Boffa Miskell

Mt Munro Wind Farm

Ecological Assessment
Prepared for Meridian Energy Ltd

19 May 2023

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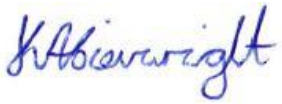
	Karin Sievwright Avifauna Ecologist	
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Cover photograph: Mt Munro site © BML, 2022

Executive Summary

Introduction

- Meridian Energy Limited (Meridian) is seeking resource consents to develop a wind farm of up to 20 turbines on Mt Munro, Tararua, approximately 5 km south of Eketahuna.
- The consenting approach that Meridian is taking for the Mt Munro wind farm includes a Turbine Envelope Zone within which all turbines and any infrastructure will be located, a Turbine Exclusion Zone where any infrastructure but no turbines will be located, and a transmission corridor and substation to connect the wind farm to the national electrical grid.
- Boffa Miskell were engaged to undertake an ecological assessment of the Mt Munro project in relation to the potential effects on terrestrial vegetation, wetlands, freshwater systems, herpetofauna and avifauna.

Methods

- A combination of desktop research and site investigations were undertaken to inform this assessment.
- The methods used to undertake this assessment were consistent with published national standard protocols and the EIANZ guidelines for undertaking ecological impact assessments, whereby ecological values are assigned, and the magnitude of effects identified in order to determine the overall potential level of effect of the proposal.

Results

Terrestrial vegetation

- None of the protected natural areas or areas of habitat for indigenous flora and fauna identified within the wider landscape lie beneath or in close proximity to the project footprint, and none will be adversely affected by this proposal.
- The project footprint is contained almost entirely on improved pasture (97%) and the land use would continue relatively unchanged by the construction of wind turbines, transmission line and substation.
- The overall potential effects on terrestrial vegetation from the Mt Munro project are considered to be Very Low (refer to Section 8.1, page 72) and primarily related to a small area of largely exotic canopy, native under canopy riparian clearance for a bridge abutment on one of the Makakahi tributaries.

- On the basis that there will be very low (and probably no) adverse effects on terrestrial vegetation, no effects management is required, nor any mitigation or offsetting.

Wetlands

- There are around 44 features[1] identified within 100 m of the Turbine Envelope and Turbine Exclusion Zones that are considered to be 'natural inland wetlands' as defined by the NPS-FM (2020). Of these six may be directly affected under the proposed road alignment. We note that under the current Horizons One Plan, the identified features do not trigger Schedule F1 wetland criteria and are not, in our opinion real natural wetlands, but under the NPS FM (2020) they can be found to be natural inland wetlands.
- All the "natural inland wetland" features are assessed as being of Negligible ecological value on the basis of the features being low diversity, uniform, exotic dominated, responses to land modification, and existing on artificial induced wet sediment trapped in old stream channels or pasture-seepages.
- The overall potential effects on wetlands from the Mt Munro project are considered to be Very Low (summarised in Table 29, page 75).
- The requirement to provide mitigation and / or offset for the loss of natural inland wetlands is dependent on which statutory document, or combination of documents, is enforced (i.e. Horizons One Plan, GWRC PNRP and / or NPS-FM (2020)). Where an offset is determined to be required (and we do not consider that such an approach is warranted from an ecological effects perspective alone), then this would be through the creation / restoration of approximately 320 m^2 of indigenous wetland, i.e. we recommend (based on historic offset of wetland of these types) a 1:1 offset ratio. We note that there are many on-site opportunities to restore an appropriate amount of indigenous natural inland wetland, and these are identified in the report.

Freshwater

- The Mt Munro wind farm site is located in the watershed of the Makakahi and Kopuaranga rivers.
- The Kopuaranga River is listed in GWRC's Regional Freshwater Plan as a waterbody of important amenity and recreational value (angling), and in the PNRP as an important trout fishery river and spawning water. The Makakahi River is listed as in Schedule B of Horizon's One Plan as having significant aquatic (SOS-A), trout fishery and trout spawning habitat.
- Based on the field investigations, the ecological values assigned to the freshwater systems on the wind farm and transmission line site are Low

[1] The "count" of those mapped depends on how each feature is viewed given some are part of a continuous gully system.

(Makakahi tributaries, Mangaroa tributary, Bruce Stream main stem and Kopuarunga tributaries) and Moderate (Bruce Stream tributaries).

- The overall potential effects on freshwater values from the project, summarised in Table 34 on page 79, relate to loss of aquatic habitat (Low), sediment release (Low to Very Low), contaminant release (Moderate if an event occurs) and impediment to fish passage through culverts (Low)
- The loss of ~240 m of aquatic habitat in the Mangaroa tributaries requires offsetting, which we recommend be in the form of the enhancement of around 720 m of a similar nearby perennial tributary.

Herpetofauna

- Approximately 92% of the wind farm site and 97% of the Turbine Envelope and Turbine Exclusion Zones (i.e. the potential footprint) is improved grazed pasture which is considered to be unsuitable habitat for indigenous herpetofauna species, as it lacks refugia and is frequently disturbed.
- No lizards were observed in any of the rock outcrops or boulder fields searched on the site, nor were any arboreal lizards seen while spotlighting. However, two skink (likely the northern grass skink) were observed within areas of rank grass/weeds at the western end of the proposed transmission line, at the road margin.
- These results indicate that the northern grass skink is present on the site in low densities. Given the low detectability of many lizard species, these results do not confirm the absence of other species. They do, however, indicate that any other species present are likely to be in very low/undetectable densities, and the general lack of suitable habitat on the site further reduces the likelihood of their presence.
- The scale of potential clearance of potential lizard habitats on the site is low relative to available surrounding habitat. If any sensitive or rare species are present within the proposed footprint, they likely would be in very low numbers and would not constitute a stable population. As such, the overall potential effects of the Mt Munro project on lizards is determined to be Very Low.

Avifauna

- A total of 23 species were recorded on the wind farm site, comprising 12 introduced and 11 native species. The native species included one *Threatened* species (bush falcon) one *At Risk* species (New Zealand pipit). The most common species observed during the wind farm point count surveys on the wind farm were introduced starling and magpie, which made up 73% of all observations.
- Due to the proximity of the proposed transmission line relative to Mt Bruce forest, flight path monitoring was undertaken for bush falcon, kaka and kereru.

- The effects of habitat loss, disturbance and collision with structures (e.g. turbines and transmission line infrastructure) were assessed for native species (including *Threatened* and *At Risk*), for which it was determined that the potential effects of the Mt Munro wind farm project will be Low to Very Low (summarised in Table 39, page 91).
- While these levels of effect do not warrant mitigation or offsetting, it is recommended that post-construction bird strike monitoring of the wind farm and transmission line be conducted for a period of one year immediately after the wind farm becomes operational. If any mortalities of *At Risk* or *Threatened* species are detected, a review will be undertaken to determine if further monitoring is required, and any remedial, mitigation or offsetting actions need to be implemented.

Conclusions

- The existing ecological values (terrestrial vegetation, wetlands, freshwater and avifauna) associated with the Mt Munro project site are Low.
- The overall potential effects of the project will be less than minor and can be appropriately addressed through best practice construction management (e.g. culvert installation, erosion and sediment control measures), and offset measures to address the loss of small areas of natural wetlands and aquatic habitat associated with a piping in a tributary for an internal access road.

CONTENTS

Appendices

1.0 Introduction

Meridian Energy Limited (Meridian) is seeking resource consents to develop a wind farm of up to 20 turbines on Mt Munro, Tararua, approximately 5 km south of the Eketahuna, 4 km to the north of Pūkaha National Wildlife Centre, and to the east of State Highway 2 (see Map 1). The consenting approach that Meridian is taking for the Mt Munro wind farm is as follows:

- A Turbine Envelope Zone within which all turbines and any infrastructure will be located (refer to Map 2); and
- A Turbine Exclusion Zone where any infrastructure but no turbines will be located (refer to Map 2); and
- A transmission corridor and substation to connect the wind farm to the national electrical grid (refer to Map 2).

1.1 Site context

The wind farm site is situated above the Wairarapa Plain, with the proposed turbine platforms ranging in elevation from 389 to 502 m above sea level. The project site comprises three landowners, all of whom raise sheep and beef cattle on their farms.

Though a relatively small site, Mt Munro project site spans a number of ecological and council boundaries. The wind farm site spans the boundaries of two ecological regions (Tararua and Pahiatua), two ecological districts (Tararua and Puketoi), two regional councils (Horizons and Greater Wellington (GWRC)) and two district councils (Tararua and Masterton). The transmission site spans both ecological regions and districts but is contained within the boundaries of the Horizons Regional Council and Tararua District Council.

1.2 Mt Munro background

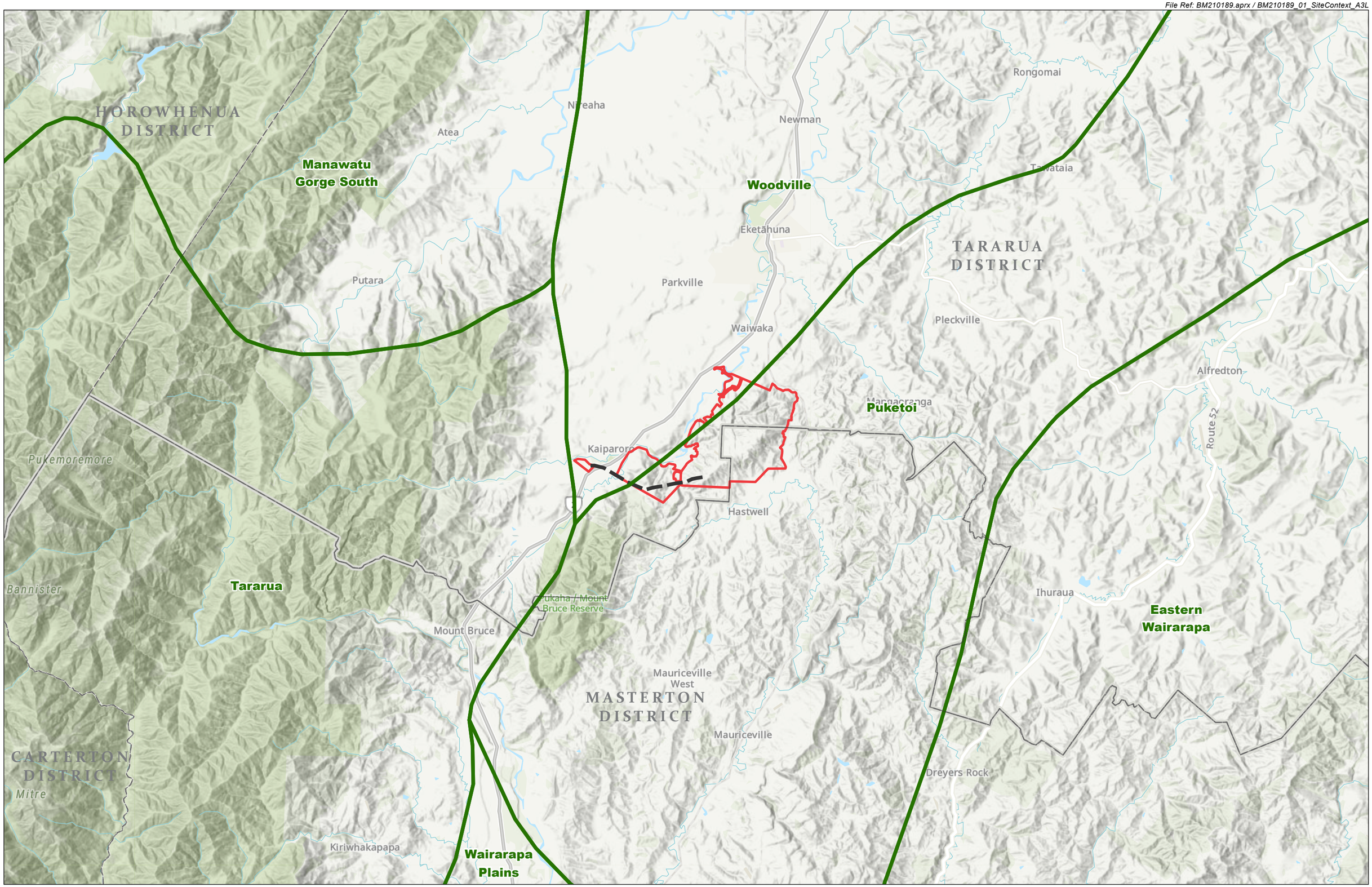
Previous ecological investigations have been undertaken on Mt Munro (2010-2012) as part of Meridian's earlier proposal to develop an 18-turbine wind farm (and associated transmission line) on the site. The ecological site investigations included:

- Mapping and describing terrestrial vegetation communities;
- Avifauna point counts on the wind farm site, and flight path monitoring across the proposed transmission corridor for New Zealand falcon, kaka and kereru;
- Freshwater investigations in relation to aquatic habitats, macro-invertebrate and fish;
- Limited bat monitoring.

The ecological data that was collected during those investigations was used to inform and prepare an Ecological Assessment of Effects (Boffa Miskell Ltd, 2011b) which accompanied the resource consent application for the previous Mt Munro project.

1.3 Current ecological assessment

This current ecological assessment is in relation to the potential effects of the refreshed Mt Munro proposal on the following: terrestrial vegetation, wetland vegetation, herpetofauna, freshwater



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Data Sources: Eagle Technology, LINZ, StatsNZ, NIWA, Natural Earth, © OpenStreetMap contributors., Eagle Technology, Land Information New Zealand, DOC

Projection: NZGD 2000 New Zealand Transverse Mercator

LEGEND

- Site Boundary
- Transmission Line Route
- Ecological Districts
- Territorial Authorities

MT MUNRO WIND FARM ECOLOGY ASSESSMENT

Site Context

Date: 05 April 2023 | Revision: 0

Plan prepared for Meridian Energy Limited by Boffa Miskell Limited

Project Manager: Leigh.Bull@boffamiskell.co.nz | Drawn: KMa | Checked: LBu

Map 1

and avifauna. We note that Tonkin & Taylor have prepared a separate assessment of effects for bats, and as such that taxonomic group has been excluded from this current assessment.

A significant amount of ecological information and data was obtained from the earlier (2009-2012) site investigations at Mt Munro, and as such has been used to inform the current ecological assessment. While there had been no change in land use at the Mt Munro since the earlier investigations, based on the time that had elapsed and the additional statutory plans that have come into effect over that time period, the following approach was taken in relation to ecological field data requirements:

- The previous mapping and description of the terrestrial vegetation communities were ground-truthed on site.
- Wetland vegetation communities were surveyed in accordance with MfE (2020) protocols in relation to wetland delineation.
- The wind farm point count and transmission line flight path avifauna monitoring were repeated following the methods used in the 2009-2012 surveys.
- Additional freshwater surveys were conducted, including spotlighting for fish.
- Given the envelope approach that is now being undertaken by Meridian at the site, the potential herpetofauna habitat across the site was identified and surveys conducted in areas of potential habitat.

For the purpose of this report:

- "The Project" refers to the Mt Munro wind farm as described in Section 2.0;
- "Turbine Envelope Zone" refers to the area in which all turbines and any infrastructure will be located, shown as the General Accordance (GA) design in Map 2.
- "Turbine Exclusion Zone" refers to areas where any infrastructure, but no turbines will be located, shown as the General Accordance (GA) design in Map 2.
- "Project site", "the site" refers to the land enclosed by the Site Boundary shown in Map 2.

The structure of this report is as follows:

- Section 2.0 (page 5) provides a description of the Mt Munro project;
- Section 3.0 (page 9) outlines the methods used to obtain ecological information on which this current assessment has been prepared;
- Sections 4.0 (page 27) and 5.0 (page 29) provide descriptions of the existing environment as these relate to the wider landscape and the project site respectively;
- Section 6.0 (page 65) provides a summary of the ecological values that are present on the site;
- Section 7.0 (page 69) provides a summary of any significant habitats that are present, as determined in the context of Section 6c of the Resource Management Act (1991);
- Section 8.0 (page 72) presents the assessment of effects of the Mt Munro project on the ecological values that have been identified; and
- Section 9.0 (page 92) recommends the measures that are required to address the residual effects of the project that cannot be avoided, remedied or mitigated.

