national threat status of At-Risk were observed or are considered to be present. We apply the EIANZ guidelines to these species below, with different scores relating to different levels of threat (See Table 6).

Table 15. Ecological values of terrestrial habitats and indigenous species within the proposed wind farm site.

Ecosystem Component	Representative	Rarity	Context	Conclusion
Terrestrial Vegetation				
• Pasture and hedgerows	Negligible	Negligible	Low	Low
Freshwater Habitat				
• Riparian planting	Negligible	Negligible	Low	Low
Avifauna (Threatened or At Risk)				
• South Island Pied Oystercatcher	(At Risk - Declining)			High
• NZ Pipit	(At Risk - Declining)			High
• Black shag	(At Risk - Naturally Uncommon)			Moderate
• All other native birds	Not Threatened.			Low

8 Assessment of Ecological Effects

Once the value of the ecosystem components has been determined (See Section 4.7), the magnitude of the effect is assessed. Magnitude of effect is a measure of the extent or scale of the impact, its duration, and the degree of change that it will cause (See Section 4.7.3). A typical scale of magnitude ranges from very high to negligible and may also include positive effects. The overall level of effect is then assessed below having regard to both the magnitude of the effect and the ecological value of the area or community affected (See Section 4.7.4). The following items are considered.

Table 16: Checklist of Potential Ecological Effects

Potential Impact	Construction phase	Operation phase
Potential vegetation and habitat effects		
• Direct habitat loss (reduced species diversity, reduced habitat, displacement)	X	X
• Indirect habitat effects and associated biological impacts such as:		
- Reduction in habitat extent (e.g. reduced habitat integrity, edge effects)	X	
- Interference with geological / morphological processes (e.g. slope processes).		X
- Interference with hydrological processes (e.g. diversions, drainage, effects on aquifers)		X
- Erosion / sedimentation (effect on freshwater systems, turbidity, siltation).	X	
Potential disturbance to mobile species		
• Noise / construction activity (disturbance of life stages, breeding, feeding)	X	
• Turbine lighting (nocturnal birds, migrants, bats)		X
• Bird / bat collision		X
• Bird / bat displacement from habitat	X	X

8.1 Potential effects on Terrestrial Vegetation

Improved pasture and pasture

Small areas of pasture will be lost to the access track and turbine footprints. We consider that this will not have an effect on habitat availability for the species which currently utilize it, given that this is a small site within many thousands of hectares of equivalent habitats.

This conclusion includes NZ pipit which can have a home range as large as several square kilometres (Beauchamp, 2007, 2009) and so will not be reliant on pasture within this site for forage and breeding.

Overall, it is our opinion that none of the native birds recorded utilising this habitat will be adversely affected by a minor reduction in the area of pasture.

Hedgerows

We understand that only a small area of this habitat will be lost at the access point off Kokiri Road and between the turbines. These hedgerows may provide habitat for highly mobile, common, Not Threatened and exotic avifauna, and potentially northern grass skink (a Not Threatened species). Narrow boxthorn hedgerows appear to be common at this site and in the wider area, and we

consider that the loss of several small areas of hedgerow will have a negligible effect on avifauna and northern grass skink (if present).

Riparian Planting

We understand that only small areas of this habitat will be directly affected by works to upgrade existing crossings and / or install new culverts. These plantings currently provide low value habitat and we consider that the loss of small areas of riparian planting and associated grassland will have a negligible effect on avifauna and northern grass skink.

Hydrology

This is being assessed separately.

Erosion & Sediment Management

Erosion control and sediment management on this flat site will be straightforward.

8.2 Potential effects on Terrestrial Fauna

Lizards

Given the small-scale loss of shelterbelt and riparian planting (the only potential habitat for indigenous lizards within the site) and availability of these habitat types on site and wider area, we consider that clearance will result in a negligible magnitude of effect on northern grass skink (the only indigenous lizard species that could potentially be present on site). Combining Low ecological value with a Negligible magnitude of effect, results in adverse effects that are Very Low. Nonetheless, for the avoidance of doubt, we recommend conducting a lizard survey prior to works as described in Section 9.1.

8.3 Potential Construction effects on Avifauna

Construction traffic and noise

Our experience at other construction projects is that the pastoral species that utilise pastoral habitats are already highly tolerant of human activity, vehicles, stock movement, top dressing, dogs, quad bikes and are highly mobile species that can easily move to adjacent grassland habitat in the surrounding area if disturbed or they feel threatened. For some species, including NZ pipit, rather than being disturbed these species quickly habituate to earthworks activities and the new foraging areas created. We consider that the magnitude of effect of the wind farm construction to indigenous avifauna will be Negligible. Combining Low to High ecological values with a Negligible magnitude of effect, results in adverse effects that are Very Low to Low.

8.4 Potential Operational effects on Avifauna

8.4.1 Mortality / Bird Turbine Strike

The following table identifies specific features of windfarms and wind turbines that have been implicated in bird strike and displacement.

Table 17. Generic risk factors of wind farms for bird collision.

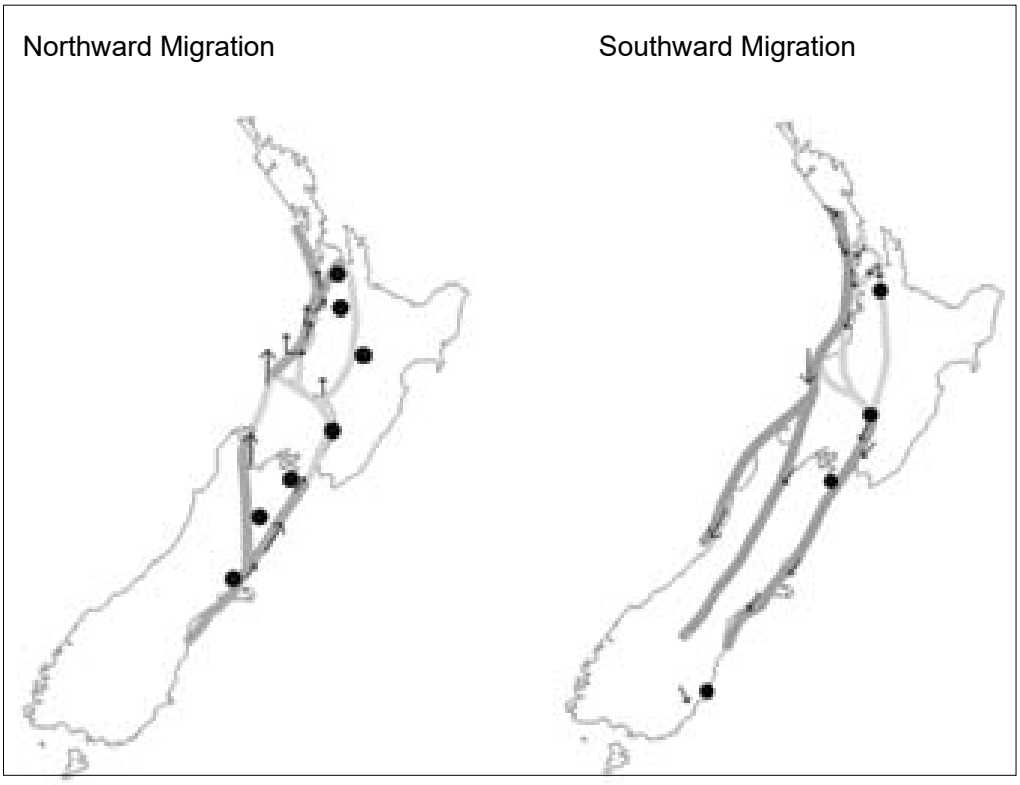
Risk Factors	Kapuni Green Hydrogen Project
Large concentrations of turbines	No, only four turbines
Closely spaced turbines	No, spaced widely apart (360m).
Turbines in uniform rows across the landscape (barrier)	Four turbines in line north to south, in an expansive pastoral landscape
Turbines within a steep valley, across saddles	No
Turbines that lie across a migratory route	No. west of a migratory route, and in line with movement direction.
Turbines in close proximity to habitats where birds congregate (wetlands, lakes, estuary's, staging areas)	No
Turbines within a site where threatened or at-risk species are resident or are local and regularly utilise habitat.	No
Frequent fog and low cloud common (esp. during migration season)	No
Large prey base (attracting raptors)	Harrier hawk are commonly seen at this site, as for all rural wind farm sites in New Zealand
Transmission lines perpendicular to prevailing winds	No (power cable will be underground)
Transmission lines crossing water	No (stream crossings will be under bored)

8.4.2 Migrants

At Kapuni the levels of migrant activity overserved were very low (1 x South Island pied oystercatcher traversing and 2 x pied stilt detected by bioacoustic recorders) in comparison to other studied sites on the west coast of the North Island such as Hauāuru mā raki (Kessels & Associates Ltd, 2009) and Taharoa wind farms (Fuller et al., 2009).

Both the Hauāuru mā raki (HMR) and Taharoa wind farm sites lied at key locations on the migration route, whereas in the case of the South Taranaki Bight it is more likely that migration movements are divided over a number of potential migration routes following landscape features, or in some locations may be dispersed across a wide front. This is discussed in Southey (2009) who prepared the following indicative maps (Figure 7) based on observations from ornithologists throughout the country during migration events.

Figure 7: Predicted Migration routes for national migrants from Southey 2009.



In comparison to these other sites, Kapuni lies within an uninterrupted landscape, consisting of 165,000 ha of continuous and largely identical pastoral land. There are no landscape features that would lead birds to it, or habitats that would encourage migrants to rest at it, in preference to any other farm surrounding the site.

Notably, while there was only one observation of SIPO crossing the site, a larger number (3 flocks, 36 birds) were observed several kilometres to the east of the Kapuni site, and closer to the low pass that lies between the foothills of the Whanganui National Park to the east, and Mt Taranaki to the west, and following SH3 between Hawera and New Plymouth.