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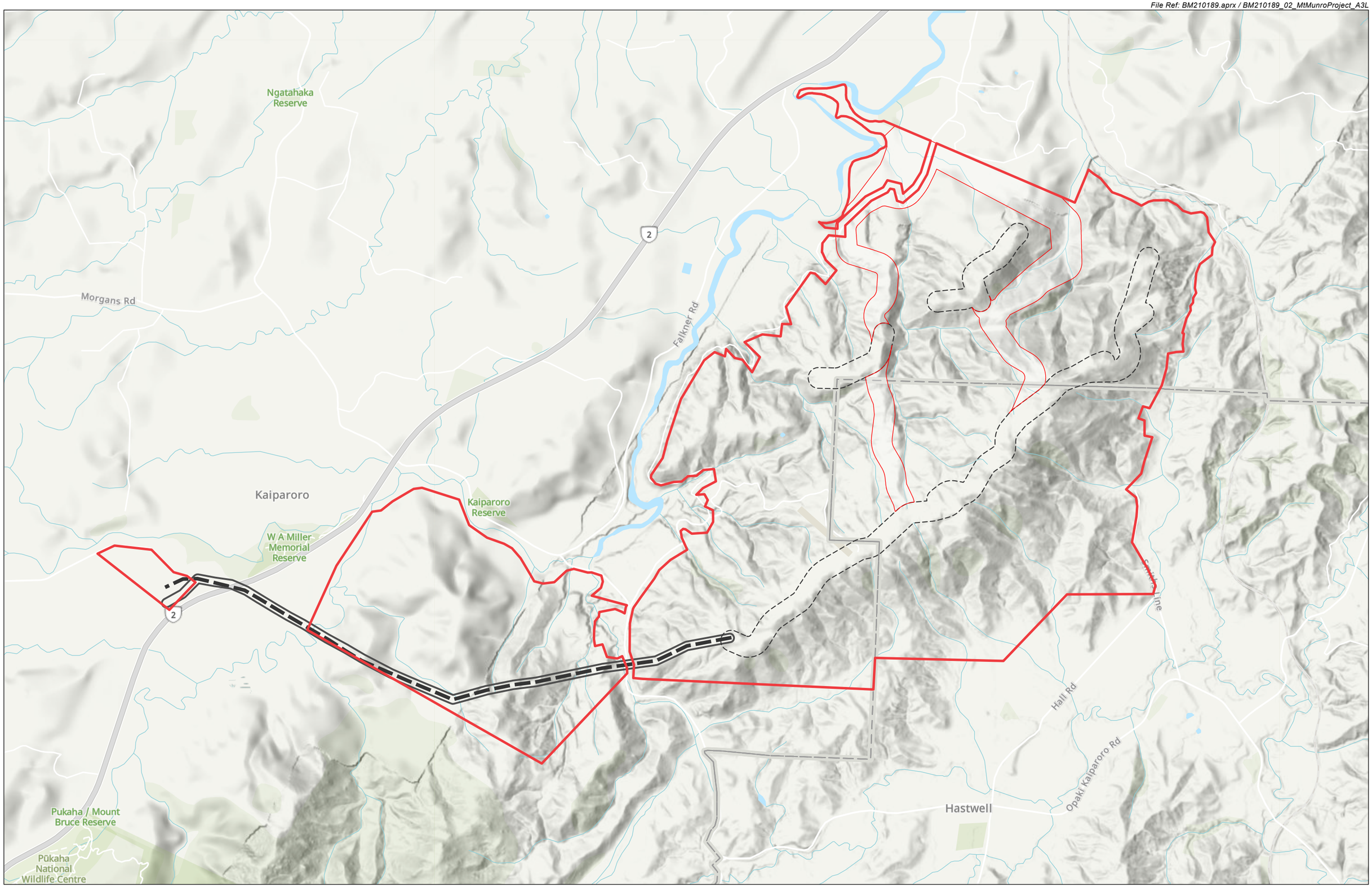

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Projection: NZGD 2000 New Zealand Transverse Mercator

LEGEND

- Site Boundary
- Transmission Line Route
- Transmission Corridor
- Turbine Envelope Zone
- Turbine Exclusion Zone

MT MUNRO WIND FARM ECOLOGY ASSESSMENT

Mt Munro project

Date: 17 May 2023 | Revision: 1

Plan prepared for Meridian Energy Limited by Boffa Miskell Limited

Project Manager: Leigh.Bull@boffamiskell.co.nz | Drawn: KMa | Checked: LBu

Map 2

2.0 Project Description

The key features and activities of the proposed Mt Munro project include:

- Main access to the wind farm will be at the northern end of the site off of Coach Road;
- Temporary project offices and one laydown area located on Coach Road opposite the main site access;
- A maximum 20 turbine layout, each having an individual access road;
- A temporary concreting batching plant on site;
- A second temporary lay down area will be located on the wind farm site;
- A substation located adjacent to SH2; and
- An overhead transmission line (and associated infrastructure) with an alignment running from the southern end of the wind farm site to the substation.

The following project description has been provided by Meridian.

2.1 Turbines

The Mt Munro wind farm will comprise up to 20 turbines which may be placed along the main ridge and the two lower hills to the northwest of the main ridge, being the Turbine Envelope Zone (refer to Map 2).

Each turbine comprises a tower, a nacelle, and a rotor hub with three blades. Turbines will have a maximum blade diameter of 136 m, and maximum height above ground level to a tip height of up to 160 m (92 m hub height) and an approximate capacity of 4.5 MW each. The turbine rotor speed will vary between 6 and 12 revolutions per minute. Aviation lighting will be installed on the top of each nacelle as required.

Each turbine will require a foundation, crane pad, and blade laydown area onto which the turbine can be erected.

The turbine transformers that step the voltage up at each turbine generator to the internal network voltage of 33kV will be located either inside the tower's base or outside the tower (in a kiosk or mounted on a pad). If located outside the tower, the transformer will be situated in a position that minimises any visual effects when viewed from outside of the project area (wherever practicable).

2.2 Internal roading

Construction of an internal road network will be required to install and service the wind turbines. The specified widths below are the widths of the *full bearing capacity part of the road* and don't include feathered edges, drains, or removal of banks on the road shoulders to enable the passing of turbine blades etc:

1) The width of the wind farm ridge roads within the Turbine Envelope Zone will be between 8 and 11 m in width. These roads will have relatively gentle slopes, resulting in relatively low levels of earthwork requirements. The combined length of these roads will be approximately 6.0 km.
2) The "access roads" that run from the bottom of the hill to the wind farm ridges via relatively steep slopes and within the Turbine Exclusion Zone will be between 6 m and 8

m in width. The combined length of these roads will be approximately 5.5 km. Two main access roads will likely be built for safety and practicality reasons: one for the heavy components and one for light traffic/service vehicles.

The access roads will be as steep as 20% in some sections, requiring suitable surfacing to enable heavy components to be safely transported to the ridge top, likely being towed/pushed by one or more support vehicle(s).

2.3 Terminal substation

The connecting Substation (Terminal Substation) for the wind farm will be located at the bottom of the hill, near the existing 110kV Transpower line, on the western side of the corner of Kaiparoro Road and SH2 (refer to Map 2). It will take the Internal Transmission Line from the wind farm and house all the electrical protection equipment to enable connection into the National Grid via Transpower's 110 kV transmission lines. The main transformer (33 kV to 110 kV) will be housed here or at the Internal Substation. The Services/O&M building may also be housed on Meridian's half of this Substation (the alternative location being at the site entrance).

2.4 Internal substation & internal transmission network

The internal wind farm 33kV network will be underground from the turbines to a point near the southwest most turbine on the main ridge. Here the cables will be collected into a small internal substation/switching station (Internal Substation).

The internal network between turbines will be buried under access roads wherever possible. It is expected that four strings of cables will be required. Some protection equipment may need to be located at the switching station.

2.5 Transmission connection between substations

The Terminal Substation will be connected to the Internal Substation by a 33kV, dual circuit 33 kV, or 110 kV line of approximately 3.5 km in length. The poles for the transmission line could be concrete or steel and up to a total height of 20 m.

The 33kV pole and line design would not use standard pin type insulators on top of the cross arms, or have pole-mounted transformers or pole-mounted switch gear. An overhead earth wire would also be incorporated into the pole design. The 110kV pole and line design would have spacings that would make touching of two phases at once practically impossible.

At the substation, the equipment will be underground / indoors or have spacings and insulators large enough to reduce the potential risk of electrocution.

2.6 Wind monitoring tower

The site will require one permanent wind monitoring tower (mast), similar to the current mast. This will be up to 92 m tall, guy-wired and a lattice type tower. The location of this monitoring mast will depend on the final locations of the wind turbines.

2.7 Site entrance

The site entrance will be located at the end of Old Coach Road on a dedicated section of land (refer to Map 2). This area will host a number of activities. During construction this will house the construction village; including temporary site offices, amenities, security, parking, and a laydown area (for deliveries of turbine components and for holding these until delivery up to final turbine locations). After commissioning, the entrance area could be used for Operations, and could house the Services/O&M building, and/or continue to function as a storage area for spares and large components required for repairs etc.

2.8 Services/O&M building

A permanent Services/O&M building will be located either at the site entrance area, or at the Substation or the corner of Kaiparoro Rd and SH2. The services building will house a workshop, control room (for managing turbines) and amenities, and will be serviced for electricity, fibre, water, sewerage and stormwater and one will support some communications equipment. This equipment would include up to two communications dishes mounted on the building or surrounding structures.

The building will be approximately 35 m x 20 m, and approximately 6.5 m high.

2.9 Portacom buildings

The following temporary portacom buildings are proposed within the site entrance area:

- Temporary cookhouse portacoms comprising separate kitchen and chiller portacom structures.
- A 12 m x 3 m portacom adjacent to the dwelling being used as a temporary office.
- A small (6 m x 3 m) portacom structure, to be used as a security office, located at the eastern end of the Site Entrance area.

The portacom structures are single storey temporary buildings and will be removed upon the completion of the construction phase.

2.10 Fuel storage

A 30,000 litre diesel tank is proposed within the Turbine Envelope or Turbine Exclusion Zone. The tank will be a steel tank, which is designed with integral secondary containment and footings. The double skin provides containment should the inner tank be ruptured.

2.11 Quarry sites

Suitable sources of quarry material will likely be sought from local suppliers, a local quarry on Opaki-Kaiparoro Road is within close proximity by established contracting companies in the region including Fulton Hogan, Oldfields and Wairarapa Aggregates. No quarrying activities will occur on the project site, other than from crushed rock from earthworks.

2.12 Concrete batching plant

The site will include two concrete batching plants to be located within the Turbine Envelope or Turbine Exclusion Zone. The likely structures and facilities, which comprise a typical concrete batching plant, including indicative dimensions, are:

- Control room and storage building;
- Prefabricated office and amenities structure;
- Mobile batching plant unit which includes, but is not limited to, hoppers, aggregate storage bins, compressor, cement silos and conveyors;
- Additional cement storage silo;
- Water tank;
- Aggregate stockpile area;
- Generator.

2.13 Controlled blasting

Based on a visual inspection of the site and the preliminary geotechnical appraisal, hydraulic excavators, large dozers with ripping attachments, and motor scrapers are likely to be used. In the event that harder material (particularly moderately/slightly weathered or intact rock) is encountered, it may be necessary to use controlled blasting operations.

3.0 Ecological Methods

3.1 Terrestrial vegetation

As part of the 2011 investigations, the terrestrial vegetation was surveyed and mapped using the following method (Boffa Miskell Ltd, 2011b). Prior to any site investigations, high resolution maps were used to identify areas of vegetation. A site visit was then undertaken on 27 January 2011 to compile a list of species (both native and introduced) that were present. All vegetation communities occurring on the site were mapped in the field and later digitised. Vegetation communities associated with the transmission line route were also mapped during site visits on 17 June and 21 October 2011.

For the purpose of the current assessment, those vegetation communities identified, described and mapped during the 2011 investigations were ground-truthed by two ecologists during a site walkover over a period of four days in November 2021. Any notable changes to previously identified vegetation communities recorded and presented in this report.

3.2 Wetlands

3.2.1 Desktop information

Databases and literature searches were undertaken to obtain information on project site and in the wider landscape in relation to any wetland surveys that had previously been undertaken, the potential for wetlands or identified areas of significance, including the New Zealand Plant Conservation Network botanical survey records, Significant Natural Areas (SNAs) identified in Council plans and reports, LENZ (Landcare Research Ltd, 2012), LRI soil portal and Land Cover Database 5.

This assessment has also been supported by the information provided in the following documents and plans:

- Published plant field species lists of (Ogle, 2006);
- PNAP survey (Beadel et al., 2004);
- Ecological Regions & Districts (McEwen, 1987);
- Past and current indigenous vegetation cover and the justification for the protection of terrestrial biodiversity within the Manawatu-Whanganui region: technical report (Maseyk et al., 2007);
- Identification and prioritisation of high value terrestrial biodiversity sites for selection with Key Native Ecosystems Programme in the Wellington Region (Crisp et al., 2016);
- Forest ecosystems in the Wellington Region (Singers et al., 2018);
- A desktop assessment of wetlands in the Wellington region (Boffa Miskell Ltd, 2011a).

3.2.2 Assessing the presence of natural wetlands

Natural wetland determination is confirmed by the legislation in the National Policy Statement for Freshwater (NPS-FM) (Ministry for the Environment, 2020a), the Resource Management Act 1991 (RMA – the Act) and Schedule F of the Horizons One Plan (Horizons Regional Council, 2014). The NPS-FM approach has largely been reflected in the Greater Wellington Regional Proposed Natural

Resources Plan (PNRP) (Greater Wellington Regional Council, 2020) but less so in the Horizons One Plan.

The Horizons One Plan contains Schedule F, in which indigenous dominated habitats are listed and recorded as Rare, Threatened or At Risk. Those habitats listed as Rare or Threatened are considered also "significant". But to be recognised as such, those habitats must meet some criteria, the first of which is to be predominantly indigenous. Otherwise, features can be tested against the Policy 13-5 significance criteria. Schedule F lists a range of wetland types, and these lists reflect identification of indigenous natural wetlands, they do not have an RMA natural wetland definition or exclusions.

The Greater Wellington Regional Council (GWRC) also as has significance criteria in Policy 23 of its Regional Policy Statement (RPS; GWRC (2013)) and these are used where required to test the significance of any natural wetlands that fall within that Council's justification.

In essence across both regions, the determination and delineation of wetland followed the NPS FM (2020) and the recently updated MfE Wetland Delineation Protocol (Ministry for the Environment, 2022b).

The RMA provides a definition of "wetland" which has been adopted and refined in the NPS-FM and PNRP to differentiate "natural wetlands" from the broad RMA "wetland" definition.

The NPS-FM defines **natural wetland** as described in the Act:

> *"permanently or intermittently wet areas, shallow water, and land water margins that support a natural ecosystem of plants and animals that are adapted to wet conditions".*

but does not include:

> *(a) In the coastal marine area; or*
>
> *(b) a deliberately constructed wetland, other than a wetland constructed to offset impacts on, or to restore, an existing or former natural inland wetland; or*
>
> *(c) a wetland that has developed in or around a deliberately constructed water body, since the construction of the water body; or*
>
> *(d) a geothermal wetland; or*
>
> *(e) a wetland that:*
>
> *(i) is within an area of pasture used for grazing and*
>
> *(ii) has vegetation cover comprising more than 50% exotic pasture species (as identified in the* National List of Exotic Pasture Species *using the* Pasture Exclusion Assessment Methodology (*see clause 1.8)); unless*
>
> *(iii) the wetland is a location of a habitat of a threatened species identified under clause 3.8 of this National Policy Statement, in which case the exclusion in (e) does not apply.*

The NPS-FM outlines the requirements for wetlands in Policy 6:

> *"There is no further loss of extent of natural inland wetlands, their values are protected, and their restoration is promoted."*

And in section 3.23 (3):

> *"In case of any uncertainty or dispute about the existence of a natural inland wetland, a regional council must have regard to the Wetland delineation protocols"*

We note, for 'natural wetlands', the National Environmental Standards for Freshwater (NES-FW; (New Zealand Government, 2020)) provides additional guidance in wetland verification and delineation. The NES-FW also provides regulations for activities in and around natural wetlands; and part of this assessment includes establishing those distances and relevant buffers from specific natural wetland boundaries.

Testing against the wetland definitions requires a scientific method in determining if an area can be considered a "natural wetland". If these tests are not met, the area is not deemed a natural wetland. This process is described below in Section 3.2.3.

3.2.3 Natural wetland assessment

To determine the presence of any natural wetlands, the nationally recognised methods outlined in Clarkson (2013) and Clarkson *et al*. (2021) is used (this is also produced in MfE (2022). This process involves dividing the landscape to be assessed into broad vegetation communities by rapidly visually assessing the dominant species in an area and using topography to assist with these broad areas.

Once these areas are identified, four tests (pasture dominance, wetland dominance indices, prevalence indices, and hydric soil testing) are conducted as required to determine the presence of natural wetland or otherwise. These tests require a representative 2x2 m vegetation plot in each identified vegetation community, whereby the percent cover of all species within a plot is estimated (based on above-ground live biomass).

3.2.3.1 Definitions and terms and protocol

The flow charts below outline the pathway for identifying natural wetlands. There is a new flow diagram published in the new pasture method incorporated by reference (Figure 1). It basically asked the questions prior to the flow process below, is the potential wetland a habitat for threatened species and (if no) does the pasture exclusion provision apply, and if no proceed as per Figure 2.

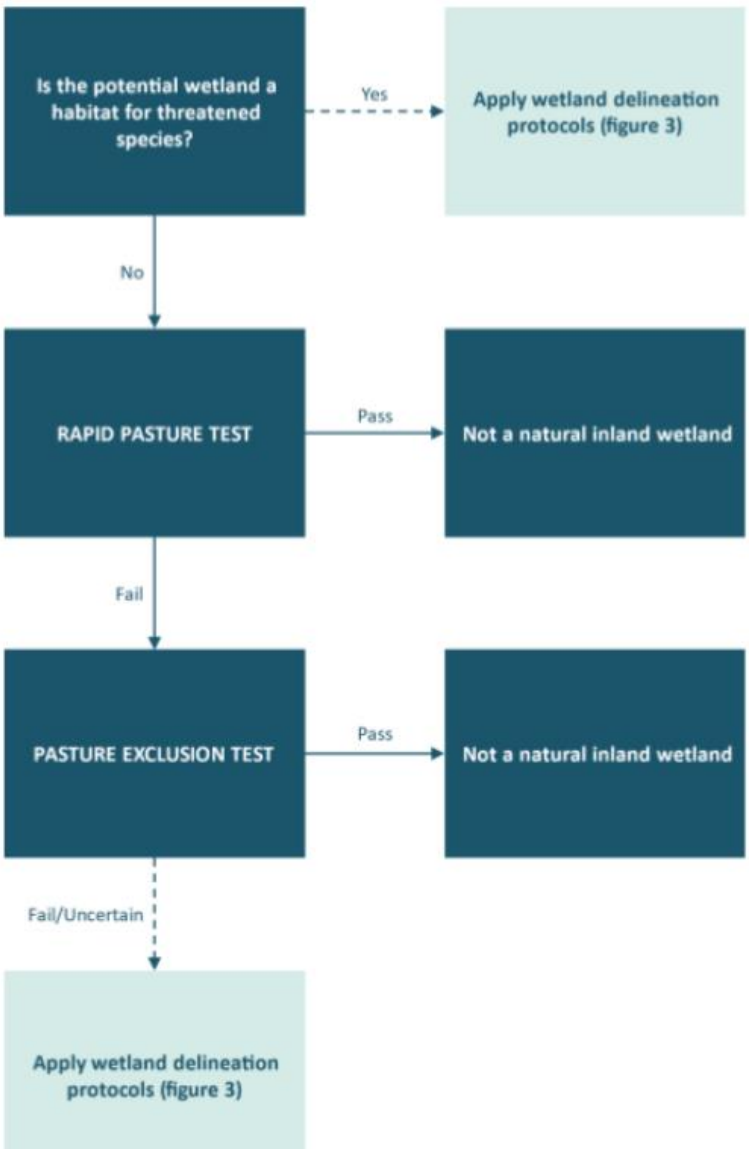
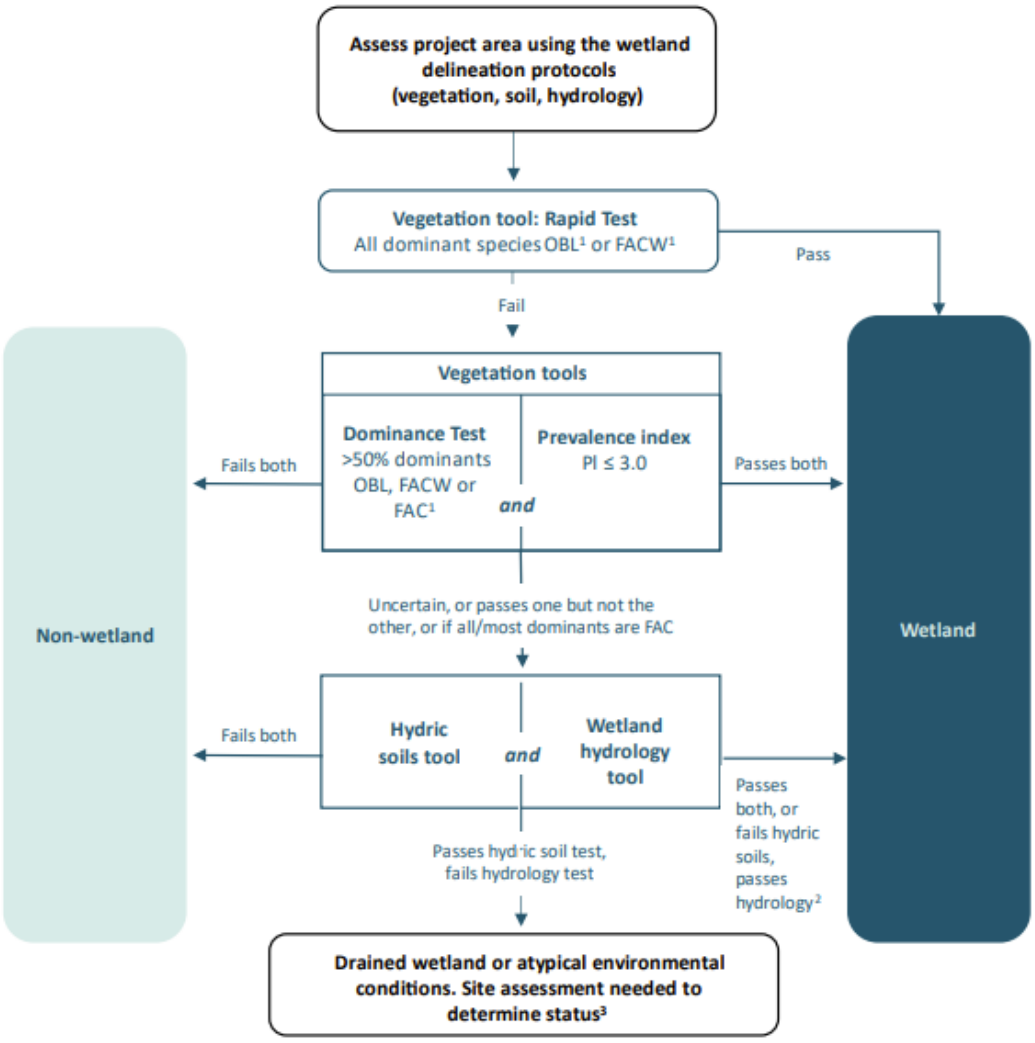


Figure 1. First component of the wetland test on farms where it might be pasture.



Footnotes:
[1] Wetland indicator status abbreviations: FAC = facultative, FACW = facultative wetland, OBL = obligate wetland.
[2] For example, recent wetland.
[3] The US procedures for atypical or problematic situations are recommended.

Figure 2 Conceptual flow diagram to identify natural wetlands following MfE protocol (2022).

3.2.3.1.1 Pasture dominance test

A pasture dominance test is conducted with reference to the published National list of exotic pasture species (Ministry for the Environment, 2022a), a recent statutory document which outlines a restricted list of exotic pasture species found in New Zealand. The pasture test relates to exclusion c), which considers that if a plot is more than 50% covered in pasture species, it is not considered a "natural wetland", irrespective of the prevalence/dominance outcomes, and no further testing is required.

If the feature is not dominated by pasture, then the following tests are used to further determine if the feature is a natural wetland:

3.2.3.1.2 Wetland species dominance test

This test ascertains the "dominant" species following a 50/20 rule, whereby all species are ranked according to their percentage cover, and the highest covering species are sequentially selected

until cumulative coverage exceeds 50%. Any other species which comprise at least 20% coverage are also selected. If more than 50% of the dominant species are OBL, FACW, or FAC (see Section 3.2.3.1.3) species, then the “dominance test” threshold is met, and the area is a natural wetland. However, if there is a large FAC species presence, caution is recommended, and further analysis should be undertaken. This test is carried out alongside the Prevalence test, described below.

3.2.3.1.3 Prevalence Test

This is carried out in conjunction with the dominance test, as outlined in Figure 2. Each vegetation species identified is allocated to a prescribed category based on their degree of affinity for water, as described by Clarkson (2013). These categories are:

- OBL: Obligate. Almost always is a hydrophyte, rarely in uplands (estimated probability >99% occurrence in wetlands)
- FACW: Facultative Wetland. Usually is a hydrophyte but occasionally found in uplands (estimated probability 67–99% occurrence in wetlands)
- FAC: Facultative. Commonly occurs as either a hydrophyte or non-hydrophyte (estimated probability 34–66% occurrence in wetlands)
- FACU: Facultative Upland. Occasionally is a hydrophyte but usually occurs in uplands (estimated probability 1–33% occurrence in wetlands)
- UPL: Obligate Upland. Rarely is a hydrophyte, almost always in uplands (estimated probability <1% occurrence in wetlands)

Using these data, a Prevalence Index Score[2] is calculated for each plot. Mathematically, this score must fall between 1 and 5, with 1 indicating entirely wetland species (OBL), and 5 indicating entirely upland species (UPL). A score below 3 is indicative of a wetland/hydrophilic community, though Clarkson (2013) cautions that a score between 2.5 and 3.5 is not reliable for determining a hydrophilic community on vegetation measures alone.

If, following the above tests, uncertainty still surrounds the outcome, looking to hydric soils and hydrology is recommended. We consider at this point that the wider context of the feature should be evaluated.

3.2.4 What is pasture?

The PNRP or One Plan does not define the word "pasture", and nor do either expressly refer to any external document that provides guidance as to the meaning of that word. The NPS FM (2020) does however, define, by way of a list, what species are to be accepted as being pasture.

Prior to the NPS FM 2020 pasture was usually defined (dictionaries) as a place – usually fields - deliberately sown or maintained for growing plants on which to graze animals and has an array of typical sown and self-colonised species that form the plant community.

The types of species were fluid and related to the use/purpose rather than an ideal of a best for agriculture perspective.

The amended NPS FM now prescribes a very limited species list of what can be accepted as pasture for the purposes of considering pasture exclusion of wet areas on farms. That list contains no species that are FACW or OBL and so grasses imported early in the century for managing wet

[2] More recently there is a move to sample and understand if hydric soils are present and this method is gaining in prominence.

pasture such as creeping bent (*Agrostis stolonifera*), mercer grass (*Paspalum districhum*), sweet grasses (*Glyceria declinata, G. maxima, G. fluitans, G. striata* and *G. pedicellate*) or wet pasture associated species such as creeping buttercup do not now count as pasture species.

Consequently, under the NPS FM (2022) we are now often identifying exotic, induced, grazed non representative small areas which were never historically wetland as "natural inland wetland" with a requirement to avoid adverse effects or diminishment of the size and "values" of these features.

This is not what we consider was intended by the NPS FM where the issue identified was the diminishment of indigenous wetlands to less than 10% of their historic extent across New Zealand. Consequently, while we adhere to the processes of the NPF FM (2020) and identify natural wetlands by those processes, we do not agree with any assumption that the methods and processes and outcomes are correct or valid or will cause the protection or restoration of indigenous underrepresented wetland.

3.2.5 Site survey

Field work to collect the required wetland vegetation plot data across the proposed wind farm site (excluding the associated transmission lines) was collected over four days (10-13 November 2021). We note that this field work was undertaken before the amended NPS FM and before the pasture exclusion method. A third visit was conducted after a road alignment changer to verify a further gully system in February 2023.

During this time the weather was dry (hot) with no rain, but there had been rain sporadically in the previous two weeks (Figure 3). As such, we deemed the ground water and seepages to be normal for the time of year of the wetland survey.

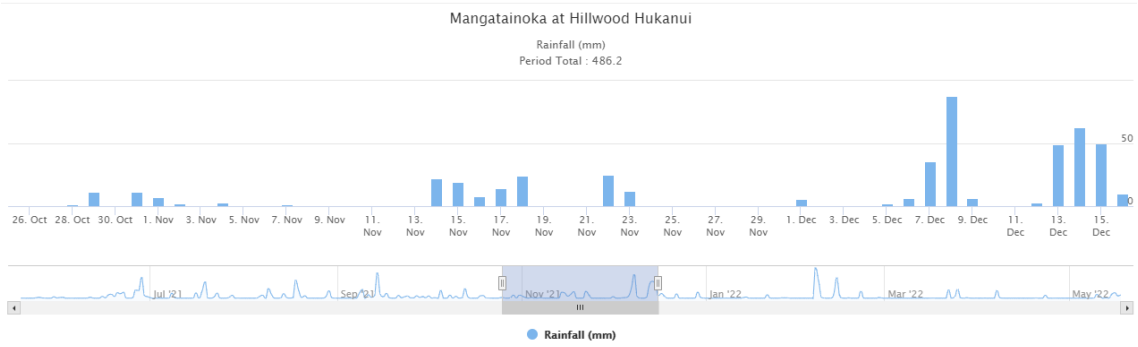


Figure 3: Rainfall logged at the Horizons Regional Council logger station at Mangatainoka at Hillwood Hukanui between 26/10/21 and 16/12/21

A further one-day survey of the prospective transmission line area was undertaken on 16 December 2021. As shown in Figure 3, 315 mm of rainfall was received at the nearby weather station in the two weeks prior to this survey, and it was raining at the time of survey. This appears a normal rain fall pattern. Not all areas of land under the transmission line buffer zone were able to be accessed for the survey but were viewed where possible.

Prior to the site visit, the landscape of the project area was scoped using google earth and drone imagery and contour data. A 100 m buffer around the Turbine Envelope and Turbine Exclusion Zones (provided by Meridian) was developed by BML GIS technical specialists, such that all of the above information was used to develop a vegetation investigation path which would cause all suspected wetland features within 100 m of any possible earthworks activities to be encountered

(refer to Map 3). This data was loaded on to an iPad as geo-referenced maps and reflected the earlier features mapped by BML (2011b) as well as the 100 m "buffer" line and all other map features.

During the site visits, the wetland survey area was walked to identify potential wetland features. While the potential wetland features were typically in gully depressions on steep hill sides, the investigation included the flatter ridge top.