Putting this site into context we show in Table 18 migrant movements over the same January period of observation at both the Taharoa wind farm site, and a similar period of observation at the Waverley/Waipipi wind farm. Note at both sites SIPO was used as a surrogate for all migrants as they are the most visible.

Table 18. Comparison of observed activity of SIPO at Kapuni, Waverley and Taharoa in January (excluding unverified radar observations at Taharoa).

	Kapuni		Waverley		Taharoa	
	Week 1: 7-12 Jan 2020 Week 2: 13-17 Jan 2020		Week 1: 7-12 Jan 2011 Week 2: 25-31 Jan 2011		Week 1: 7-12 Jan 2008 Week 2: 13-17 Jan 2008	
	Flocks (n)	Birds (n)	Flocks (n)	Birds (n)	Flocks (n)	Birds (n)
Week 1	1	1	9	39	235	3,875
Week 2	0	0	13	104	206	3,299
Total for period	1	1	22	143	441	7,174

Overall, we conclude that this site is not an important migratory route.

8.4.3 Threatened or At-Risk Species

As discussed in Section 3.3.2 there are many different factors that combine to create conditions where windfarms are either safe, or hazardous, to wildlife such as topography, the size, number and type of turbines used, the spatial arrangement of turbines; the species of concern and their breeding, feeding, roosting behaviour and movement patterns. In the following sections we consider these factors for the birds present on site.

Relevant to this discussion is Table 19 which shows the number of observations made by each native species that were within the rotor swept area (RSA). It shows that many species rarely, or only occasionally, fly within the zone of the turbine blade and therefore are not at risk.

Table 19. Native bird observations within the observer error adjusted rotor swept area (35-230 m) during the summer fixed point-fixed period surveys at the proposed wind farm locations in Kapuni between 8 and 17 January 2020. Sorted by relative abundance.

Species	Conservation Status[9]	National Population Size[10]	Total Count	Total Count Within RSA	Proportion Within RSA (%)
Black-backed gull	Not Threatened	Very abundant: hundreds of colonies throughout NZ, many >100 pairs, some >1,000 pairs	216	120	56%
Spur-winged plover	Not Threatened	Abundant. 1994 estimate of ~3,600 birds at harbours and estuaries but an underestimate of a species that occurs widely in many habitats today.	161	3	2
Harrier hawk	Not Threatened	Not specified, but widespread and very common	127	24	19
S.I. pied oystercatcher	At Risk – Declining	~100,000	1	1	100%
Welcome swallow	Not Threatened	Not specified but widespread and common	15	0	0
Pukeko	Not Threatened	>600,000	14	0	0
White-faced heron	Not Threatened	Not specified but one of NZ's most common large birds	8	1	13
Black shag	At Risk – Naturally Uncommon	~5,000-10,000	7	1	14%
Paradise shelduck	Not Threatened	~600,000-700,000	2	0	0
NZ Pipit	At Risk – Declining	Not specified but widespread and locally common	Not observed	-	-

South Island Pied Oystercatcher (At Risk – Declining)

During the 11-day bird survey conducted on site (8-17 January 2020), which coincided with the peak northward migration period for South Island pied oystercatchers (SIPO), 1 SIPO was detected within the windfarm footprint. A further 36 SIPO were observed outside and to the east of

[9] (Robertson et al., 2017)

[10] http://www.nzbirdsonline.org.nz./

the project site, traveling north. These numbers are very low when compared to a site like Taharoa, and also lower than the coastal Waverley/Waipipi wind farm.

At Waverley we calculated that it would take approximately 1,000 traverses of the 7km long, 2.2km wide, 28 turbine wind farm to result in a single mortality (this varied depending on the avoidance rate used). In contrast to Waverley, the Kapuni site is 1.3km long and 160m wide with 4 turbines. While we cannot say the risk of a collision is zero, we conclude that any such collision would be stochastic and unpredictable, and based on our observations, we do not believe SIPO would cross the site in sufficient numbers to result in mortalities sufficient to cause a population level effect given a national population of ~100,000.

Overall, we consider that the magnitude of effect of the wind farm operation to SIPO will be Negligible (that is, *having negligible effect on the known population or range of the element/feature*). Combining High ecological value with a Negligible magnitude of effect, equals adverse effects that are Very Low.

Black Shag (At Risk – Naturally Uncommon)

There were seven traverses of the site by black shag, with one traverse within RSA. At Waverley, where black shag were seen more frequently within the site, traversing to wetlands surrounding a small lake modelling suggested that it would take 8,600 traverses per annum to have an impact on the national population, equating to 23 traverses per day at a conservative avoidance rate of 98% (Boffa Miskell Ltd, 2016).

Overall, we consider that the magnitude of effect of the wind farm operation to black shag will be Negligible (that is, *having negligible effect on the known population or range of the element/feature*). Combining High ecological value with a Negligible magnitude of effect, equals adverse effects that are Very Low.

NZ Pipit (At Risk – Declining)

NZ pipit were not recorded during this study but have been recorded locally by OSNZ. The habitat is suitable for this species, although lacking in rough pasture or shrublands for nesting, and we expect pipit to be present in the wider area. This species can have a very large home range in this type of landscape and we would expect there to be at most one or two pairs whose territories overlap the windfarm site (Beauchamp, 2007, 2009).

There were approximately 39 observations of NZ pipit at the Waverley/Waipipi Wind Farm (coastal dunes being a preferred habitat), however, and all recorded flight activity was significantly below the RSA (max height = 3 m) (Boffa Miskell Ltd, 2016). We have had similar results at other windfarm sites (S. Fuller pers. obs).

Given the absence of observations, likely very large home range, and a typical behaviour of very low flight height, we do not consider this species to be at risk from the operation of a windfarm.

Overall, we consider that the magnitude of effect of the wind farm operation to NZ pipit will be Negligible (that is, *having negligible effect on the known population or range of the element/feature*). Combining High ecological value with a Negligible magnitude of effect, equals adverse effects that are Very Low.

8.4.4 All other native birds (Not threatened)

From post-construction monitoring at other windfarm sites we have identified a range of species at risk of collision mortality (See section 3.3.2, page 3).

At the West Wind site, the only New Zealand wind farm with published results (Bull et al., 2013), collision mortalities of native birds were largely of the Australian harrier, paradise shelduck, spur-winged plover, southern black-backed gull, and two tui. With the exception of tui which was not observed at the Kapuni site, we expect that these same three species will be impacted by the turbines, albeit at a lower level given the difference in extent of a four-turbine windfarm in comparison to most existing wind farms.

So, while collisions will occur, the key question is whether sufficient mortalities occurred to impact at the population level, either locally or nationally. For West Wind, this did not appear to be the case, with populations of these species generally similar at the end of the monitoring (pers. obs.). Where there were changes in species distribution across the windfarm, these appeared to be related more to changing farm practices than turbine presence.

For the native species most likely to experience periodic turbine collision (Australian harrier, paradise shelduck, southern black-backed gull, and spur winged plover) and given their abundance across this site, the surrounding landscape and nationally, we consider the potential magnitude of effect to be Negligible (that is "*Having negligible effect on the known population or range of the element/feature"*). Combining Low ecological value with a negligible level of effect, equals adverse effects that are Very Low. We do not consider that any mitigation or offsetting is required.

8.4.5 Bird Strike – Turbine Lighting

Turbine lighting has been identified as a concern in some countries. It appears to be specific to the site and the species present; for example, certain migrant species or bats which commute. To date, there is no evidence from post construction monitoring of windfarms in New Zealand, that this is an issue. Given that the site and the wildlife present are very similar to West Wind wind farm, and lighting related issues were not observed, we see no reason for this to be a matter of concern at Kapuni.

8.4.6 Bats

Based on the data on the DOC bat database, the closest known location of short-tailed bats to the project site is approximately 83 km to the north east, near Tahora, and the closest known location of long-tailed bats is approximately 25 km to the east in forest that forms part of the Matemateonga Range on the Western fringe of Whanganui National Park.

Given that no bat surveys had been conducted on the pastoral-dominated landscape of the ring plain, where the project site is located, a bat survey was conducted on site between 12 October and 9 November 2020. No bats were detected during this survey.

We acknowledge that bats have a very large home range and therefore we cannot rule out the possibility that a population within the wider landscape could enter the site at some time in the future, however, there are no features at this site that make it stand out from the surrounding landscape or would specifically attract bats to it. This combined with the absence of bats in spring 2020 lead us to conclude that it is highly unlikely that this site provides important habitat for bats.

8.5 Summary of the Level of Ecological Effects

Ecosystem Component	Ecological Value	Magnitude of Effect	Overall Level of Effect
Terrestrial Vegetation			
• Pasture and hedgerows	Low	Negligible	Very Low
• Riparian planting	Low	Negligible	Very Low
Avifauna			
• South Island Pied Oystercatcher	High	Negligible	Very Low
• NZ Pipit	High	Negligible	Very Low
• Black shag	Moderate	Negligible	Very Low
• All other native birds	Low	Negligible	Very Low
Herpetofauna			
• Northern grass skink	Low	Negligible	Very Low

9 Avoid, Minimise, Remedy and Mitigate

The following actions are recommended to avoid, minimise, remedy and mitigate any potential adverse terrestrial ecological effects of construction and operation of the proposed wind farm.

9.1 Construction

9.1.1 Avoid

Terrestrial Vegetation

- Most areas of hedgerow will be avoided on site, except where small areas of clearance is required to install the access track during construction. Most of this potential low value habitat will therefore not be affected.

Riparian Vegetation

- We understand that most riparian plantings will be avoided on site, except for small areas of riparian vegetation (and associated rank grassland) that will be affected during construction to upgrade existing crossings and / or install new culverts. Most of this potential low value habitat will therefore not be affected.

9.1.2 Remedy

- There are no adverse ecological effects requiring remediation.