At each feature a rapid assessment was undertaken and included photographs and notes on hydrology, vegetation and soil. Where the rapid test was inconclusive a vegetation plot and soil core was undertaken. The number of plots was determined and located in order to fully represent the majority of the character of the feature. At those plots the Clarkson (2013) plot measures (a 2 m x 2 m square) were recorded using averaged cover of two ecologists estimates (only one ecologist in the transmission line survey) of each species in the plot's surface cover. When values were over 100% these were rationalised later in the data.

A soil core using a Groundtest© corer was undertaken to at least a depth of 50 cm (if this was possible). The cores were extracted photographed and assessed after exclusion of the top soil layer (20-30 cm) following Fraser (2018). Lastly consideration was given to the hydrology of the feature following MfE (2021).

The data were collated, and the various indices and exclusion percentage covers calculated.

3.3 Herpetofauna

3.3.1 Desktop investigation

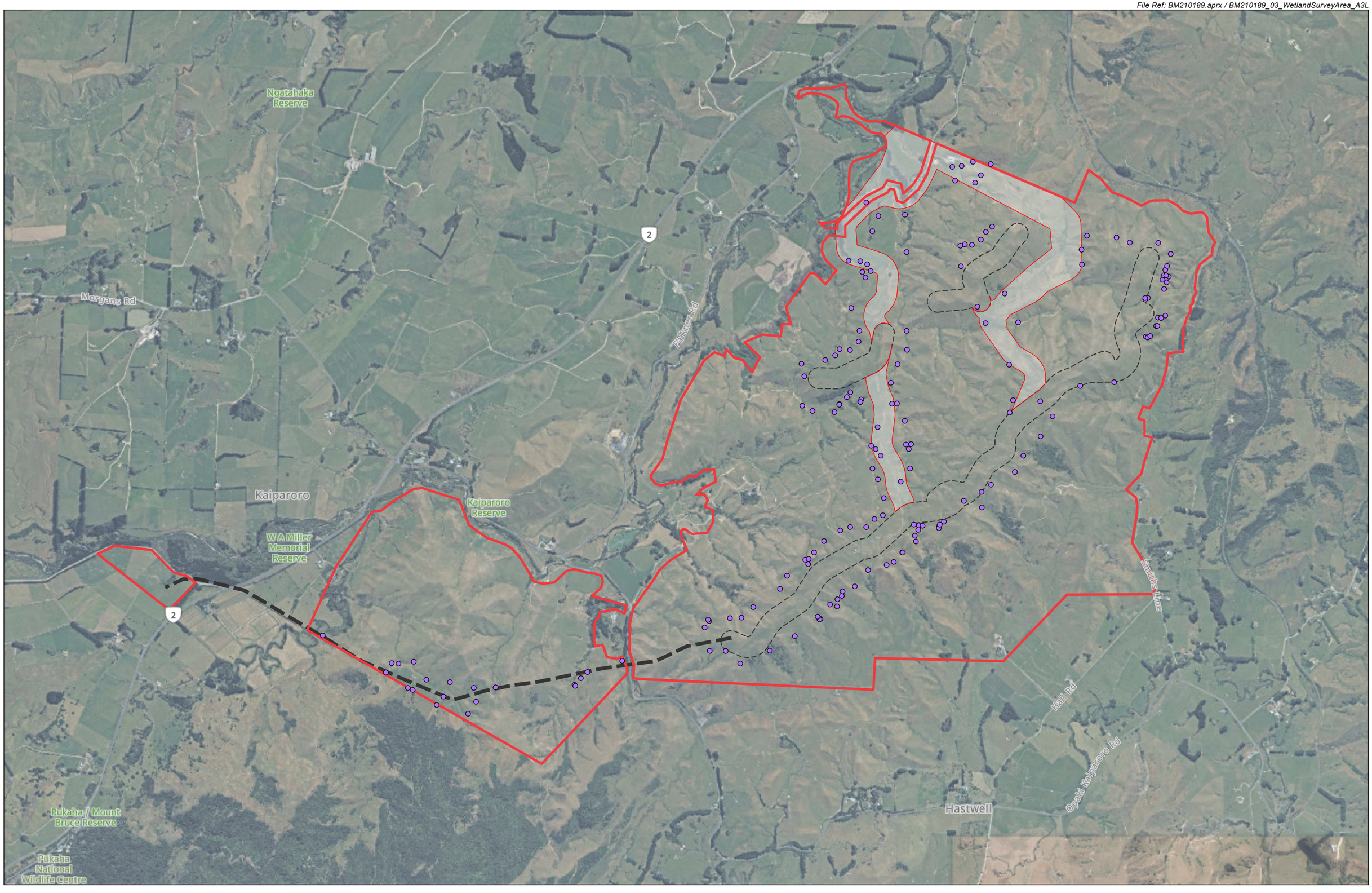
A desktop review was undertaken of the site and wider area, to determine what herpetofauna species could potentially be present in and around the footprint. This included reviews of databases, management plans, scientific literature (published and unpublished) and website searches. Prior to undertaking the field investigations (outlined in Section 3.3.2 below), the DOC BioWeb database herpetofauna records were accessed for within 20 km of the proposed wind farm. Additional desktop studies included a review of aerial imagery and preliminary vegetation maps to aid in determining where field surveys should be focused.

3.3.2 Field surveys

Lizard surveys were carried out between November 2021 and April 2022. Surveys were conducted over eight days across four trips (Table 1) in conjunction with bat and/or bird surveys and focused on areas expected to be directly or indirectly impacted by the proposed works. Four survey methods were used and are described below.

Table 1: Summary of lizard surveys conducted within the Mt Munro study area.

DATE	DESCRIPTION
9-11 November 2021	Habitat assessment, artificial cover object (ACO) set-up, limestone and rockpile searches
8-9 December 2021	ACO checks, debris searches
3-4 February 2022	ACO checks, spotlighting
31 March – 1 April 2022	ACO checks and removal



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Projection: NZGD 2000 New Zealand Transverse Mercator

LEGEND

- Surveyed Sites
- Site Boundary
- Transmission Line Route
- Turbine Envelope Zone
- Turbine Exclusion Zone

MT MUNRO WIND FARM ECOLOGY ASSESSMENT

Wetland survey area

Date: 17 May 2023 | Revision: 2

Plan prepared for Meridian Energy Limited by Boffa Miskell Limited

Project Manager: Leigh.Bull@boffamiskell.co.nz | Drawn: KMa | Checked: LBu

Map 3

Initial investigations of the site, using both aerial imagery and a site drive-over, were used to determine the herpetofauna habitat types within and adjacent to the proposed footprint of works. Areas of best quality habitat within the site were then targeted with the three survey methods described below.

3.3.2.1 Manual searches

Manual searches for lizards and lizard sign (e.g. scat, shed skin) were undertaken across the site, and included:

- Outcrop searches: Rock outcrop crevices provide lizard habitat, particularly for gecko species. Searches were undertaken of all outcrops found within the potential footprint, using an LED headtorch to inspect crevices in the rock.
- Debris searches: Debris searches were undertaken to search for terrestrial lizards and primarily focused on the overturning of rocks and logs within the footprint.

Locations of outcrop searches and debris fields can be found in Map 4, however smaller scale debris searches (e.g. where incidental rocks, logs, artificial debris were overturned) are not mapped.

3.3.2.2 Spotlighting

Nocturnal searches are used to survey for nocturnal arboreal lizard species, which are most active after dark. It is also a useful technique for searching for diurnal green geckoes, which rest in the foliage at night.

Spotlighting was conducted in the early regenerating native vegetation that falls within the potential footprint on the north-western margin of the site (see Map 4). While this vegetation is considered unlikely to house arboreal lizards, given its age, isolation and size, this survey was carried out for the purpose of comprehensiveness. Spotlighting was carried out for a total of 3 person-hours (two ecologists for 1.5 hours) on the 3 February 2022.

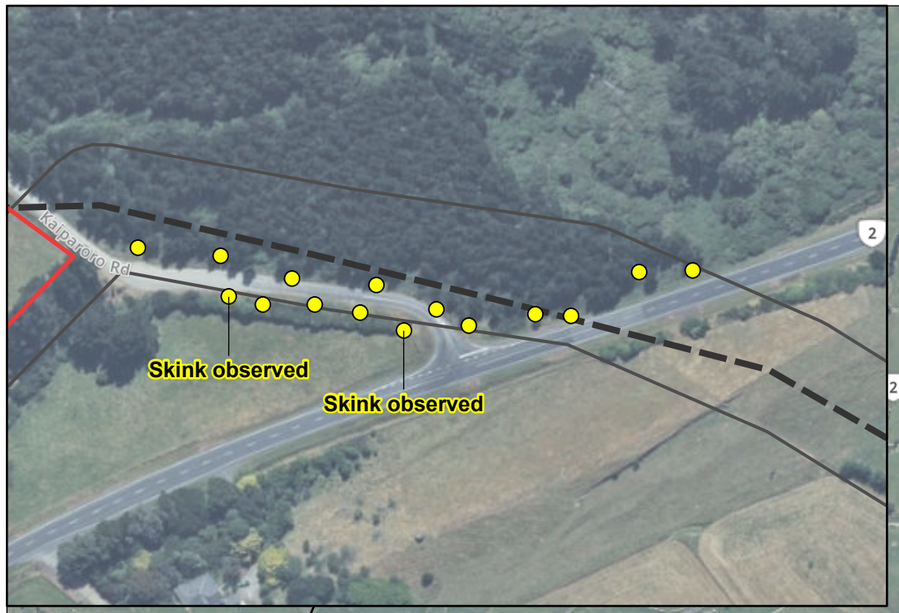
3.3.2.3 Artificial Cover Objects (ACOs)

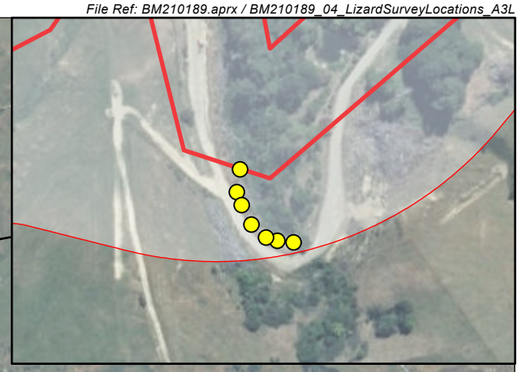
In total, 30 double layered Onduline ACOs were laid out in areas of potential terrestrial lizard habitat. The locations of the ACOs are shown in (Map 4). Habitat types included forest margins, rank grass and an ornamental garden. The ACOs were left in place for a minimum of four weeks[3], to allow sufficient time for lizards to habituate to and colonise the covers. Each ACO was checked six times, for a total of 180 trap nights.

3.4 Freshwater

In 2011 (Boffa Miskell Ltd, 2011b) and again in 2021, aquatic sampling was undertaken at a total of 11 sites (refer to Map 5 and Table 2). The 2021 sampling was undertaken in order to supplement the 2011 sampling by providing up-to-date data and recordings of the freshwater sites including the addition of three new sampling sites. The 2011 and 2021 investigations combined are considered sufficient to inform a values and effects assessment. If the wind farm design was to change to include direct effects on intermittent and/or perennial reaches of the Makakahi or Kopuaranga River catchments, then further investigations may be needed.

[3] Four weeks before the first two checks, another eight weeks before checks 3 and 4, and then eight weeks before checks 5 and 6. ACOs were in place for a total of 20 weeks.





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LEGEND

- Site Boundary
- Transmission Line Route
- Transmission Corridor
- Turbine Envelope Zone
- Turbine Exclusion Zone
- Boulderfield and outcrops
- Line layer selection
- ACO locations

MT MUNRO WIND FARM ECOLOGY ASSESSMENT

Lizard survey locations

Date: 17 May 2023 | Revision: 3

Plan prepared for Meridian Energy Limited by Boffa Miskell Limited

Project Manager: Leigh.Bull@boffamiskell.co.nz | Drawn: KMa | Checked: LBu

Map 4

The objective of the site investigations was to determine the condition, biological health, and value of the streams. Sample sites were chosen based on the scale of the works proposed and the catchments in which they will occur.

Table 2: Freshwater survey and monitoring sites relevant to this assessment, their descriptions, and when data was been collected

SITE LABEL	LOCATION	CATCHMENT	2011 SURVEY	2021 SURVEY
BRU1	Bruce Stream	Makakahi River	Y	Y
BRU2	Bruce Stream	Makakahi River	Y	Y
BRU3	Bruce Stream	Makakahi River		Y
KOP1	Kopuaranga River tributary	Kopuaranga River	Y	Y
KOP2	Kopuaranga River tributary	Kopuaranga River	Y	Y
MAG2	Mangaroa Stream tributary	Makakahi River		Y
MAK1	Makakahi River tributary	Makakahi River	Y	Y
MAK2	Makakahi River tributary	Makakahi River	Y	Y
MAK3	Makakahi River tributary	Makakahi River	Y	Y
MAK4	Makakahi River tributary	Makakahi River	Y	Y
MAK5	Makakahi River tributary	Makakahi River		Y

3.4.1 Physical aquatic environment

3.4.1.1 Stream habitat and morphology

Visual stream inspections were undertaken in both 2011 and 2021 to categorise the condition of the stream at each survey site including the level of sedimentation. In 2011 stream substrate composition focused on fine sediment utilising a method outlined in Wagenhoff et al. (2009) (discussed below). In 2021 stream habitat condition (including riparian condition) was surveyed following Clapcott et al. (2011).

3.4.1.2 Water quality

Water quality parameters (pH, dissolved oxygen, NTU and TSS) were recorded during the 2011 survey using an InsiteIG Model 3150 and TPS 90FL-T multi-meter. Water quality parameters were not reassessed in 2021.

3.4.1.3 Deposited sediment

Visual estimation of percent cover of fine sediment (grain size <2 mm) on the stream bed was carried out at each 2021 survey sites. Assessment methodology followed the standard visual assessment methodology (Sediment Assessment Method 2; SAM2) from Clapcott et al. (2011). Instream visual assessments were made from run habitat(s) at each monitoring site and the proportion (%) of fine sediment (in comparison to other substrate classes) was determined. At each survey site, 20 visual estimates were made which comprised four estimates of sediment cover taken across five transects at each location.

3.4.2 Aquatic fauna

3.4.2.1 Macroinvertebrates

Macroinvertebrate communities were sampled using the Protocol C1 (Hard-bottomed, semi-quantitative; Stark, Boothroyd, Harding, Maxted, & Scarsbrook, 2001) method. A standard D-

shaped kick-net (0.5 mm mesh) was used to collect benthic and pelagic macroinvertebrates. A small section of the streambed was disturbed by 'scuffing' the streambed immediately upstream of the placed net. Disturbed macroinvertebrates were then collected in the net.

In 2011, a total of 1.0 m^2 of streambed was disturbed at each site. In 2021, five pooled kick samples were collected at each site ensuring a total of 0.6 m^2 of streambed. Macroinvertebrate sampling took place at the same sites as in 2011, plus two new sites (Table 3).

Each sample was preserved in >70% ethanol and sent to the laboratory for processing and identification. All samples were processed in accordance with Protocol P3 (Full Count; Stark et al., 2001) in 2011 and Protocol P1 (Coded Abundance; Stark et al., 2001) in 2021. The resulting data was analysed to determine the following macroinvertebrate indices:

- Taxa richness
- Sensitive EPT (Ephemeroptera, Plecoptera, Trichoptera) taxa richness
- MCI score (Macroinvertebrate Community Index)
- QMCI (Quantitative MCI)

3.4.2.2 Freshwater fish

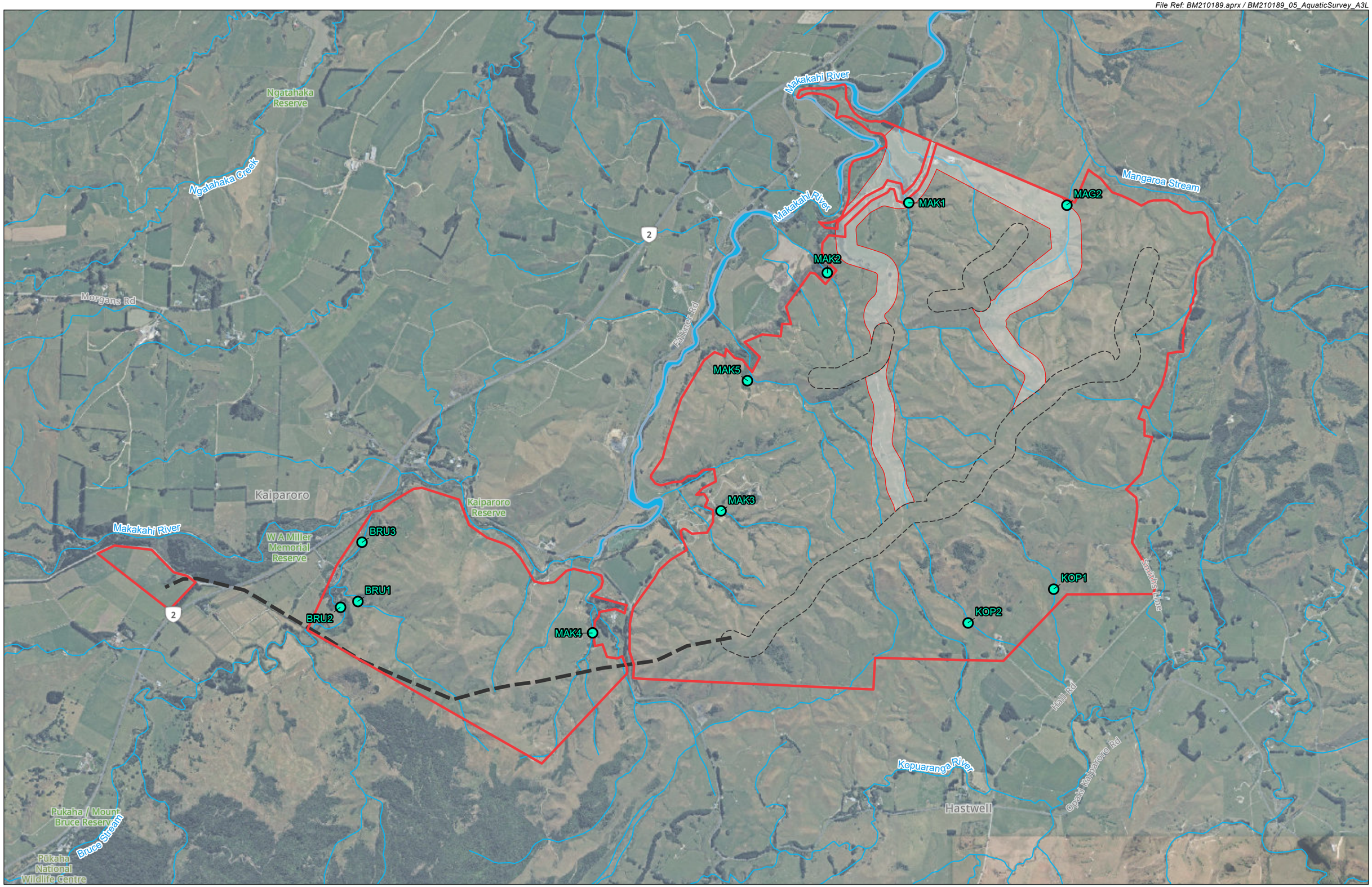
In 2011, sites were surveyed for fish utilising backpack electrofishing methodology described by Joy et al. (2013). A 50 m reach of each stream was electric fished (double passed) to determine what species were present. The particular area of 50 m reach chosen in each stream was deemed to be representative of the habitat types present within that stream.

In 2021 spotlighting methodology was employed to survey the freshwater fish present. Approximately 250 m of watercourse was spotlighted by two operators following the methodology outlined by Joy et al. (2013). Spotlighting occurred in a select number of the sites during the 2021 field investigations (Table 3).

Fish caught in each survey were captured (where possible), identified, measured and released.

Table 3. Record of sites that were surveyed for macroinvertebrates or fish in 2011 and 2021

SITE	2011 SURVEY		2021 SURVEY	
	Macroinvertebrate	Electrofishing	Macroinvertebrate	Spotlighting
BRU1	Y	Y	Y	
BRU2	Y	Y	Y	
BRU3				Y
KOP1	Y	Y	Y	
KOP2	Y	Y	Y	Y
MAG2			Y	Y
MAK1	Y	Y	Y	Y
MAK2	Y		Y	
MAK3	Y	Y	Y	
MAK4	Y	Y	Y	Y
MAK5			Y	



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Projection: NZGD 2000 New Zealand Transverse Mercator

LEGEND

- Site Boundary
- Transmission Line Route
- Turbine Envelope Zone
- Turbine Exclusion Zone
- Surveyed Sites
- Streams (LINZ)
- Rivers (LINZ)

MT MUNRO WIND FARM ECOLOGY ASSESSMENT

Freshwater aquatic survey sites

Date: 17 May 2023 | Revision: 1

Plan prepared for Meridian Energy Limited by Boffa Miskell Limited

Project Manager: Leigh.Bull@boffamiskell.co.nz | Drawn: KMa | Checked: LBu

Map 5

3.5 Avifauna

3.5.1 Desktop investigation

A base list of bird species that are present, or potentially present, within the Mt Munro project area was compiled from:

- the Ornithological Society of New Zealand (OSNZ) bird atlas (C. J. R. Robertson et al., 2007) of all species recorded during the 1999-2004 atlas programme within the 10 km x 10 km grid square (273,605) that encompasses the project area;
- the online eBird Atlas Effort map[4] to determine previously sighted birds in the two grid squares (BS74 and BS75) that encompass the project area[5]; and
- the 2010-2012 avifauna survey data collected (Boffa Miskell Ltd, 2011b). This study included:
    - 30.75 hours of point count observations at nine locations across the site;
    - 4.25 hours of nocturnal surveys in forest fragments across site (any birds seen or heard during the first 1.5-2 hours after dusk were recorded);
    - 2.75 hours of stream observations at 12 points along the Makakahi River; and
    - recording incidental observations of birds observed while traversing between survey sites.
- The national threat classification of avifauna species was derived from Robertson et al. (2021).

The location of the site in relation to possible migratory pathways was also investigated (Southey, 2009) to get an understanding of the sensitivity of the site.

3.5.2 Field surveys

3.5.2.1 Wind farm point counts

Point count surveys were conducted at eight locations (PC1-8) over the wind farm site (refer to Map 6). At each location, 20-minute bird counts were undertaken, preceded by a 5-minute stand down period to record weather conditions (visibility, cloud cover, precipitation, temperature, wind strength, wind direction). Flight descriptions were also recorded, including minimum and maximum flight heights, flight direction, distance from observer, relative height, and behaviour.

Three point count surveys were conducted each season over a year, resulting in 12 point counts for each of the eight sites (refer to Table 4 below); totalling 96 point counts across the wind farm over a one-year period and 32 hours of observation). The three seasonal counts at each location comprised both morning (before midday) and afternoon (after midday) surveys to account for temporal variation in bird activity across the sites (refer to Appendix 1 for start times for all point counts).

[4] New data is being collected over five years for a revised version of the OSNZ bird atlas; for each grid square across New Zealand this online effort map has a list of species that have been observed to date.

[5] The data was accessed on 21 June 2022.

Table 4: Survey dates for the point count and transmssion line avifauna monitoring

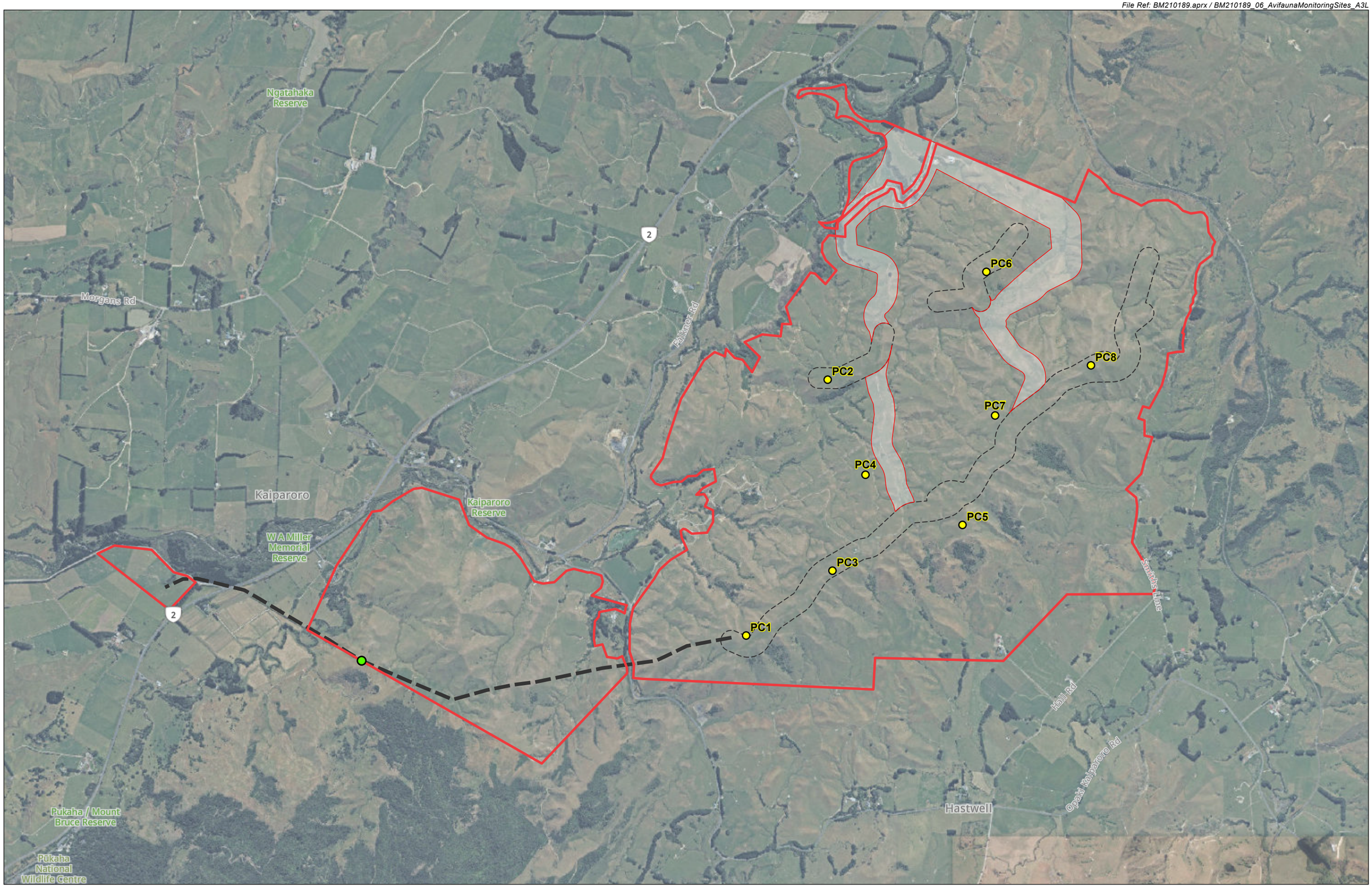
SEASON	POINT COUNT SURVEY DATE	TRANSMISSION LINE SURVEY DATE
Winter	10/08/21	11/08/2021
	11/08/21	23/06/2022
	12/08/21	24/06/2022
Spring	10/11/21 (am)	15/09/2021
	10/11/21 (pm)	11/11/2021 (am)
	26/11/21	11/11/2021 (pm)
Summer	04/02/22	3/02/2022
	15/02/22	15/02/2022
	21/02/22	22/02/2022
Autumn	11/03/22	11/03/2022
	03/04/22	21/04/2022
	04/05/22	6/05/2022

3.5.2.2 Transmission line flight path monitoring

Due to the proximity of the proposed transmission line relative to the Mt Bruce forest, flight path monitoring of New Zealand falcon, kereru and kaka was undertaken at one of the proposed pole locations along the proposed transmission line (refer to Map 6). The location selected provided a good vantage point to observe any bird movements between the Mt Bruce forest block (defined in Section 4.0), the wind farm site and the proposed transmission line.

Three monitoring sessions were undertaken per season (refer to Table 4 above); resulting in a total of 12 monitoring sessions over the course of a year). Each session comprised four hours of observation, and each season included both morning and afternoon monitoring sessions. In total, 48 hours of observation were undertaken.

During each monitoring session, two observers were positioned at the survey site. One observer viewed the landscape to the east and the other viewed the landscape to the west (i.e. each had 180 degrees views enabling 360 degree coverage of the survey area; Photo 1 and Photo 2). The observers alternated their viewpoints every hour to account for observer variability. For each observation of a falcon, kereru or kaka, the flight path was drawn on a map. Flight descriptions were also recorded including minimum and maximum flight heights, flight direction and distance from observer. Weather conditions were recorded, including visibility, cloud cover, precipitation, temperature, wind strength and wind direction. All flight paths were then digitised and maps were made that showed the flight paths for each species colour coded by season.



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Projection: NZGD 2000 New Zealand Transverse Mercator

LEGEND

- Site Boundary
- Transmission Line Route
- Turbine Envelope Zone
- Turbine Exclusion Zone
- Transmission line monitoring site
- Point count (PC) sites

MT MUNRO WIND FARM ECOLOGY ASSESSMENT

Avifauna monitoring sites

Date: 17 May 2023 | Revision: 1

Plan prepared for Meridian Energy Limited by Boffa Miskell Limited

Project Manager: Leigh.Bull@boffamiskell.co.nz | Drawn: KMa | Checked: LBu

Map 6

Photo 1: View of the Mt Bruce forest block during the 2021-2022 transmission line surveys at Mt Munro.

Photo 2: View of farmland with scattered vegetation (pre-dominantly exotic) during the 2021-2022 transmission line surveys at Mt Munro. The Tararua Range is present in the background.

3.5.2.3 Incidental observations

Bird species not recorded during the formal point count surveys and flight path monitoring, but incidentally observed while on site, were also recorded (both indigenous and exotic species).

3.6 Ecological data constraints

3.6.1 Wetlands

As with any site survey undertaken at one time of the year, the data are reflective of the condition and state at the time of survey and cannot indicate the variance in hydrology, soil moisture and vegetation which might occur throughout different periods of the year or if there is a trend in those factors.

Also, as with any large site the sampling undertaken is representative of particular chosen conditions identified from the wider holistic survey techniques and the number of those data collection points is limited by time and effort, such that not every area of every wetland can receive a vegetation plot, and a number of assumptions and decisions are required in the assessment.

3.6.2 Herpetofauna

There are challenges with confirming the presence or absence of low densities of lizard species. As such, a conservative approach has been taken whereby the presence of suitable habitat has been used as a proxy, based on their likelihood of supporting stable lizard populations.

3.6.3 Freshwater

As with the wetland data collection the freshwater data collection is a representative set limited by the frequency of sampling through time and under different flows and the spatial spread of the samples amongst the tributaries; it is reflective of the season and flows at survey. While the great majority of tributary length has been walked, we cannot be absolutely certain which areas are perennial, which are always ephemeral, and the extent of intermittent reached, which varies year to year and season to season. We may also not account for every fish species present, but our sampling will be strongly indicative of the major populations of species. We note further that we make assumptions based on the NIWA Freshwater data base records for the larger rivers to which these tributaries contribute rather than any on site records. Our mapping and estimates however, we consider, are representative and sufficient to understand the general condition and instream values.

3.6.4 Avifauna

Nocturnal bird surveys were not conducted, instead the results of the desktop investigation were used to determine which nocturnal bird species are present, or likely present, on site (this included the results of the nocturnal bird survey conducted during the 2010-2012 surveys conducted on site for the previous ecological assessment).

3.7 Ecological assessment

The methods used to undertake this assessment are consistent with the EIANZ guidelines for undertaking ecological impact assessments (Roper-Lindsay et al., 2018), whereby ecological values are assigned (refer to Table 5 for species, Table 6 for terrestrial and aquatic habitats) and the magnitude of effects identified (Table 7) in order to determine the overall level of effect of the proposal (Table 8).