9.1.3 Mitigate / Offset

- For the avoidance of doubt, we recommend that once infrastructure plans and associated extents and locations of hedgerow and riparian planting (including associated grassland) clearance are finalised, a lizard survey is conducted in these areas by a suitably qualified and experienced ecologist. If lizards are detected, then a lizard management plan should be prepared, and a DOC permit obtained to rescue and relocate lizards.

9.2 Operation

9.2.1 Post-construction bird collision monitoring

- We have considered the necessity of post-construction monitoring of bird strike at this site. It is our conclusion that, there are no species with a status of threatened or at risk that are likely to interact with these four turbines sufficiently for there to be an adverse effect on the local or national populations of those species.
- We are aware that mortalities of a number of common native species will occur, but as for other wind farms that have undergone post construction monitoring, those mortalities will be of common and widespread species of pastoral landscapes, and are unlikely to occur at levels that will have local or national population level effects.

10 Conclusion

The proposed wind farm site is located on a dairy farm and is dominated by exotic vegetation, primarily grassland with small areas of fenced, native riparian planting and exotic hedgerows.

The terrestrial habitats and species of the project site do not trigger any of the significance criteria within the Taranaki Regional Policy Statement, and as such are not considered to be significant.

The terrestrial habitats of the project site are considered to have low ecological value. Two species of bird observed on site (South Island Pied Oystercatcher and Black shag) have a threat status of At Risk (Declining and Naturally uncommon) and are considered to have high and moderate ecological value for rarity respectively.

No natural indigenous vegetation will be affected. Effects on recent native riparian planting and indigenous species will be very low to low.

For birds, the actual and potential effects of the proposal that have been assessed include habitat loss; disturbance and displacement and turbine collision. Using the process for assessing the magnitude and scale of effect detailed in EIANZ guidelines, we find that there will be a very low, approximating no ecological effect of this project on birds.

We have considered if any effects need to be avoided, minimised, remedied, mitigated or offset. We recommend conducting a lizard survey in areas where hedgerows and riparian planting (including rank grassland) will be cleared to create the access track (and preparing a lizard management plan and getting a DOC permit if lizards are detected). Given the very low level of ecological effect on avifauna we conclude that mitigation or offsetting is not required.

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12 Site Photos

Photo 1: From near proposed turbine site 3, looking north over the project site. A bioacoustic recorder visible on fencepost. Typical boxthorn hedgerows.

Photo 2: Looking south over the project area from near proposed turbine site 2. Large pines are 270m west of proposed turbine site 3.

Photo 3: Looking south from near proposed turbine site 1 over the project site. Area of fenced riparian planting. Hedgerows visible in distance are boxthorn.

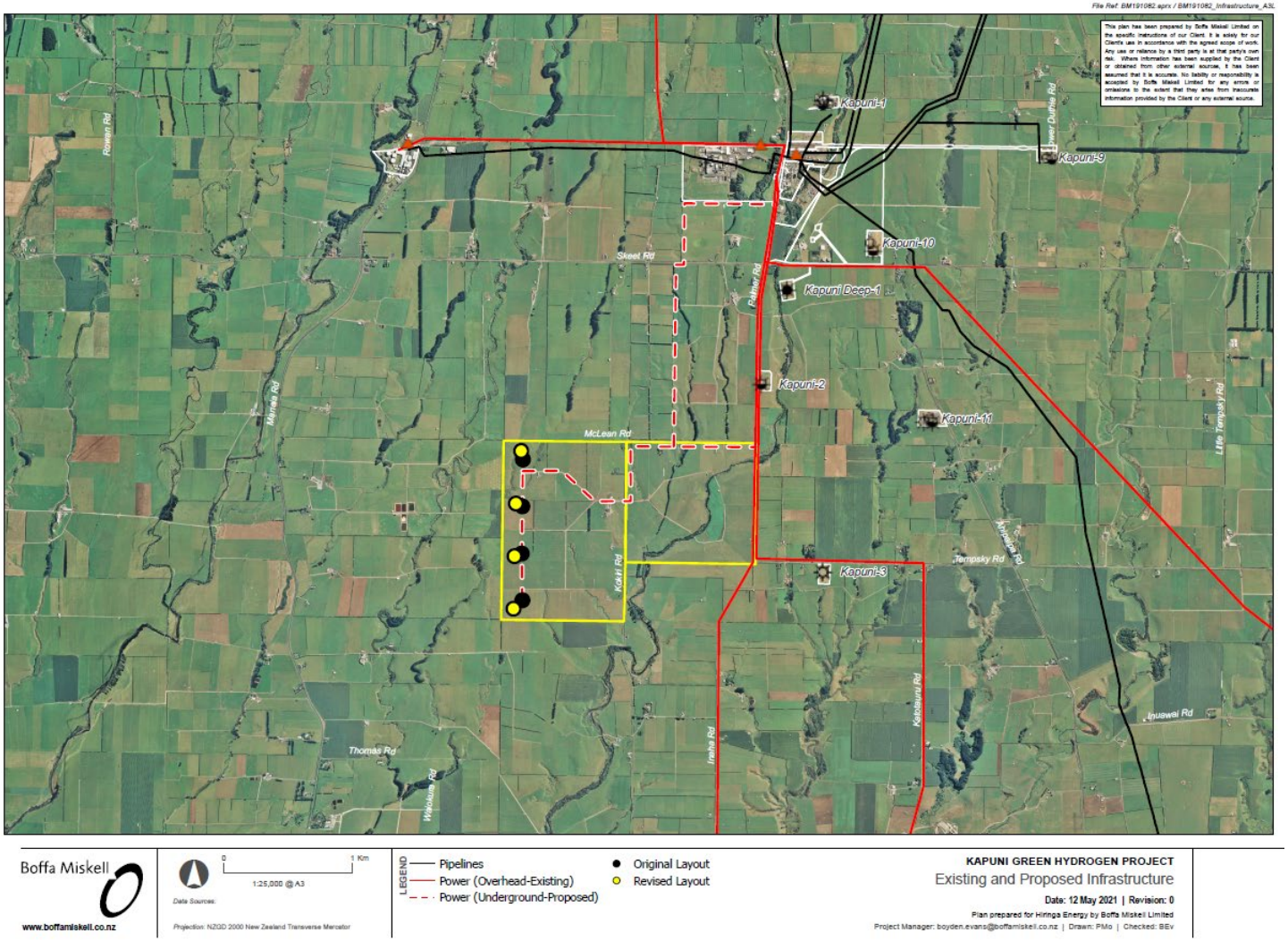
Photo 4: Area of fenced planting along the access track to site. Predominantly rank grass.

Photo 5: Fenced riparian planting area on site. Dominated by rank pasture grasses, cress and buttercup where wet, convolvulus and blackberry as key weeds.

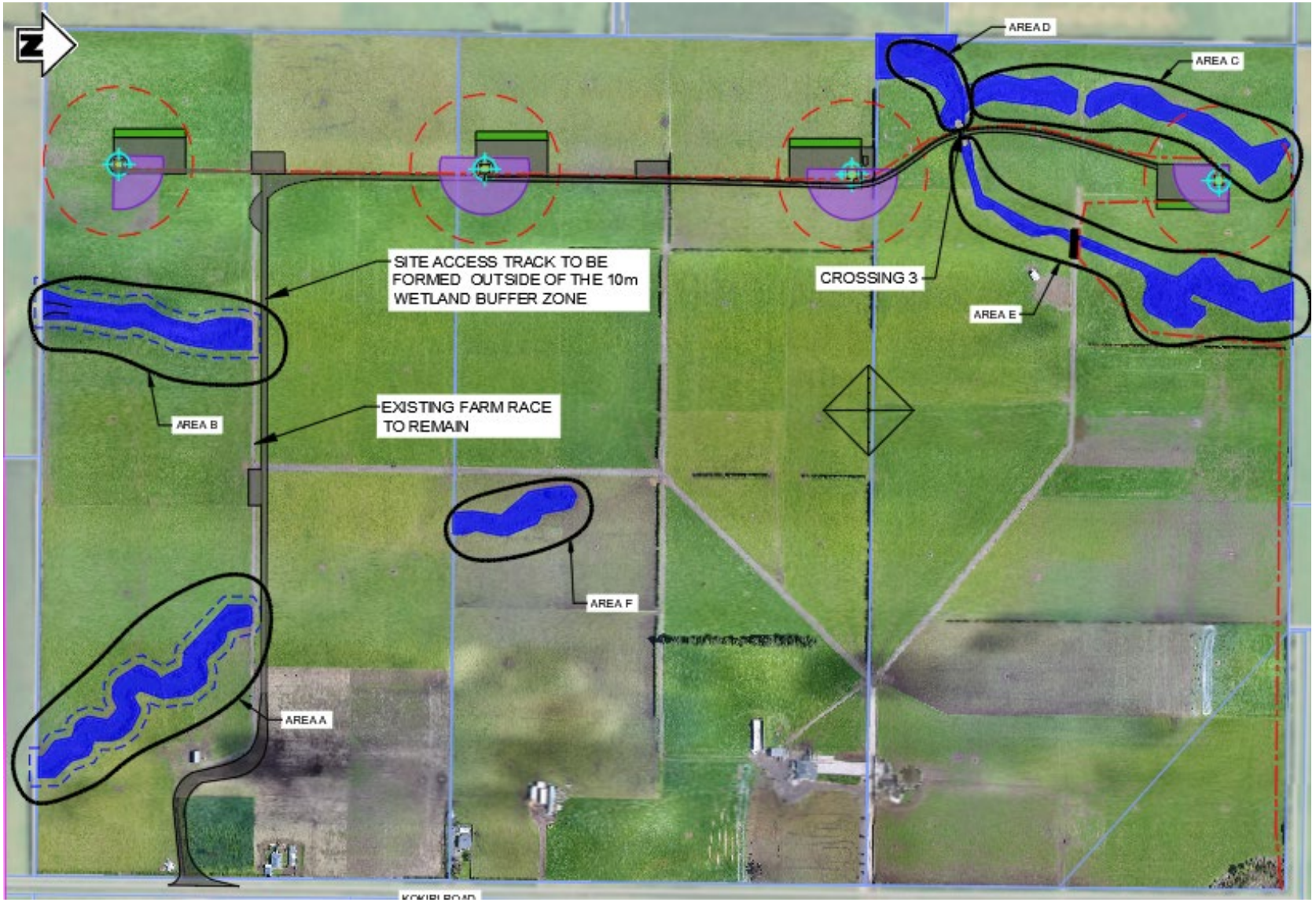
Photo 6: Area of riparian planting with flax and toetoe and a small area of raupō. The remainder is rank pasture grasses, blackberry, and scattered planted shrubs.