According to Roper-Lindsay et al. (2018), the overall level of effect can then be used to guide the extent and nature of the ecological management response required (including the need for biodiversity offsetting):

- Very High adverse effects require a net biodiversity gain.[6]
- High and Moderate adverse effects require no net loss of biodiversity values.
- Low and Very Low effects should not normally be a concern. If effects are assessed taking impact management developed during project shaping into consideration, then it is essential that prescribed impact management is carried out to ensure Low or Very Low effects.

[6] Though when ecological compensation is required because biodiversity offsetting is not possible, the principles of no-net-loss or net-gain do not apply (Maseyk et al., 2018).

Table 5: Criteria for assigning ecological value to species (Roper-Lindsay et al., 2018).

ECOLOGICAL VALUE	SPECIES CLASSIFICATION
VERY HIGH	*Nationally Threatened* (Nationally Critical, Nationally Endangered, Nationally Vulnerable, Nationally Increasing[7]) species found in the ZOI[8] either permanently or seasonally.
HIGH	Species listed as *At Risk – Declining* found in the ZOI either permanently or seasonally.
MODERATE	Species listed as any other category of *At Risk* (Recovering, Relict, Naturally Uncommon) found in the ZOI either permanently or seasonally; or Locally (ED) uncommon or distinctive species.
LOW	Nationally and locally common indigenous species.
NEGLIGIBLE	Exotic species, including pests, species having recreational value.

Table 6: Assigning overall value to areas (refer to Appendix 2 for the matters to be considered for terrestrial and freshwater communities) (Roper-Lindsay et al., 2018)

VALUE	DESCRIPTION
NEGLIGIBLE	Area rates Very Low for three matters listed in Appendix 2 and Moderate, Low or Very Low for remainder.
LOW	Area rates Low or Very Low for majority of assessment matters listed in Appendix 2 and Moderate for one. Limited ecological value other than as local habitat for tolerant native species.
MODERATE	Area rates High for one matter listed in Appendix 2, Moderate and Low for the remainder, or Area rates Moderate for two or more assessment matters Low or Very Low for the remainder Likely to be important at the level of the Ecological District.
HIGH	Area rates High for two of the assessment matters listed in Appendix 2, Moderate and Low for the remainder, or Area rates High for one of the assessment maters, Moderate for the remainder. Likely to be regionally important and recognised as such.
VERY HIGH	Area rates High for three or all of the four assessment matters listed in Appendix 2. Likely to be nationally important and recognised as such.

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

[7] Nationally Increasing is category that was devised by DOC (Michel, 2021) in 2021 to resolve a problem that would arise if the population of a taxon assessed as At Risk Recovering A should stabilise. Threatened – Nationally Increasing is assigned to "Small population that have experienced a previous decline (or for which it is uncertain whether it has experienced a previous decline) and that is forecast to increase >10% over the next 10 years or 3 generations, whichever is longer" (Rolfe et al. 2021). Thus, while such a threat category is not identified in Roper-Lindsay et al. (2018), we have included it along with all other *Threatened* classifications in to the Very High ecological value category.

[8] Roper-Lindsay et al. (2018) define the Zone of Influence (ZOI) as "*the areas/resources that may be affected by the biophysical changes caused by the proposed project and associated activities.*"

MAGNITUDE	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/ 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 existing baseline conditions such that the 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 existing baseline conditions, such that post-development character, composition and/or attributes 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 the existing baseline condition will be similar to pre-development circumstances/patterns; AND/OR Having a minor effect on the known population or range of the element / feature.
NEGLIGIBLE	Very slight change from existing baseline condition. Change barely distinguishable, approximating to the "no change" situation; AND/OR Having a negligible effect on the known population or range of the element / feature.

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

LEVEL OF EFFECT		ECOLOGICAL AND / OR CONSERVATION VALUE				
		Very High	**High**	**Moderate**	**Low**	**Negligible**
MAGNITUDE	**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

3.8 Effects management hierarchy

The order of priority for ecological impact management we have applied to this assessment is outlined in Table 9 and Figure 4. This process has followed the effects management hierarchy as described in Roper-Lindsay et al. (2018) and Maseyk et al. (2018).

Table 9: Effects management hierarchy and terminology (Maseyk et al., 2018)

EFFECTS MANAGEMENT HIERARCHY	DEFINITION
1) Avoidance	To modify a project proposal to prevent any environmental damage or loss of an ecological or environmental feature or function.
2) Remediation	To reverse or stop any environmental damage.
3) Mitigation	To alleviate, or to abate, or to moderate the severity of something (environmental damage), and typically occurs at the point of impact.
4) Biodiversity offset	A measurable conservation outcome resulting from actions designed to compensate for residual, adverse biodiversity effects arising from activities after

EFFECTS MANAGEMENT HIERARCHY	DEFINITION
	appropriate avoidance, remediation, and mitigation measures have been applied. The goal of a biodiversity offset is to achieve no-net-loss, and preferably a net-gain, of indigenous biodiversity values. Biodiversity offsetting includes: • **Like-for-like offset -** The residual effect is offset to a no-net-loss or net-gain level by exchanging the same type of biodiversity in accordance with all of the offset principles. • **Trading-up offset -** An out-of-kind exchange of biodiversity that demonstrably exchanges biodiversity of a lesser conservation value for biodiversity of greater conservation value. Meets key offset principles except equivalence of type but is considered to overall deliver an equivalent or improved outcome, because the biodiversity gained is considered to be of greater conservation importance to the biodiversity lost. No standard metrics are currently available to evaluate the exchange so trading up involves an element of subjectivity and societal preference.
5) Environmental compensation	Non-quantified biodiversity benefits are offered to compensate for biodiversity losses. The compensation actions may benefit different biodiversity to that lost (out-of-kind compensation), including biodiversity of lesser conservation concern than that lost. Compensation is not quantified or balanced with losses and may involve subjective decision-making subject to socio-political influences.

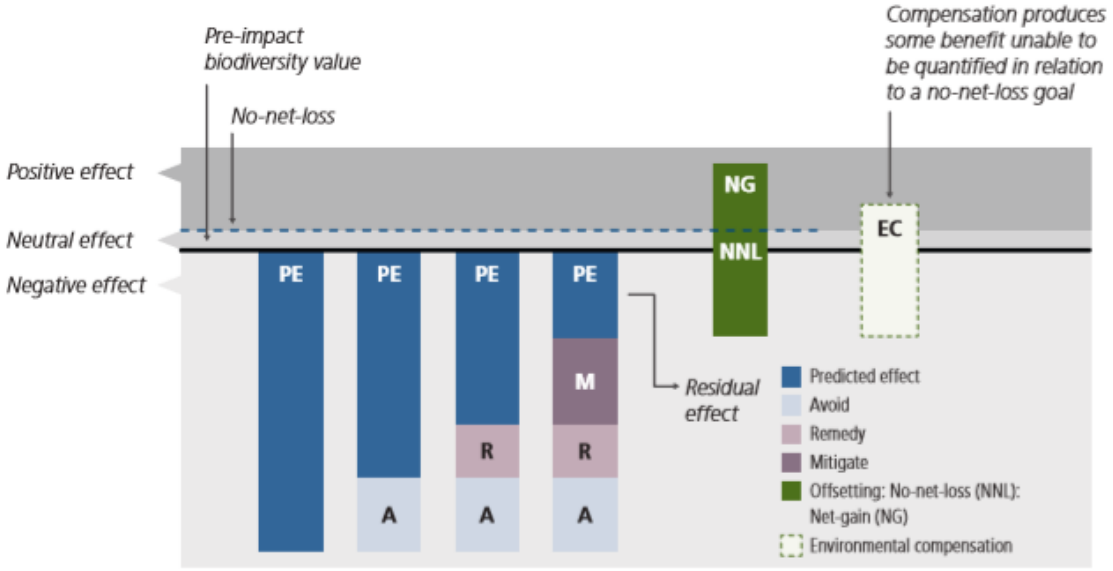


Figure 4: Conceptual illustration of effects management hierarchy progressing from avoidance to environmental compensation (Figure 2 from Maseyk et al. (2018))

4.0 Existing Environment – Wider Landscape

The Mt Munro site lies within the Puketoi and Woodville Ecological Districts (EDs), and close to the Tararua ED (refer to Map 1). The historic vegetation cover for the Mt Munro site, as predicted by LENZ, was predominantly rimu/tawa-kamahi forest (refer to Map 8). The site sits in a landscape classified as Not Threatened (i.e. > 30% remaining and > 20 % of that is protected); this is the least threatened category and has the largest amounts of protected area (Landcare Research Ltd, 2012).

The project footprint itself does not contain any protected areas, nor any land administered or owned by DOC (refer to Map 7). Land administered and owned by DOC and the District Council in the wider study area include Stewardships, Scenic Reserves, Gravel Reserves, Marginal Strips and Forest Park (see Map 7). The three largest and most ecologically valuable sites within the wider study area are Tararua Forest Park, Pūkaha Mount Bruce and WA Miller Scenic Reserve (Table 10).

Table 10: Protected Natural Areas

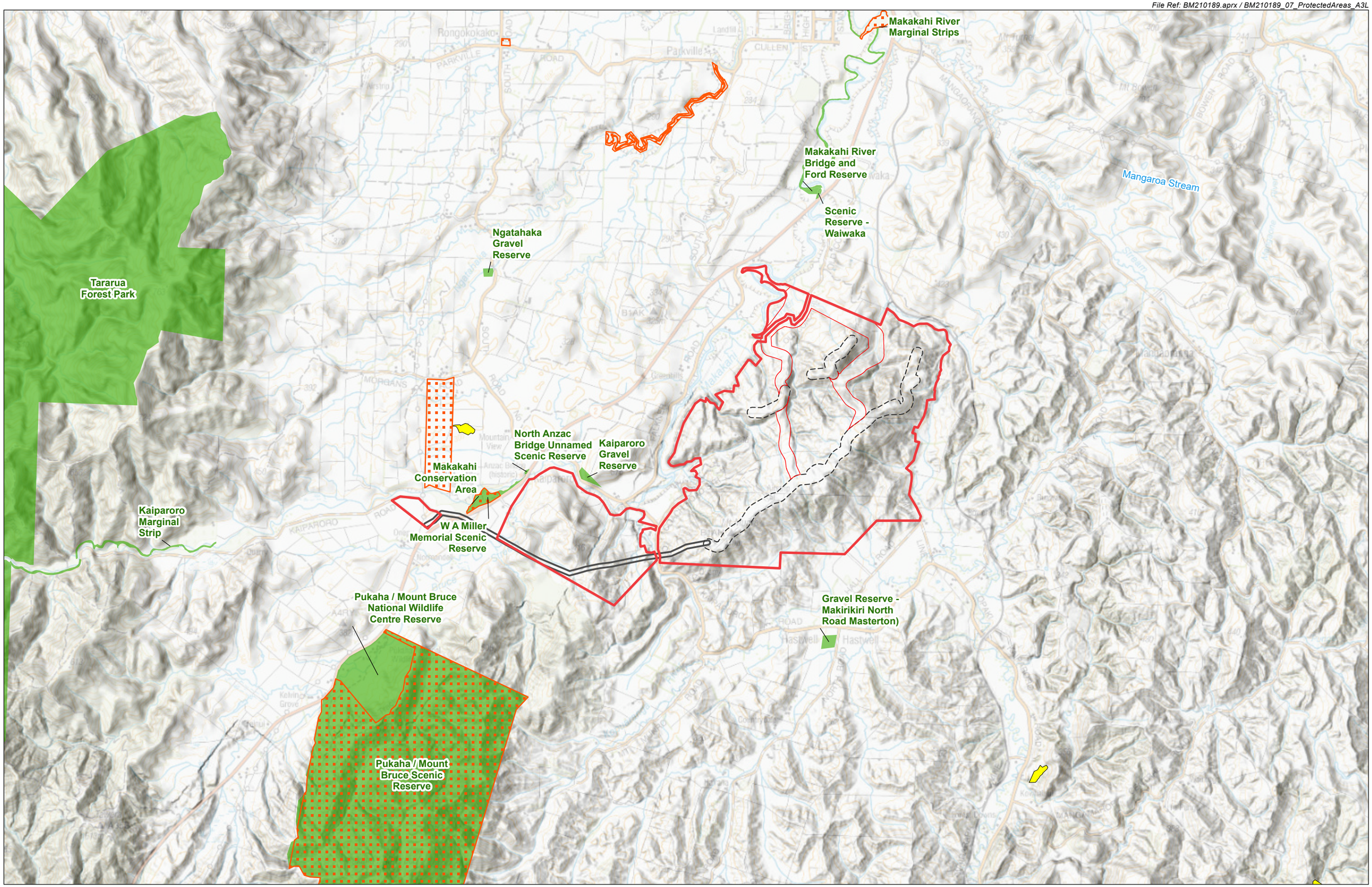
NAME (AREA)	REASONS FOR SIGNIFICANCE (DOC 1996)
Tararua Forest Park (116535.6 ha)	• Large almost continuous forest containing beech and podocarp species • Terrestrial fauna include kaka, kereru, falcon, blue duck, yellow-crowned parakeet, long- and short-tail bats, *Powelliphanta* and *Wainui* land snails, and giant dragonfly. • *Galaxias brevipinnis* (koaro), *G. fasciatus* (banded kokopu) and *G. postvectis* (short-jaw kokopu) at Otaki Forks. *Galaxias fasciatus* also at Makahika Stream and Ohau River.
Pūkaha Mt Bruce (941.8 ha)	• Incorporates the National Wildlife Centre and Mt Bruce Scenic Reserve. • Lowland forest and stream habitats. • Captive breeding facility for threatened species. • Kaka , kiwi, kokako, rifleman and kereru occur there.
W A Miller Scenic Reserve (4.5 ha)	• Remnant miro / totara / matai / tawa forest. • Habitat for kereru.

Pūkaha, Mt Bruce, is the only DOC administered reserve within close proximity to the Mt Munro project site. This area includes the Pūkaha, Mt Bruce National Wildlife Centre (NWC) and the adjoining Mt Bruce Scenic Reserve (Department of Conservation, 2019). Pūkaha, Mt Bruce, is an area of hill country covered in lowland indigenous forest (Department of Conservation Wellington Conservancy, 1996). It is a remnant of the 40-Mile Bush which stretched from Mauriceville to Woodville. The northern, eastern and western faces represent good examples of successional regeneration following fire and milling; the southern portion has not been milled and retains significant stands of lowland forest (Department of Conservation Wellington Conservancy, 1996).

Contiguous forest habitat extends outside of the defined reserve boundaries. As such for the purpose of this report, 'Mt Bruce forest block' refers to the forest located within, and contiguous with, Pūkaha, Mt Bruce (NWC and Scenic Reserve). The Mt Bruce forest block provides habitat and feeding resources for a variety of native birds such indigenous bird species as kereru, tui, whitehead, grey warbler, rifleman and silvereye (Department of Conservation Wellington Conservancy, 1996). Since 1996, kaka, kiwi and kōkako have been released into the forest as part of the Pūkaha, Mount Bruce Restoration.

At its closest, the Tararua Forest Park is located approximately 6 km to the west of the wind farm site. The Forest Park is an area of almost continuous forest, providing habitat for a number of terrestrial and freshwater species (Table 10).

The WA Miller Scenic Reserve, located along State Highway 2, is situated to the west-southwest of the wind farm site and 1.5 km north of Mt Bruce. The reserve contains remnant miro/totara/matai/tawa forest which provides habitat and feeding resources for native avifauna species occurring both within the Mt Bruce forest block and the Tararua Forest Park (Department of Conservation Wellington Conservancy, 1996).



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Data Sources: Eagle Technology, Land Information New Zealand, DOC, QEII Trust

Projection: NZGD 2000 New Zealand Transverse Mercator

LEGEND

- Site Boundary
- Transmission Corridor
- Turbine Envelope Zone
- Turbine Exclusion Zone
- QEII Covenants
- DOC Conservation Unit
- Reserves

MT MUNRO WIND FARM ECOLOGY ASSESSMENT

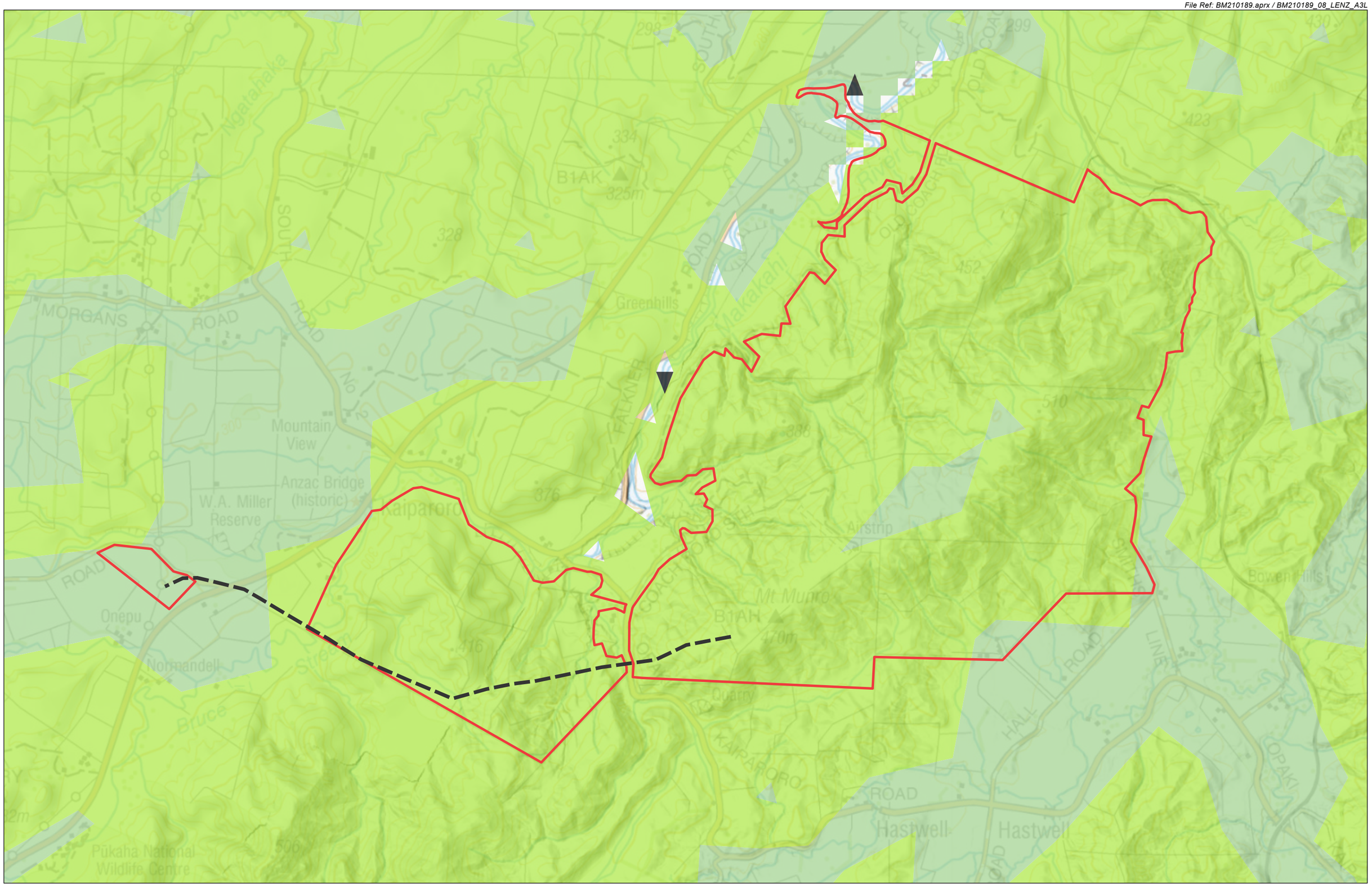
Protected areas

Date: 17 May 2023 | Revision: 1

Plan prepared for Meridian Energy Limited by Boffa Miskell Limited

Project Manager: Leigh.Bull@boffamiskell.co.nz | Drawn: KMa | Checked: LBu

Map 7



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Data Sources: Eagle Technology, Land Information New Zealand, Landcare Research

Projection: NZGD 2000 New Zealand Transverse Mercator

LEGEND

- Site Boundary
- Transmission Line Route
- Rimu/tawa-kamahi forest
- Rimu-matai-miro-totara/kamahi forest
- Unclassified

MT MUNRO WIND FARM ECOLOGY ASSESSMENT

LENZ

Date: 17 May 2023 | Revision: 0

Plan prepared for Meridian Energy Limited by Boffa Miskell Limited

Project Manager: Leigh.Bull@boffamiskell.co.nz | Drawn: KMa | Checked: LBu

Map 8

5.0 Existing Environment – Project Site

5.1 Terrestrial vegetation

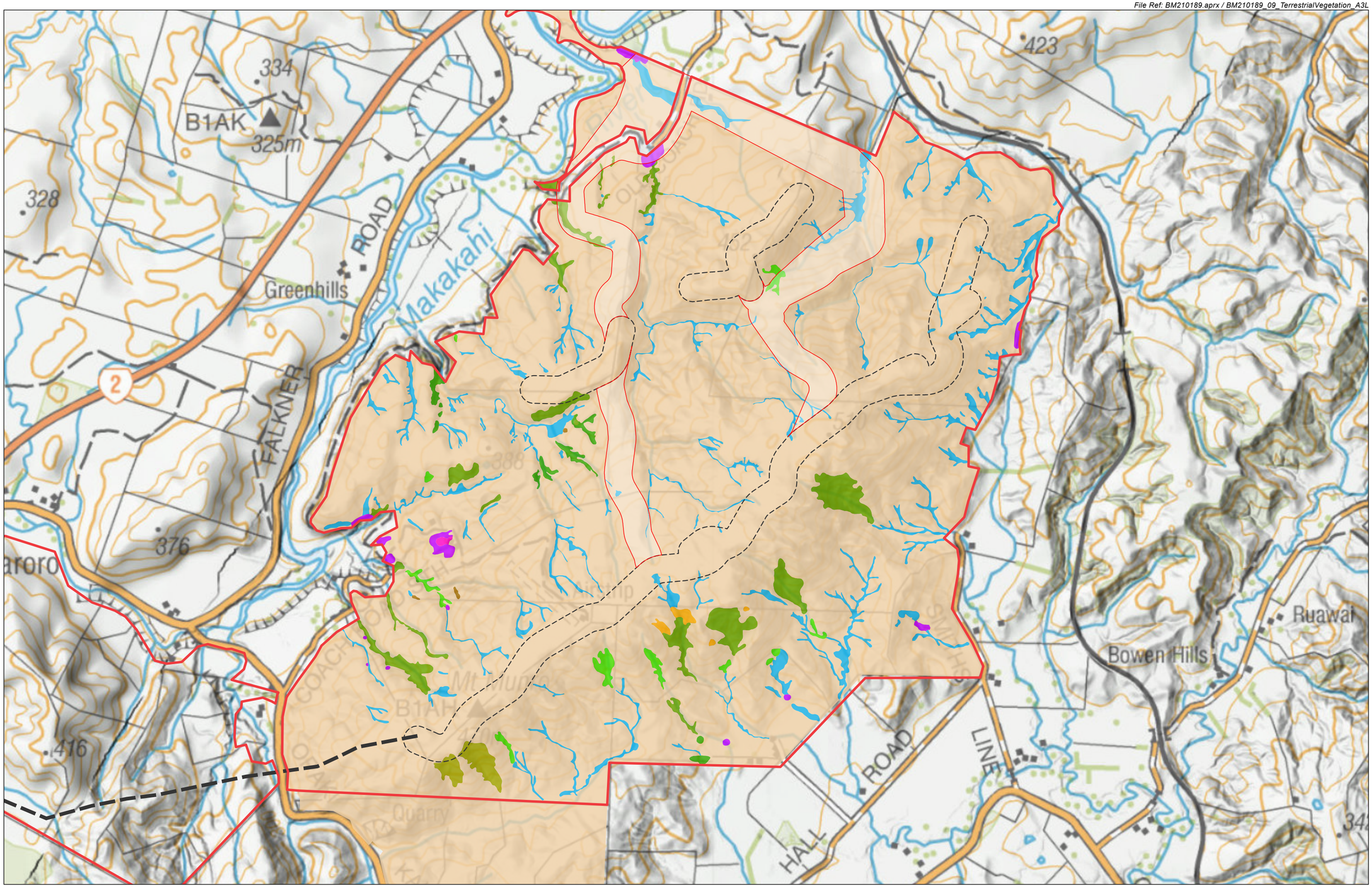
All vegetation types on the wind farm site were previously described in detail by BML (2011b). These previously identified vegetation types (refer to Map 9), excluding those assessed as potential wetlands which are addressed in Section 5.2, include:

- Improved pasture
- Divaricating shrublands
- Mānuka / kānuka shrublands
- Mahoe / broadleaf treeland associated with regenerating shrublands
- Mahoe / kamahi forest associated with regenerating shrublands
- Mahoe treeland associated with regenerating shrublands
- Mahoe and low forest
- Exotic trees
- Ornamental garden

During the current site investigations, the vegetation on site was found to meet the same descriptions and locations as identified by BML (2011b), bar expected changes such as increases in canopy height of scrub. The land-use remains the same as prior, with the majority of site actively farmed and grazed with improved pasture, and remaining patches of scrub, forest fragment and ornamental garden. Within the Turbine Envelope and Turbine Exclusion Zones, the vast majority (estimated over 97%) of land cover is improved pasture (refer to Map 9 and Table 11 below). There are occasional scrub edges or lone trees which are within the project footprint (refer to Map 9 and Table 11), namely edges of scattered, mahoe scrub patches which extend past the usual narrow, steep gullies the other trees are confined to. There are no significant areas of terrestrial vegetation or habitats of indigenous fauna within the project site.

Table 11: Areas and types of broad scale vegetation communities within the wind farm site and project footprint

VEGETATION COMMUNITIES	WIND FARM SITE		TURBINE ENVELOPE & TURBINE EXCLUSION ZONES	
	Area (ha)	Area (%)	Area (ha)	Area (%)
Grass and Rushlands				
Improved pasture	638.28	91.88%	103.28	97.10%
Rushland and wet pasture	28.57	4.11%	1.28	1.20%
Regenerating Shrublands				
Divaricating shrublands	0.82	0.12%	-	-
Manuka/kanuka shrublands	0.14	0.02%	-	-
Native Forest & Tree lands associated with Regenerating Shrublands				
Mahoe / broadleaf treeland associated with regenerating shrublands	2.83	0.41%		
Mahoe / kamahi forest associated with regenerating shrublands	15.69	2.26%	0.24	0.22%
Mahoe treeland associated with regenerating shrublands	3.40	0.49%	1.03	0.97%
Mahoe and low forest	2.33	0.34%	0.09	0.09%



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Data Sources: Eagle Technology, Land Information New Zealand, BML

Projection: NZGD 2000 New Zealand Transverse Mercator

LEGEND

- Site Boundary
- Transmission Line Route
- Turbine Envelope Zone
- Turbine Exclusion Zone
- Improved pasture
- Rushland & wet pasture
- Divaricating shrublands
- Manuka/kanuka shrublands assoc. w/ regenerating shrublands
- Mahoe/broadleaf treeland assoc. w/ regenerating shrublands
- Mahoe/kamahi forest assoc. w/ regenerating shrublands
- Mahoe treeland
- Mahoe & low forest
- Exotic trees
- Garden ornamentals

MT MUNRO WIND FARM ECOLOGY ASSESSMENT

Terrestrial vegetation (2011)

Date: 17 May 2023 | Revision: 1

Plan prepared for Meridian Energy Limited by Boffa Miskell Limited

Project Manager: Leigh.Bull@boffamiskell.co.nz | Drawn: KMa | Checked: LBu

Map 9

VEGETATION COMMUNITIES	WIND FARM SITE		TURBINE ENVELOPE & TURBINE EXCLUSION ZONES	
	Area (ha)	Area (%)	Area (ha)	Area (%)
Exotic Communities				
Exotic trees	2.41	0.35%	0.45	0.42%
Ornamental garden	0.19	0.03%		
TOTAL	**694.67**		**106.37**	

There are a small number of woodlands (often referred to as shrublands) remaining in some of the gullies outside of the development footprint which are loose associations of lower canopy forest species (see Photo 3 below). The remaining trees include canopy taxa of tawa, kamahi, broadleaf, and mahoe, but also canopy aged milktree, konono, five finger, pigeonwood and pate. Under these loose canopies, but denser in the gully bottoms, are the divaricate shrubs (*C. ridgida* in the main), and shield fern, ongaonga, rangiora, pohuehue, various climbing rata and other epiphytes. Notably these woodland gullies do not contain the wetlands seen in the open pasture gullies, but some muds are unvegetated and covered in leaves between small stream flows, providing direct evidence that the hill slopes prior to farming did not contain, under forest, any natural wetland areas. The features are mapped and described in by BML (2011b).

Photo 3: Broadleaf gully woodland on the southern face of Mt Munro ridge line

5.2 Wetlands

Within the wind farm wetland survey area (i.e. a 100m envelope about all infrastructure), more than 140 features were identified and assessed (labelled as 'surveyed sites' on Map 10), 97 of which were determined to be individual gully wetlands (as per the RMA definition of wetland). Of those 97 'RMA' wetlands, 47 (and one ambiguous) where identified as 'natural' wetlands determined from 106 vegetation plots. These 48 natural wetland features are narrowed to 44

(some being the same gully system in reality) and are identified in yellow, orange and red in Maps 11 to 13.

The great majority of the features surveyed were wet spongy features of deposited sediments in narrow steep hill side gully systems. Most, under the NPS-FM identification system (vegetation, hydric soil and hydrology) qualify as natural wetland initially (dominated by wetland associated species), but a little over half are excluded because of the level of pasture species coverage. Despite 48 features identifying as "natural wetland" under the current definitions, there were no actual natural wetlands on site that are representative of natural indigenous wetland assemblages, or appropriate to the topography and place; all are a product of historic forest clearance, farming, slope erosion, gully sediment accumulation and stream retardation giving rise to wet muddy gullies (rather than streams under canopy). These conditions have allowed wet adapted species (mostly exotic) to colonise and persist under the grazing pressure.

The following describes the various types of natural wetland features recorded on site during the field investigations.

5.2.1 Wetland vegetation communities

Four broad wetland types were recorded across the site:

1) Gully mud sponges;
2) Gully heads and hollows on the upper ridge line;
3) Stream terraces; and
4) Steep hill seepage slumps.