Appendices

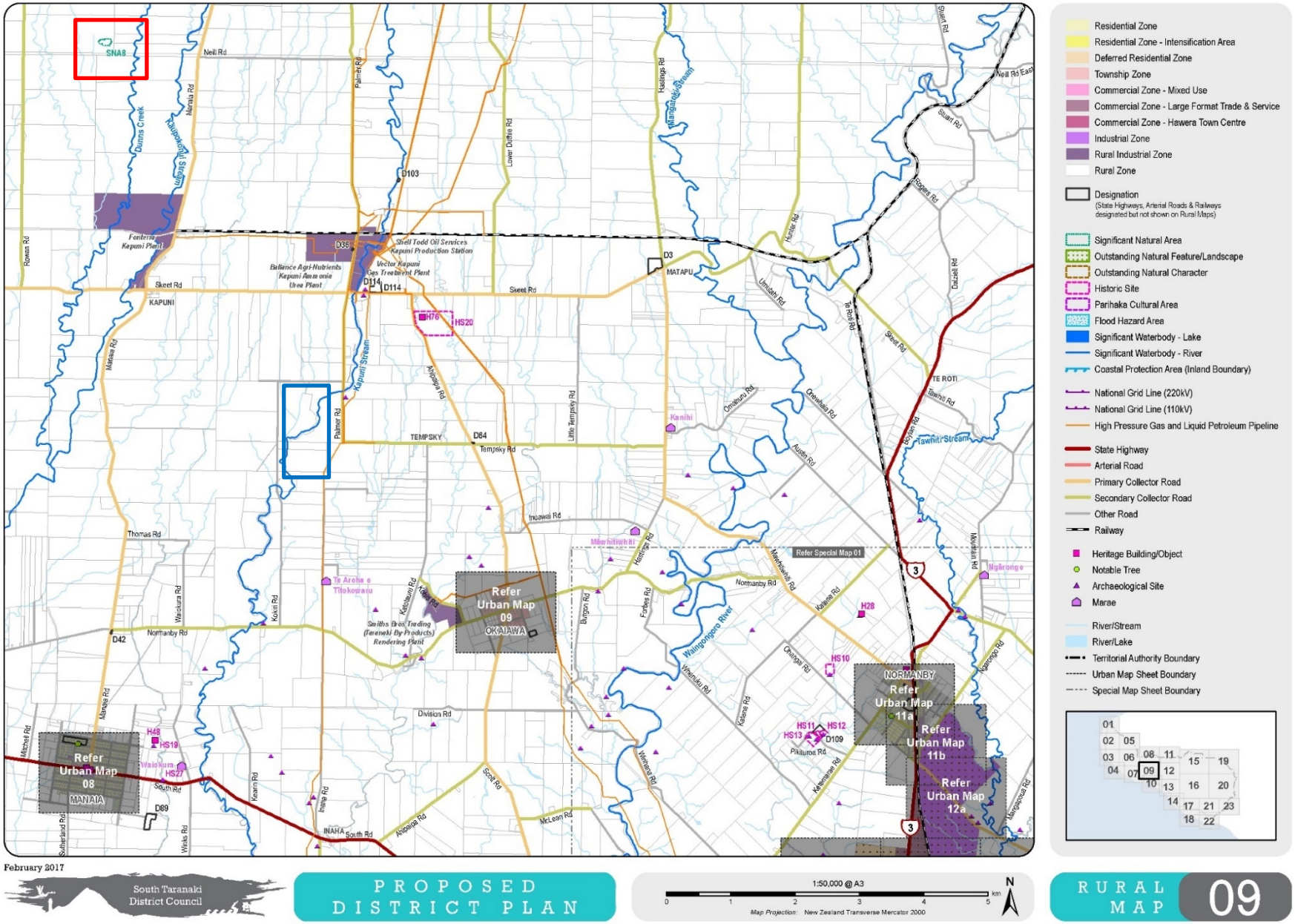
Appendix A: Project Layout



Access Road Location



Appendix B: Nearest SNA to site (red box) and prosed windfarm (blue box)



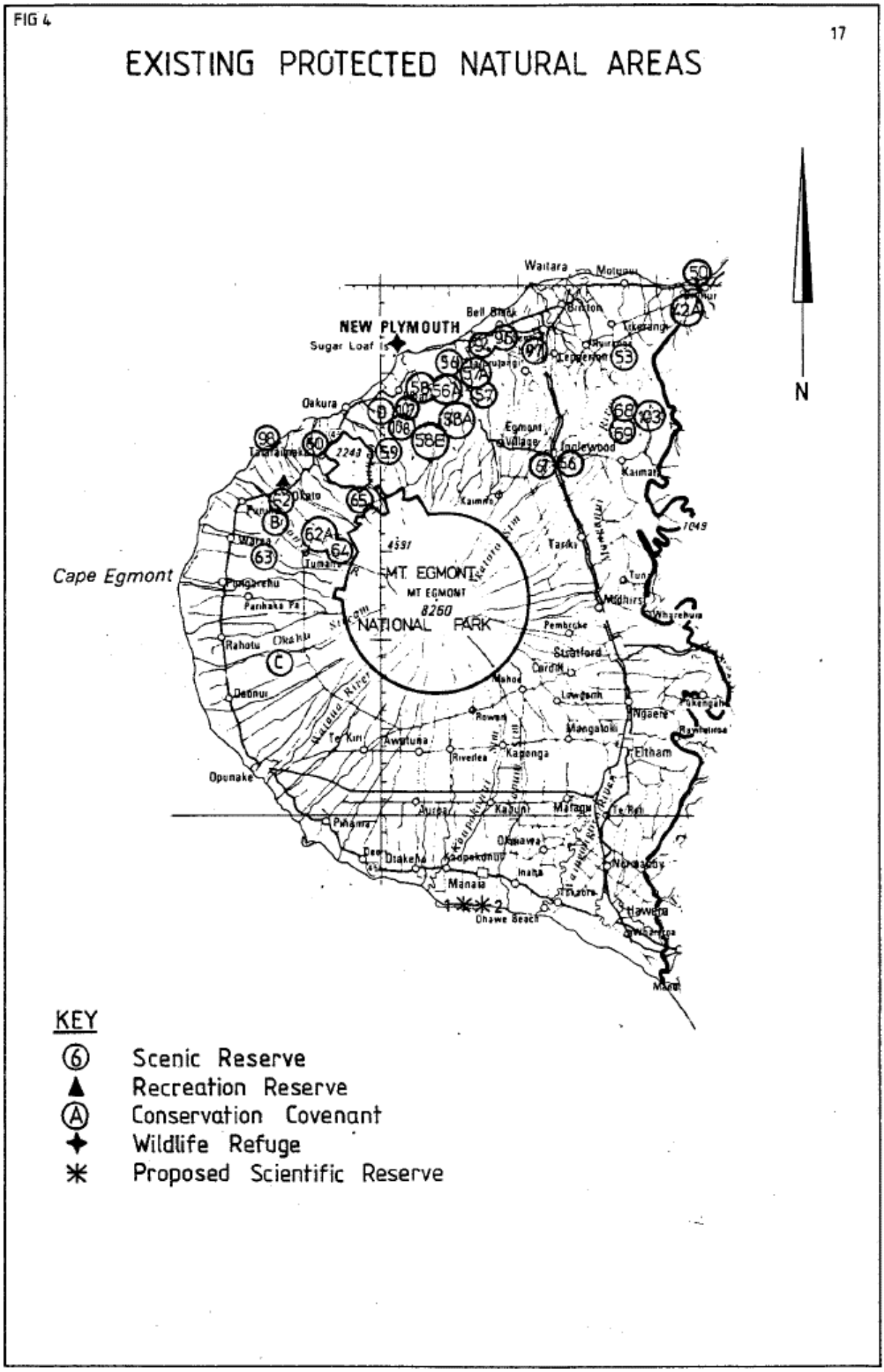
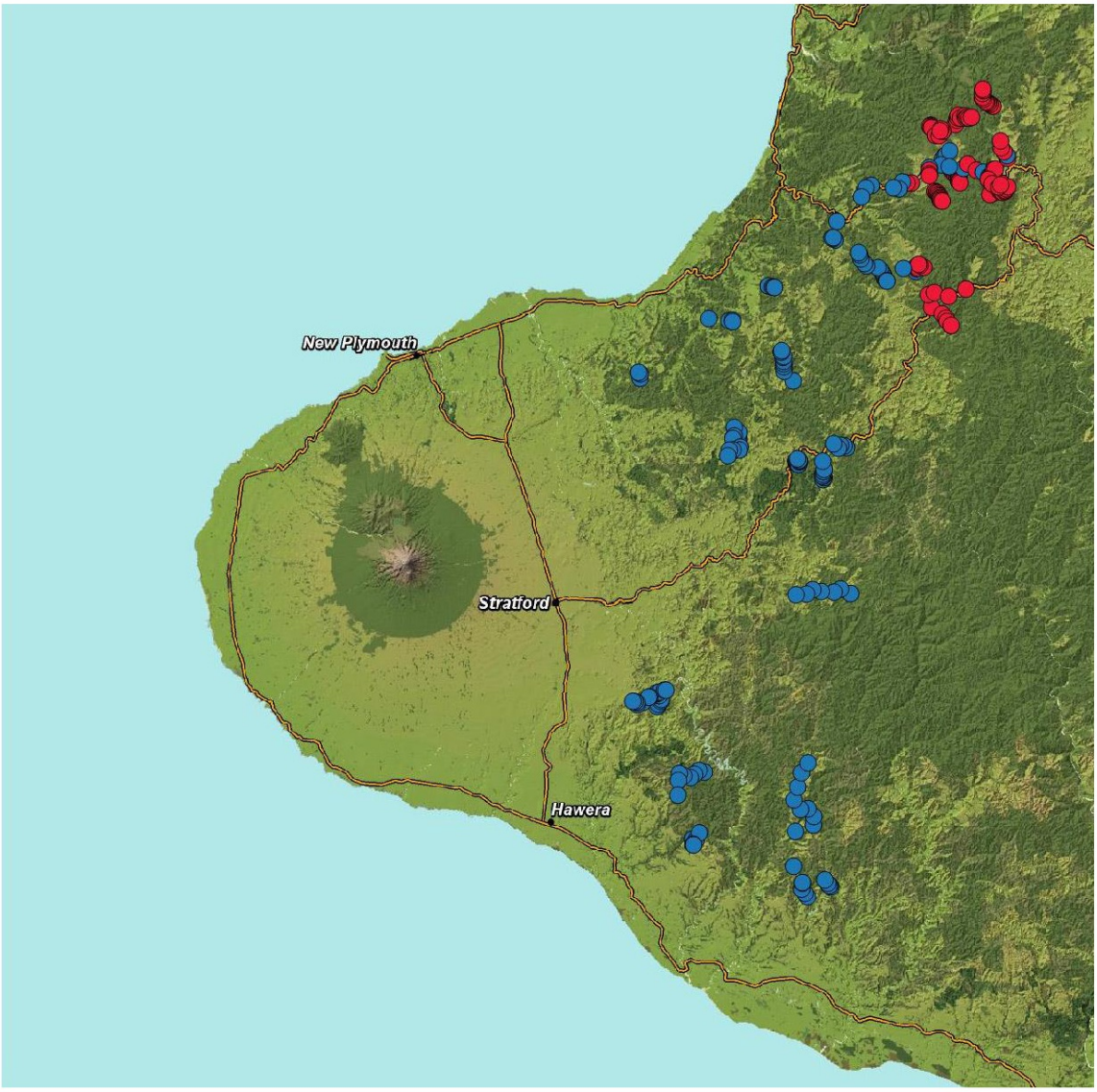


FIG 4
17
EXISTING PROTECTED NATURAL AREAS
N
NEW PLYMOUTH
Sugar Loaf Is
Waitara
Bell Block
Oakura
Egmont Village
Inglewood
Kaimata
Cape Egmont
MT. EGMONT
MT EGMONT
8260
NATIONAL PARK
Tariki
Midhurst
Whareheia
Pembroke
Stratford
Cardiff
Mahoe
Lowgarth
Ngaere
Mangaoaki
Eltham
Kapenga
Rowan
Awatuna
Riverlea
Te Kiri
Opunake
Kaupokonui
Manaia
Ohawe Beach
Hawera
Normanby
KEY
Scenic Reserve
Recreation Reserve
Conservation Covenant
Wildlife Refuge
Proposed Scientific Reserve

Annex C to
Bat Surveying in Taranaki
2019-20 Report

Taranaki Bat Survey Results – All Seasons



Key to Symbols:

- Long-tailed bat
- Both Long-tailed and Short-tailed bats

C1

Appendix E: Timing of Migrations

Migratory movements for eight shorebird species. Blue is the period where the majority of movements occur in most years, grey indicates the time range of migration activity.

Species	National Migrants				Trans-Equatorial Migrants			
	NZ pied oyster-catcher	Pied stilt	Banded dotterel	Wrybill	Bar-tailed godwit	Lesser knot	Turnstone	Golden plover
Dec								
Jan								
Feb								
Mar								
Apr								
May								
June								
July								
Aug								
Sept								
Oct								
Nov								

Appendix F: Key Species Threat Status and Population Size

Key Species	Status (Robertson *et al.* 2013)	Explanation of Status Classification (Townsend *et al.* 2008 criteria)	Population size Modelled
NZ pied oystercatcher	At Risk – Declining, B (1/1)	There is an ongoing or predicted decline of 10–50% in the total population or area of occupancy due to existing threats, taken over the next 10 years or three generations, whichever is longer.	111,100 (Sagar & Geddes 1999)
Pied stilt	Not Threatened	There is an ongoing or predicted decline of 10–50% in the total population or area of occupancy due to existing threats, taken over the next 10 years or three generations, whichever is longer. Qualifier: Secure Overseas	30,000 (Southey 2009)
Black shag	At Risk – Naturally Uncommon SO, Sp	Distribution is naturally confined to specific substrates, habitats, or geographic areas, or occur within naturally small and widely scattered populations. This distribution is not the result of past or recent human disturbance. Populations may be stable or increasing. Qualifiers: Secure Overseas and Sparse	10,000 (Heather & Robertson 2000)
NZ pipit	At Risk – Declining, C (1/1)	There is an ongoing predicted decline of 10-70% in the total population or area of occupancy due to existing threats, taken over the next 10 years or three generations, whichever is longer.	Unknown

Appendix G: Additional Results of Bird Activity and Behaviour

Fifty-three percent of all birds observed were either flying north, south or were circling/traversing in no particular direction. Combined southern directions (south, south-east, south-west) were the most common direction of travel (30.9%) of all observations, followed by combined northern directions (north, north-east, north-west; 23%) (Table 20 and Table 21).

Table 20. Directions of bird movements for each bird observed flying (not stationary) during the summer fixed point-fixed period surveys at the proposed wind turbine locations in Kapuni between 8 and 17 January 2020.

Species	Direction of Bird Movement								
	North	Northeast	Northwest	East	South	Southeast	Southwest	West	Circling or random movements obs.
Black-backed gull	43	10	13	33	55	17	11	21	12
Spur-winged plover	26	3	24	19	15	3	7	9	12
Harrier hawk	11	4	2	10	14	3	12	11	58
SIPO	17					20			
Welcome swallow	1	2		2		1		3	6
Pukeko	2								1
White-faced heron	1		4	1	2				
Black shag	1	1		1	2	1		1	
Paradise shelduck			2						
Unidentified shag species					1				
Total	102	20	45	66	89	45	30	45	89

Table 21. Summary of the directions of bird movements during the summer fixed point-fixed period surveys at the proposed wind turbine locations in Kapuni between 8 and 17 January 2020.

Direction of Bird Movement	No. of Birds	Proportion of Birds (%)	Proportion of Birds (%) Combined General Directions
North	102	19.2	23.0
Northeast	20	3.8	
Northwest	45	8.5	
East	66	12.4	12.4
South	89	16.8	30.9
Southeast	45	8.5	
Southwest	30	5.6	
West	45	8.5	8.5

Circling or traversing in no particular direction	89	16.7	16.7
Total	531	100	100

The average maximum flight height of all species combined was 30 m, with a maximum height of 250 m. The average minimum flight height of all species combined was 19 m, with a minimum height of 0 m. South Island pied oystercatchers flew the highest of all species (average maximum height of 115 m and maximum height of 250 m) (Table 22).

Table 22. Flight heights of birds observed during the summer fixed point-fixed period surveys at the proposed wind turbine locations in Kapuni between 8 and 17 January 2020.

Species	Ave. Max Flight Height (m)	Max Flight Height (m)	Ave. Min Flight Height (m)	Min Flight Height (m)
Black-backed gull	39	250	28	20
Spur-winged plover	10	40	2.5	0
Harrier hawk	22	50	12	0
S.I. pied oystercatcher	115	250	85	50
Welcome swallow	9	20	4	0
Pukeko	2	2	0	3
White-faced heron	21	40	15	3
Black shag	35	60	29	20
Paradise shelduck	25	25	20	20
Unidentified shag species	40	40	30	30
All species combined	30	250	19	0

The most common behaviour exhibited by the birds observed was traversing (57.7%). 60% of the observations of traversing birds were of black-backed gulls. The second most common behaviour was 'other' (11.4%) which includes circling/travelling in no particular direction and chasing or being chased by other birds (Table 23).

Table 23. Behaviours of all birds observed during the summer fixed point-fixed period surveys at the proposed wind turbine locations in Kapuni between 8 and 17 January 2020.

Species	Behaviour											
	Traverse	Depart	Arrive	Short Flight	Feeding (ground/stream)	Feeding (air)	Feeding (canopy)	Heard not seen	Breeding	Other (e.g. circling, chasing, being chased)	Resting	Singing/calling
Black-backed gull	203	2		1						10		
Spur-winged plover	17	40	27	34	17			17			5	4
Harrier hawk	57	6	6	2						54	2	
S.I. pied oystercatcher	37											
Welcome swallow	7			2		4				2		
Pukeko		1			1			11		1		
White-faced heron	8											
Black shag	7											
Paradise shelduck	2											
Unidentified shag spp.	1											
Total	339	49	33	39	18	4	0	28	0	67	7	4

Appendix H: Initial Comments from the Department of Conservation

Department of Conservation
Te Papa Atawhai

DOCDM-6418229

2 September 2020

Hiringa Energy Ltd
C/O Cam Twigley
BTW Company Limited
179 Courtenay Street
New Plymouth 4312

Attention: Cam Twigley

Dear Cam,

RE: COMMENTS ON SUMMER BIRD MONIROTING REPORT, HIRINGA ENERGY, KAPUNI

Thank you for the opportunity to provide feedback on Hiringa Energy Ltd's Summer Bird Monitoring Report. This Report was prepared as a part of the resource consent application for Hiringa Energy Ltd to construct four wind turbines on Kokiri Road, Kapuni. The turbines are associated with the establishment of a proposed hydrogen energy facility and the Report has been prepared to inform an assessment of ecological effects.

You have requested confirmation of the department's view on whether a winter survey of migratory bird species is required and for any other relevant comments the department has in relation to the monitoring undertaken. Please find my feedback on this below.

Feedback:

1) It is recommended that monitoring of migratory birds using daytime visual, acoustic bird monitoring devices, and doppler radar is undertaken during the full extent of the migratory period.

Comment:

It is not clear that sufficient migratory bird monitoring has been undertaken during the full extent of the summer migratory period. The monitoring methods described in the summer migratory bird survey will not detect South Island pied oystercatcher (SIPO) or other birds that fly silently over the site at night. Further, the migratory period is over a longer time period than the monitored period, so the number of birds that may fly over this site at different times of the migratory period is unknown.

2) It is recommended that monitoring of migratory birds (using the methods described above) is undertaken during the full extent of the north-south SIPO migratory period.

Comment:

It is necessary to understand winter migration of birds through the site. The flight paths and flight heights of NZ migratory bird species are largely unknown, and there

is significant uncertainty in understanding details of north-south migration for most species. Whether the flight paths are the same, similar or different compared to south-north migration is unknown, and the variability of flight paths between different years and weather conditions is also largely unknown.

3) A variety of monitoring techniques should be used, and other methods also considered (e.g. doppler radar) to detect other bird species, for at least one full season in order to understand how this site is used by threatened bird species.

Comment:

There are several other bird species that may be affected by this development. Several of these species are not migratory. The likely species that may be present (usually intermittently) at this site include Nationally Critical species - black stilt, Australasian bittern, black-billed gull, black-fronted tern; Nationally Vulnerable species – Caspian tern, wrybill, banded dotterel; At Risk species – NZ dabchick, NZ dotterel, red-billed gull, white-fronted tern, banded godwit, NZ pipit, brown teal, variable oystercatcher, black shag, little black shag, royal spoonbill, NI fernbird, spotless crake, pied stilt.

4) It is recommended bat monitoring is undertaken for at least one month of continuous monitoring at the site between April-March.

Comment:

There is likely to be some remnant habitat near the site that may support bat populations. Bats are known to be present about 25 km away, but no survey has been undertaken near the site. Therefore, it is unknown if bats are present or absent at this site.

If you have any further questions, please feel to contact Jacob Stenner on 0272148837 or jstenner@doc.govt.nz.

Yours sincerely

Gareth Hopkins
Operations Manager
Ngāmotu/ New Plymouth Office

Appendix I: Bat Acoustic Recorder Locations

ABM location	GPS location NZTM		Notes
	Northing	Easting	
1	1698914.56	5626141.62	On vegetation on the western edge of gully facing N-E-S at southern boundary
2	1698615.64	5626132.44	In shelterbelt hedge at S-W corner of boundary
3	1698619.68	5626449.64	In shelterbelt hedge along western boundary
4	1698657.62	5626653.29	On waratah in pasture near turbine location
5	1698852.66	5626822.63	in shelterbelt hedge corner next to track
6	1698619.99	5626851.8	On fencepost along western boundary
7	1698706.47	5627059.05	In shelterbelt hedge
8	1698847.03	5627278.15	In tree next to track (northern track side)
9	1698890.69	5627518.14	In shelterbelt hedge edge next to western extent of gully
10	1698630.31	5627514.02	In shelterbelt hedge at N-W corner of boundary

Appendix J: Bat Survey Weather Data

Survey Night	Date	Time	Precipitation (mm)	Relative Humidity (%)	Min Temp (°C)	Surface Wind Speed (km/hr)	Maximum Wind gust (km/hr)
	20201012	1900	0	98	12.3	15.5	36.7
	20201012	2000	0	98	11.4	5.8	17.6
	20201012	2100	0	99	11.4	4.7	10.8
	20201012	2200	2.7	98	10.7	4	10.8
	20201012	2300	1.8	98	10.7	3.2	8.6
	20201013	0	0.1	98	10.6	2.2	4.3
1	20201013	100	0.2	98	10.7	3.6	7.9
	20201013	200	0.2	98	10.7	6.1	12.2
	20201013	300	0	98	10.4	6.8	14
	20201013	400	0	98	10	5.8	11.5
	20201013	500	0	98	10	2.9	7.6
	20201013	600	0	97	9.2	5.8	12.2
	20201013	700	0	96	9.4	5	10.8
	20201013	1900	0	89	10.5	9	17.3
	20201013	2000	0	93	9.8	5	16.2
	20201013	2100	0	95	9.2	4	7.2
	20201013	2200	0	96	8.5	3.2	7.2
	20201013	2300	0	97	8.4	4	7.6
	20201014	0	0	97	8.5	4.3	7.6
2	20201014	100	0	97	8	4	7.9
	20201014	200	0	98	8	4.3	10.1
	20201014	300	0	95	6.5	4	9.7
	20201014	400	0	97	5.8	4.7	13
	20201014	500	0	92	6.1	10.8	24.8
	20201014	600	0	86	7.3	13	29.5
	20201014	700	0	91	7.5	5	15.1
	20201014	1900	0.1	88	10.1	8.6	18.7
	20201014	2000	0.3	95	8.7	11.9	26.3
	20201014	2100	0	91	8.7	11.9	22.7
	20201014	2200	0	89	8.7	11.5	24.8
	20201014	2300	0	93	8.2	11.5	21.2
	20201015	0	0.1	97	8.3	11.5	21.2
3	20201015	100	0	97	7.6	12.6	27.4
	20201015	200	0	96	5.6	15.5	33.1
	20201015	300	0	91	5.7	15.5	30.6
	20201015	400	0	87	5.8	18	31.3
	20201015	500	0	86	5.7	16.2	28.8
	20201015	600	0	84	5.8	17.3	32.4
	20201015	700	0	82	5.7	15.8	29.5

Survey Night	Date	Time	Precipitation (mm)	Relative Humidity (%)	Min Temp (°C)	Surface Wind Speed (km/hr)	Maximum Wind gust (km/hr)
	20201015	1900	0	70	6.1	15.5	26.6
	20201015	2000	0	73	5.6	14	25.9
	20201015	2100	0	69	4.7	13	25.9
	20201015	2200	0	70	3.8	10.8	20.2
	20201015	2300	0	76	3.6	10.8	19.4
	20201016	0	0	82	2.3	11.2	19.8
4	20201016	100	0	86	2	11.9	20.2
	20201016	200	0	86	1.8	10.4	20.2
	20201016	300	0	87	1.5	10.8	19.4
	20201016	400	0	87	1.6	10.8	19.1
	20201016	500	0	87	1.2	10.4	17.3
	20201016	600	0	86	1.4	11.5	18.7
	20201016	700	0	84	1.5	9.7	18.7
	20201016	1900	0	75	6.7	7.6	14.8
	20201016	2000	0	84	4.8	5	15.1
	20201016	2100	0	86	3.7	6.1	15.8
	20201016	2200	0	86	3.3	6.5	15.1
	20201016	2300	0	78	4.5	13.3	23
	20201017	0	0	80	3.4	5.8	14.4
5	20201017	100	0	80	3.6	8.6	23.4
	20201017	200	0	84	1.3	5	9.7
	20201017	300	0	90	0.7	4.7	10.8
	20201017	400	0	88	0.8	6.1	10.8
	20201017	500	0	90	1	6.5	12.2
	20201017	600	0	91	1.5	5.8	13
	20201017	700	0	86	2.4	5.8	15.8
	20201017	1900	0	81	9.7	4	9.4
	20201017	2000	0	88	7.6	3.2	7.2
	20201017	2100	0	92	6.2	2.5	6.5
	20201017	2200	0	94	5.3	4	7.2
	20201017	2300	0	95	5.2	4.7	7.9
	20201018	0	0	95	4.1	4.3	7.2
6	20201018	100	0	96	4.3	5	8.3
	20201018	200	0	95	3.7	2.9	5
	20201018	300	0	96	2.9	2.9	7.6
	20201018	400	0	98	3.2	4.3	7.9
	20201018	500	0	98	3.6	4.7	8.6
	20201018	600	0	98	4	4.7	9.4
	20201018	700	0	98	5.3	6.8	13.7
7	20201018	1900	0.1	94	9	10.1	24.5

Survey Night	Date	Time	Precipitation (mm)	Relative Humidity (%)	Min Temp (°C)	Surface Wind Speed (km/hr)	Maximum Wind gust (km/hr)
	20201018	2000	0.6	97	9	11.5	22
	20201018	2100	0.7	98	9	9.7	23.8
	20201018	2200	0.4	98	9.4	12.6	24.5
	20201018	2300	0.3	98	9.7	15.1	29.9
	20201019	0	0	98	10.5	14.8	28.8
	20201019	100	0	96	10.6	13.3	28.4
	20201019	200	0	96	10.7	11.9	28.1
	20201019	300	0	96	10.6	14.8	28.4
	20201019	400	0	98	10.8	12.6	28.8
	20201019	500	0.2	99	11	11.9	26.6
	20201019	600	0	99	11.4	14	33.1
	20201019	700	0	98	11.9	14.8	36.4
	20201019	1900	1.4	96	13.3	11.9	38.5
	20201019	2000	4.2	97	13.4	14.4	35.3
	20201019	2100	3.2	97	13.4	14	40.7
	20201019	2200	3.8	97	13.4	13	33.1
	20201019	2300	0.2	97	13.3	14	37.4
	20201020	0	0	96	13.2	11.2	46.8
8	20201020	100	0	95	13.3	4.3	10.8
	20201020	200	0	95	12.3	4.3	19.4
	20201020	300	0	95	11.1	4.7	10.1
	20201020	400	0	96	10.5	6.1	10.1
	20201020	500	0	97	9.9	8.6	18
	20201020	600	0	97	10.1	7.2	14.4
	20201020	700	0	97	10	5.4	10.1
	20201020	1900	0	90	10.7	4.3	16.6
	20201020	2000	0	92	10.2	4	9.7
	20201020	2100	0	93	10.2	3.6	7.2
	20201020	2200	0	94	9.8	4	7.9
	20201020	2300	0	94	8.6	2.5	4.7
	20201021	0	0	96	8	2.2	4.3
9	20201021	100	0	97	7.9	4	6.5
	20201021	200	0	97	7.2	2.5	6.1
	20201021	300	0	98	6.9	2.5	5
	20201021	400	0	98	6.9	2.9	5.8
	20201021	500	0	98	7.2	2.9	7.9
	20201021	600	0	98	7.3	1.8	5
	20201021	700	0	98	7.6	3.2	7.6
	20201021	1900	0	81	12.1	2.9	10.4
10	20201021	2000	0	87	10.5	4.3	7.9
	20201021	2100	0	92	9.8	5	9.4

Survey Night	Date	Time	Precipitation (mm)	Relative Humidity (%)	Min Temp (°C)	Surface Wind Speed (km/hr)	Maximum Wind gust (km/hr)
	20201021	2200	0	93	9.4	2.5	9
	20201021	2300	0	93	9.6	2.5	6.1
	20201022	0	0	93	9.2	2.5	5
	20201022	100	0	95	9.1	2.2	5.8
	20201022	200	0	95	8.5	2.9	5.4
	20201022	300	0	96	8.1	4	9.7
	20201022	400	0	96	7.8	3.2	7.2
	20201022	500	0	96	7.6	3.2	8.3
	20201022	600	0	97	7.9	4.7	8.6
	20201022	700	0	96	8.5	2.5	7.9
11	20201022	1900	0	93	11.8	6.8	14.8
	20201022	2000	0	96	11.4	3.6	7.9
	20201022	2100	0	97	11.3	3.6	6.8
	20201022	2200	0	97	11.4	2.5	5.8
	20201022	2300	0	98	11.5	3.6	6.8
	20201023	0	0	98	10.9	3.2	6.1
	20201023	100	0	98	10.8	2.5	7.9
	20201023	200	0	98	10.4	3.6	7.9
	20201023	300	0	98	10.2	4.7	10.4
	20201023	400	0.1	99	10	5.8	11.2
	20201023	500	0.2	99	10.1	3.6	8.6
	20201023	600	0.1	99	9.9	3.2	7.9
	20201023	700	0	99	10.3	3.2	6.8
12	20201023	1900	0	90	13	8.3	18
	20201023	2000	0	93	12.1	4	10.1
	20201023	2100	0	95	11.4	2.5	8.3
	20201023	2200	0	96	10.6	3.6	7.2
	20201023	2300	0	97	10.4	5	10.1
	20201024	0	0	98	11.1	5.8	13.7
	20201024	100	0	99	10.9	6.8	16.6
	20201024	200	0	98	11.2	6.8	18
	20201024	300	0	96	12	5.8	14.4
	20201024	400	0	95	12.2	5.4	10.1
	20201024	500	0	97	12.2	7.2	12.2
	20201024	600	0.2	97	12.2	5	9.7
	20201024	700	0	98	12.5	5	9
13	20201024	1900	0	91	14.4	9.7	21.6
	20201024	2000	0	95	13.7	8.3	19.1
	20201024	2100	0	97	13.4	7.9	16.6
	20201024	2200	0	98	13.3	9.4	18

Survey Night	Date	Time	Precipitation (mm)	Relative Humidity (%)	Min Temp (°C)	Surface Wind Speed (km/hr)	Maximum Wind gust (km/hr)
	20201024	2300	0	96	13.1	11.9	22.3
	20201025	0	0	97	13	13.7	25.2
	20201025	100	0	96	13.1	13	24.1
	20201025	200	0	96	12.8	11.2	26.3
	20201025	300	0	96	12.8	10.4	23.4
	20201025	400	0.1	97	12.9	11.2	23.8
	20201025	500	0.2	97	13	10.1	22
	20201025	600	0	97	12.9	9.4	19.4
	20201025	700	0	98	13.1	11.9	25.9
	20201025	1900	0	90	15	11.2	25.9
	20201025	2000	0	92	14.2	10.8	29.5
	20201025	2100	0	94	13.4	9.4	15.8
	20201025	2200	0	95	13.1	10.1	20.2
	20201025	2300	0	96	12.8	12.2	21.6
	20201026	0	0	96	12.9	12.6	28.8
14	20201026	100	0	96	12.8	13.7	25.2
	20201026	200	0	96	12.9	12.6	30.6
	20201026	300	0	96	13.2	10.4	25.6
	20201026	400	0	96	13.4	11.9	27
	20201026	500	0	95	13.4	12.2	23.8
	20201026	600	0	95	13.5	12.2	29.5
	20201026	700	0	94	13.7	10.4	28.8
	20201026	1900	0	91	13.5	12.6	24.5
	20201026	2000	0	94	13.4	10.4	20.9
	20201026	2100	0	94	13.3	9	19.1
	20201026	2200	0	93	13.3	7.2	22.3
	20201026	2300	0	94	13.3	10.4	22
	20201027	0	0.2	95	13.2	11.5	26.6
15	20201027	100	0.3	95	13.1	11.9	26.6
	20201027	200	0	95	13.2	13.3	29.5
	20201027	300	0	95	13.3	11.5	25.2
	20201027	400	0	95	13.2	11.9	26.6
	20201027	500	0	95	13.2	13.7	32
	20201027	600	0	94	13.2	13.7	31
	20201027	700	0	95	13.2	15.1	33.1
	20201027	1900	0.5	98	10.7	7.6	15.1
	20201027	2000	0.7	98	10.5	7.9	14
	20201027	2100	0.4	98	9.9	10.8	19.1
16	20201027	2200	0.2	98	9.2	10.4	18
	20201027	2300	0.2	98	9.3	9.4	18.7
	20201028	0	0.2	98	9	9.7	22.3

Survey Night	Date	Time	Precipitation (mm)	Relative Humidity (%)	Min Temp (°C)	Surface Wind Speed (km/hr)	Maximum Wind gust (km/hr)
	20201028	100	0.7	98	8.8	8.3	16.9
	20201028	200	0.4	98	8.8	6.5	11.2
	20201028	300	1.8	98	8.3	9	15.8
	20201028	400	2.6	98	8	8.3	17.3
	20201028	500	2.7	98	8.1	6.8	13
	20201028	600	1.4	98	8	7.6	13
	20201028	700	0.5	98	8.1	6.1	12.2
	20201028	1900	0	93	14.2	7.9	15.8
	20201028	2000	0	95	14	6.5	16.6
	20201028	2100	0	96	13.6	5.4	13
	20201028	2200	0	96	13.8	5.8	13
	20201028	2300	0	96	13.9	7.2	15.1
	20201029	0	0	96	13.9	6.5	15.8
17	20201029	100	0	96	13.7	2.9	10.1
	20201029	200	0	96	13.4	5.4	14.4
	20201029	300	0	97	13.7	6.8	14.4
	20201029	400	0	97	14	4.7	10.1
	20201029	500	0	96	13.8	1.8	10.8
	20201029	600	0	96	13.3	1.1	4.3
	20201029	700	0	96	13.6	6.1	13
	20201029	1900	0	96	13.7	3.2	5.8
	20201029	2000	0	96	13.7	1.4	4.7
	20201029	2100	0	97	13.4	3.2	6.8
	20201029	2200	0	98	13.2	4	7.9
	20201029	2300	0	98	13	3.2	8.6
	20201030	0	0	97	12.8	2.2	7.2
18	20201030	100	0	98	12.3	5.8	10.1
	20201030	200	0	97	12.4	5.4	11.5
	20201030	300	0	98	12.4	3.2	6.5
	20201030	400	0	98	12.6	3.6	8.3
	20201030	500	0	98	12.6	6.1	11.5
	20201030	600	0	99	12.6	7.9	14.4
	20201030	700	0	98	13.1	10.4	20.5
	20201030	1900	0	91	14.7	9.4	26.6
	20201030	2000	0	94	14.4	9	25.9
	20201030	2100	0	94	14.3	10.4	21.6
	20201030	2200	0	94	14.1	11.5	22.3
19	20201030	2300	0	94	14	12.2	27
	20201031	0	0	95	13.8	14	30.2
	20201031	100	0.2	96	14.1	19.4	40.3
	20201031	200	1.3	96	14.1	15.8	40.3

Survey Night	Date	Time	Precipitation (mm)	Relative Humidity (%)	Min Temp (°C)	Surface Wind Speed (km/hr)	Maximum Wind gust (km/hr)
	20201031	300	1.6	96	13.7	17.3	41
	20201031	400	1.3	96	13.6	16.9	33.1
	20201031	500	0.7	96	13.5	18	36.7
	20201031	600	0.4	97	13.5	19.8	42.5
	20201031	700	0.4	96	13.5	23	42.8
	20201031	1900	0.4	95	14.9	12.2	31.7
	20201031	2000	0	93	14.1	6.5	21.6
	20201031	2100	0	90	13.4	9.7	21.6
	20201031	2200	0	92	12.4	7.6	23
	20201031	2300	0	94	12.1	13.3	23
	20201101	0	0	95	11.1	11.9	20.2
20	20201101	100	0	96	11	7.6	16.6
	20201101	200	0	96	10.9	8.3	19.4
	20201101	300	0	97	10.2	6.5	17.6
	20201101	400	0	97	9.6	7.6	19.4
	20201101	500	0	96	8.5	5.4	13
	20201101	600	0	97	7.8	5.4	9.7
	20201101	700	0	97	9	6.8	13.7
	20201101	1900	0	79	11.7	8.3	16.6
	20201101	2000	0	85	9.8	7.2	13
	20201101	2100	0	91	8.8	5.4	9.4
	20201101	2200	0	94	8.2	3.2	7.9
	20201101	2300	0	96	7.5	2.2	5.4
	20201102	0	0	97	6.9	2.5	5
21	20201102	100	0	97	6.7	4.3	8.6
	20201102	200	0	97	6.7	2.9	6.1
	20201102	300	0	97	6.2	3.6	7.9
	20201102	400	0	97	5.6	2.9	7.2
	20201102	500	0	98	5.5	2.2	4.7
	20201102	600	0	98	5.7	2.9	6.1
	20201102	700	0	98	6.6	1.8	5.8
	20201102	1900	0	89	13.6	5.8	13
	20201102	2000	0	92	12.4	6.8	16.2
	20201102	2100	0	93	12	6.5	11.5
	20201102	2200	0	93	11.9	6.1	15.1
22	20201102	2300	0	94	12	4	8.3
	20201103	0	0	94	11.8	1.8	5
	20201103	100	0	95	11.7	2.2	5.8
	20201103	200	0	95	11.6	4	10.1
	20201103	300	0	95	12.5	6.8	11.5

Survey Night	Date	Time	Precipitation (mm)	Relative Humidity (%)	Min Temp (°C)	Surface Wind Speed (km/hr)	Maximum Wind gust (km/hr)
	20201103	400	0.6	96	12.8	4.3	10.1
	20201103	500	2.4	97	12.8	6.5	14
	20201103	600	0.6	98	12.9	11.2	21.6
	20201103	700	0.1	97	13.3	16.2	27.4
	20201103	1900	0	88	15.8	16.2	40
	20201103	2000	0.1	93	14.9	17.6	37.4
	20201103	2100	0.1	95	14.7	19.1	31
	20201103	2200	0	94	14.7	16.2	28.8
	20201103	2300	0	92	14.5	17.6	32.4
	20201104	0	0	91	14.3	16.6	27
23	20201104	100	0	92	14.2	10.1	20.9
	20201104	200	0	93	13.6	6.1	13.7
	20201104	300	0.1	94	13.8	3.2	9
	20201104	400	0	96	13.8	7.6	22.3
	20201104	500	0.3	95	14	19.8	39.6
	20201104	600	0.4	97	13.8	19.4	33.8
	20201104	700	0	96	13.9	20.5	33.8
	20201104	1900	0	83	16.1	9.4	26.3
	20201104	2000	0	87	15.3	7.2	20.9
	20201104	2100	0	90	15.2	8.3	16.2
	20201104	2200	0	89	15.1	10.4	18
	20201104	2300	0	85	15.2	9.7	18.7
	20201105	0	0	85	14.9	12.2	21.6
24	20201105	100	0	87	14.8	15.8	24.8
	20201105	200	0	88	14.6	13	24.1
	20201105	300	0	89	14.6	12.6	23
	20201105	400	0	89	14.5	11.2	19.8
	20201105	500	0	90	14.4	11.5	21.6
	20201105	600	0	91	14.4	13	22
	20201105	700	0.1	92	14.6	16.2	25.9
	20201105	1900	1.9	96	13.2	9	22.3
	20201105	2000	0.7	96	13.4	11.5	22.7
	20201105	2100	0.2	95	14.1	12.6	22.7
	20201105	2200	0.3	96	14.1	9	18.4
	20201105	2300	1.7	97	14.3	6.1	14.4
25	20201106	0	1.7	97	14.1	7.6	19.4
	20201106	100	1.1	97	14.1	5.8	20.2
	20201106	200	1.5	97	13.8	7.6	16.6
	20201106	300	0.4	97	13.7	4.7	13.3
	20201106	400	0.5	98	13.4	10.8	24.1
	20201106	500	0.5	97	13.1	15.1	35.3

Survey Night	Date	Time	Precipitation (mm)	Relative Humidity (%)	Min Temp (°C)	Surface Wind Speed (km/hr)	Maximum Wind gust (km/hr)
	20201106	600	0	96	13.2	13	27.4
	20201106	700	0	93	13.4	12.6	32.4
26	20201106	1900	0	89	14.6	11.5	28.1
	20201106	2000	0	94	14	8.3	23
	20201106	2100	0.1	94	13.5	11.2	24.5
	20201106	2200	0.2	96	13.3	10.4	21.2
	20201106	2300	0	96	13.2	7.9	18.4
	20201107	0	0	96	13.6	9	20.5
	20201107	100	0	96	13.4	9.4	24.5
	20201107	200	0	96	13.4	8.6	21.2
	20201107	300	0.3	96	13.7	9	22.7
	20201107	400	0	96	13	7.6	17.6
	20201107	500	0	96	13.1	8.6	21.2
	20201107	600	0	96	13.3	8.3	20.2
	20201107	700	0.6	96	13.8	7.2	18
27	20201107	1900	0	91	14.8	12.6	25.9
	20201107	2000	0	92	13.8	11.9	20.2
	20201107	2100	0	93	13.6	10.1	16.9
	20201107	2200	0	91	13.8	10.1	18
	20201107	2300	0.4	93	14.4	16.9	35.3
	20201108	0	0.2	93	14.5	18.7	34.9
	20201108	100	4.4	96	14.1	22	46.8
	20201108	200	1	97	14.1	28.8	54
	20201108	300	2.3	97	14.2	23.4	58.3
	20201108	400	0.9	97	14.2	17.3	48.2
	20201108	500	3.6	97	14.2	17.3	49
	20201108	600	0.1	97	13.5	11.2	29.5
	20201108	700	0	95	13.7	10.8	24.8
28	20201108	1900	0	89	9	13.3	27
	20201108	2000	0	92	9	13.7	29.2
	20201108	2100	0	93	9	13.3	27.4
	20201108	2200	2.1	94	8.9	11.9	27.7
	20201108	2300	1.3	93	8.4	14.4	31.7
	20201109	0	2.1	92	7.8	15.1	33.8
	20201109	100	1.8	95	7.4	14	27.7
	20201109	200	4.5	95	7.1	11.5	26.6
	20201109	300	3.9	96	6.9	12.2	27
	20201109	400	2.3	96	6.8	10.8	21.2
	20201109	500	3.8	96	6.7	11.9	25.9
	20201109	600	0	95	6.8	14	25.9

Survey Night	Date	Time	Precipitation (mm)	Relative Humidity (%)	Min Temp (°C)	Surface Wind Speed (km/hr)	Maximum Wind gust (km/hr)
	20201109	700	0	92	6.9	14	35.3
29	20201109	1900	0.3	91	6.6	15.5	30.2
	20201109	2000	1.4	94	6.1	13	27
	20201109	2100	0.2	94	6.1	13	23.8
	20201109	2200	1.2	95	6.1	11.9	23.8
	20201109	2300	4.1	96	6.1	13.3	25.9
	20201110	0	1	97	6.3	14.8	28.4
	20201110	100	1.4	97	6.5	15.5	32
	20201110	200	0.8	97	6.8	15.8	33.1
	20201110	300	0.9	97	7.1	13.7	28.4
	20201110	400	2	97	7.5	15.8	29.5
	20201110	500	1.6	97	7.2	15.8	30.2
	20201110	600	0.2	97	7.4	14.4	26.6
	20201110	700	0	97	7.7	15.1	29.2

Appendix K: Summary of Good Weather Days During the Bat Survey

- NB: green represents suitable weather conditions for monitoring bats and red represents unsuitable weather conditions for monitoring bats during the survey period.

Night	Date	Precipitation (mm)	Relative humidity (%)	Min temp (°C)	Surface wind speed (km/hr)	Max wind gust (km/hr)	Full moon
1	12.10.2020						
2	13.10.2020						
3	14.10.2020						
4	15.10.2020						
5	16.10.2020						
6	17.10.2020						
7	18.10.2020						
8	19.10.2020						
9	20.10.2020						
10	21.10.2020						
11	22.10.2020						
12	23.10.2020						
13	24.10.2020						
14	25.10.2020						
15	26.10.2020						
16	27.10.2020						
17	28.10.2020						
18	29.10.2020						
19	30.10.2020						
20	31.10.2020						
21	01.11.2020						
22	02.11.2020						
23	03.11.2020						
24	04.11.2020						
25	05.11.2020						
26	06.11.2020						
27	07.11.2020						
28	08.11.2020						
29	09.11.2020						

Appendix L: Acoustic Recorder Survey Data

- NB: ^ = fine weather and no full moon

ABM location	Bat monitor #	SD card	Bat passes (Y/N)	ABMs set by	ABM data analysed by	Survey start date	Survey end date	# Total nights surveyed	# Suitable nights surveyed^	Sunset	Sunrise	Moon phase	Recordin g start time	Recording end time
1	W1	M4	N	Tine Ulrich, Cam Twigley (BTW)	Tine Ulrich	12.10.2020	10.11.2020	29	13	19:38 (12.10.) - 20:00 (1.11.)	6:38 (13.10.) - 6:11 (2.11.)	Deployed during waning moon; last full moon 2.10.; new moon 17.10.; Full moon 1.11. (Excluding 31.10.-2.11.!)	18:30	7:45
2	W10	M26	N				3.11.2020	22	9					
3	W9	M7	N				10.11.2020	29	13					
4	W17	M31	N				10.11.2020							
5	W8	M28	N				07.11.2020	26	12					
6	W15	M21	N				10.11.2020	29	13					
7	W5	M16	N				10.11.2020							
8	W14	M24	N				10.11.2020							
9	W18	M9	N				10.11.2020							
10	W12	M5	N				10.11.2020							