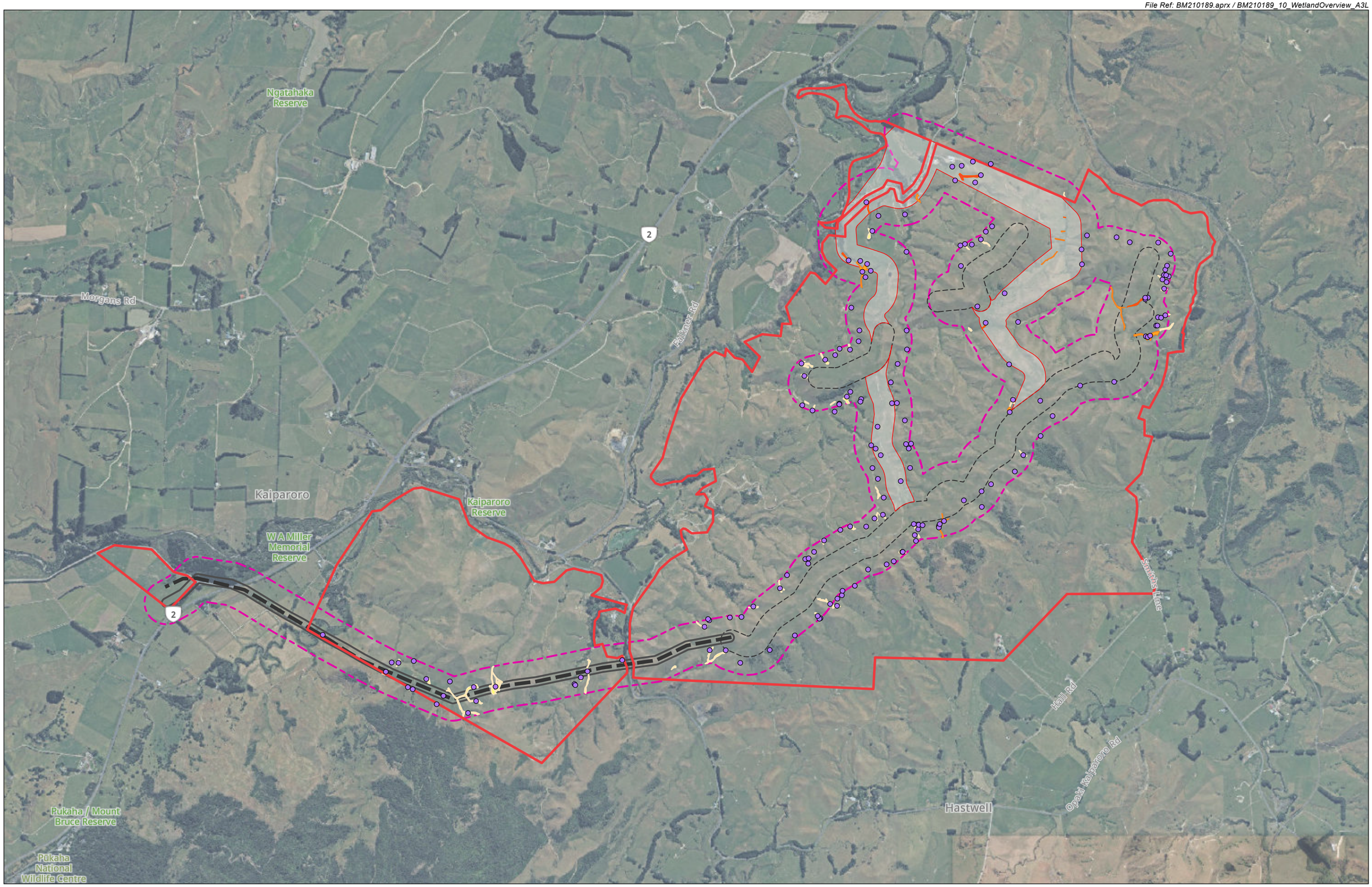
Further details regarding the individual characteristics of the four wetland types are provided in the following sections. However, the four wetland types generally have the same species in them but with different proportions of different species reflecting the hydrological and sediment differences of the features.

Virtually all of the larger systems are products of long-term sediment discharge off the steep hill slopes collecting in the gully beds (sponges), and those sponges hold very wet muds even through dry summers, which are thickly covered in wetland vegetation.

There were **no indigenous dominated representative wetlands present**. All of the features are induced opportunistically colonised features with a small diversity of exotic and indigenous wet tolerant species. No feature present could meet Schedule F wetland types or pass Policy 13-5 (Horizon One Plan), or Policy 23 (GWRC RPS) criteria.

Thirty-four (34) taxa were recognised in the various wet features. Thirty are FAC, FACW or OBL wetland species, the other 18 were FACU taxa. The characterising species (those in more than 40% of the 100 vegetation plots undertaken) of most of the features were: blue sweet grass (*Gylceria declinata*), dwarf montia (*Montia fontana subsp. Chondrosperma*), little mouse ear chickweed (*Cerastium semidecandrum*), creeping buttercup (*Ranunculus repens*), Yorkshire fog (*Holcus lanatus*), sweet vernal (*Anthoxanthum odoratum*), clover (*Trifolium* sp.), duckweed (*Lemna disperma*), water forget-me-not (*Myosotis laxa* subsp. *caespitosa*) and broom rush (*Juncus sarophorus*). These nine taxa are the most frequent and abundant cover of most of the wet features. The most cover dominant taxa were blue sweet grass, exotic dwarf montia, and sweet vernal, each typically around 30% of the total vegetative cover in any one plot.

Sweet vernal and blue sweet grass are pasture grasses once sown and used for grazing stock. Sweet vernal is commonly used today in support of sheep, but blue sweet grass is less commonly sown.



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Projection: NZGD 2000 New Zealand Transverse Mercator

LEGEND

- Site Boundary
- Transmission Line Route
- Transmission Corridor
- Turbine Envelope Zone
- Turbine Exclusion Zone
- Wetland survey area
- Surveyed Sites

Proximity

- Near
- Within
- Partially within

MT MUNRO WIND FARM ECOLOGY ASSESSMENT

Overview of wetland survey

Date: 17 May 2023 | Revision: 1

Plan prepared for Meridian Energy Limited by Boffa Miskell Limited

Project Manager: Leigh.Bull@boffamiskell.co.nz | Drawn: KMa | Checked: LBu

Map 10

However, the conservation plant network describes the uses of the blue sweet grass and its reason for introduction as pasture. Dwarf montia is a naturalised species from Europe typical of springs, but not a pasture species by definition. There are many species in the lists recorded which are pasture associated species but not identified on the MfE pasture list (Ministry for the Environment, 2022a) (see Appendix 3). There were 11 indigenous taxa in total across the site, but any one wetland feature only ever contained one or two indigenous taxa and in very low abundance. Across the 100 plots the frequency of occurrence of a native species was < 10%.

5.2.1.1 Gully mud sponges

The majority of features identified across the steep hill slopes, and indeed the lower gully areas (including both the north and south faces), were narrow, steep, linear gullies which, since clearance of the forest and onset of farming, have received and held considerable amounts of sediment. This, coupled with a spring or other sub-surface discharge of water, or a wider lower gradient bottom gully, has created mud sponges (Photo 4 and Photo 5). This combination of factors (mud and water) has produced a deep (1-1.5m) bed of soft, loose, waterlogged mud usually between 2-5 m wide, but varying with gradient down the hill slope.

Often this type of feature starts as the gradient lessens from the top of the hill. These wet deep muds have developed a characteristic cover of blue sweet grass and exotic dwarf montia with characteristic scatterings of water forget-me-not, water cress in small patches, speckled duckweed and *Isolepis* (Photo 6). The cover is usually in excess of 80% sweet blue grass and exotic dwarf montia. Where cover is predominantly exotic dwarf montia or sweet blue grass, the feature is technically a natural wetland by the current definitions, even while it is an exotic dominated, induced feature.

Photo 4: Gully mud sponges

Photo 5: A wide lower gradient gully mud sponge

Photo 6. Example of a mud sponge vegetation cover

5.2.1.2 Gully heads/hollows

At the upper end of some of the gullies and along some of the lower top-terraces there are, in places, pockets of depressions in loose gatherings (Photo 7, Photo 8 and Photo 9). These features are not mud sponges, but depressions predominantly vegetated in *Juncus* species with Yorkshire fog and sweet vernal, chickweed, lotus and clover. These features typically classify as wet pasture with rushes. This means they do not meet either the Schedule F classification of the One Plan or the PNRP (being wet pasture with rushes, typically <20% wet species cover), or they are excluded as pasture through the NPS-FM process.

Photo 7: Gully heads

Photo 8: Gully heads and hollows

Photo 9: A upper ridge hollow

5.2.1.3 Stream terraces

Central to the ring of hills that comprise the Mt Munro site and associated with the array of small and low flow tributaries, there are narrow stream terraces (Photo 10 and Photo 11). They could also be considered stream wet riparian systems as much as wetland.

Most were classified as wet pasture, and few had any abundance of wetland species in any concentration.

On the northern side (near houses) there is one dammed stream feature which has a build-up of water behind it which continues up the stream gully. It is not a mud sponge but a more typically raupo / *Eleocharis* / watercress / monkey musk / open water wetland. The feature results from the intersection of a track and a controlled culvert outlet with the stream. This has led to the stream gully flooding, followed by wetland species colonising the area.

Photo 10: Stream edge rushland

Photo 11: Stream terrace rushland

5.2.1.4 Steep hill seepage slumps

In a few areas around the site the steep lands nearer the tops of the hill slopes have evidence of slumping which may be related to high ground water. These slumps are signalled by sparse to clustered *Juncus* and creeping bent (Photo 12). Plots indicate that the features are best described as wet pasture with scattered rushes.

Photo 12: Steep hill seepage slumps

5.2.1.5 Mangaroa tributary gully

Following the completion of the wetland site investigations, a road alignment refinement was raised by Meridian which has eventually seen the access road move around a hill rather than over it and so require the infilling of a gully area – the Mangaroa tributary gully (Photo 13), sampled in the freshwater assessment and referred to there as MAG2. When undertaking the wetland survey this gully was scoped and photographed, however no plots were undertaken in this feature. We have determined from those photographs and a subsequent on-site sruvey that the areas of the gully about the stream are seepage slump wetlands and stream side terrace wetlands which are predominantly pasture with scattered *Juncus* and on the terraces, creeping buttercup, and are excluded from being natural wetlands by the cover of pasture species and limited FACW or OBL species.

Photo 13: The Mangaroa gully area to be piped and filled for the roading.

5.2.2 Natural wetland assessment

The rapid assessment (i.e. the onsite observations of the Ecologists) did not recognise any predominantly indigenous natural representative wetland features. This is not surprising given the landform, historic vegetation cover, land use and level of modification. However, numerous features clearly meet the RMA wetland definition, and a smaller number meet the NPS-FM natural wetland definition through the rapid assessment.

From an ecological perspective, no feature present is natural in that they are not caused by natural processes. They are a product of the land modifications caused by humans and are therefore an induced state with species assemblages that do not represent naturally occurring indigenous wetland assemblages.

Appendix 3 presents the 100 plots of data and the various assessments (pasture dominance, wetland species dominance, hydric soil, prevalence indices etc).

Very few soil cores produced a hydric soil result. Nearly all cores showed that the vegetation of most natural wetland features was perched on a 1 m deep loose mud and water sponge. This is not surprising given the slopes, history, and processes present. What was present in most gullies was a hydrology which lends itself to creating wetland when sufficient sediments are entrained and trapped, such that floods do not clean out that sediment and the sediment retains the water. Where land-use-caused sediments are not present, these gullies would be intermittent streams. This induced situation has then created place for wet adapted plants on the mud sponges and are less affected by grazing stock. This, however, does not make the features valuable habitat. They are not indigenous dominated or representative of a natural wetland assemblage and do not provide wetland habitat for fish, birds, even aquatic macroinvertebrates. They do supply some wetland functions of water retention, filtration, entrapment and mini carbon sequestering, at the expense of the historic stream habitats.

Following the rapid assessment (undertaken above), the next of step of the NPS-FM assessment is to test for pasture exclusion; where if more than 50% of the plot's vegetation cover is pasture species, then the "improved pasture" exclusion applies irrespective of other characteristics. Where the plot is representative of the gully, the gully is therefore not a natural wetland. In some cases, a gully feature contains areas of natural wetland and areas of wet pasture, and this is indicated by more than one plot, and one or more of those plots having a cover exceeding 50% exotic pasture species.

Table 12 below presents the total pasture species cover of all plots measured. Orange cells indicate where pasture exceeds 50%, and so is sufficiently dominant to indicate the plot and corresponding gully area are not natural wetland.

Table 12: Plot data from all Mt Munro site plots (including transmission lines), numbered by gully. Any plot exceeding 50% pasture species cover (pasture species as per NPS FM) is considered not natural wetland (orange).

TURBINES / ROADING	GULLY 4A	GULLY 4B	GULLY 5A	GULLY 5C	GULLY 9	GULLY 10A	GULLY 10B	GULLY 10C	GULLY 11A	GULLY 11B	GULLY 11C
Pasture % cover	4	2	11	54	4	2	0	0	0	4	0

GULLY 16	GULLY 20A (DOME)	GULLY 20B	GULLY 21A	GULLY 21B	GULLY 22	GULLY 23A	GULLY23B - EDGE	GULLY 24 HEAD	GULLY 25	GULLY 26A
0	24	1	92	89	4	1	73	2	2	7

GULLY 26B	GULLY 27	GULLY 28	GULLY 29	GULLY 33	GULLY 39	GULLY 40	GULLY 44A	GULLY 44B	GULLY 45	GULLY 46
89	89	89	81	22	2	2	56	2	12	22

GULLY 47	GULLY 48	GULLY 49	GULLY 50	GULLY 52A	GULLY 52B	GULLY 52E	GULLY 52D	GULLY 54	GUL.LY 55A	GULLY 55B
60	2	66	20	2	2	30	25	90	90	0

GULLY 55 C	GULLY 56A	GULLY 56B	GULLY 56C	GULLY 57	GULLY 58	GULLY 59A	GULLY 59B	GULLY 60	GULLY 61A	GULLY 61B
71	0	43	0	22	0	0	60	0	0	60

GULLY 63	GULLY 64	GULLY 67A	GULLY 67B	GULLY 67C	GULLY 68	GULLY 69	GULLY 69B	GULLY 69C	GULLY 71	GULLY 72
0	22	1	1	1	1	10	0	55	55	22

GULLY 74	GULLY 75	GULLY 79	GULLY 80A	GULLY 80B	GULLY 82A	GULLY 82B	GULLY 83	GULLY 84	GULLY 85	GULLY 86
22	22	22	0	22	54	0	60	0	60	0

GULLY 88	GULLY 89	GULLY 90	GULLY 91	GULLY 92A	GULLY 92B	GULLY 92C	GULLY 93	GULLY 93A
60	1	60	72	60	0	17	6	0

GULLY 93B	GULLY 93C	GULLY 93D	GULLY 93E
0	5	0	48

TRANSMISSION LINES	POINT 1	POINT 2	POINT 3	POINT 4	POINT 5A	POINT 5B	POINT 5C	POINT 6	POINT 7
Pasture % cover	38	17	10	29	29	29	29	51	37

POINT 8	POINT 9	POINT 10	POINT 11	POINT 12	POINT 13	POINT 14	POINT 15
42	20	10	29	74	43	74	21

Seventy-eight plots did not have a pasture cover exceeding 50% (refer to Table 12). Therefore, these gullies (or parts of gullies) are not immediately excluded by the pasture exclusion test and are put to the remaining tests to determine if they meet the criteria for natural inland wetland. There was no pattern as to where these non-pasture dominated sites were located, they are scattered across the site (see Map 10).

The next step, outlined in the recently updated Wetland Delineation Protocols (Ministry for the Environment, 2022b) is to determine both the dominance of wet adapted species (dominance test) and prevalence test, following Clarkson et al. (2021). Dominant species are determined by their level of cover within the plot using the 20/50 rule. Once determined, all dominant species have the same weighting in that plot. If Obligative (OBL), Facultative Wet (FACW) and Facultative (FAC) species make up more than 50% of the dominant species in that plot, the plot 'passes' the dominance test and is considered indicative of a 'natural wetland' community. If there is a strong FAC dominant presence, caution is advised, and deeper analysis should be carried out.

As well as a dominance test, a prevalence test is carried out as stipulated in the updated Wetland Delineation Protocols. Both tests are carried out alongside one another. As Table 13 shows, all prevalence scores were below 3, and so 'pass' the test for natural wetland. However, there were 16 features which either did not 'pass' the dominance test, or had a strong facultative species element, and so require further analysis. Those are shown in orange in Table 13. All other plots passed both the dominance and prevalence tests and so are considered natural wetlands.

Table 13: Gullies with less than 50% pasture cover considered for the dominance test and prevalence test. Strong FAC elements or non-wetland dominant plots are shown in orange.

FEATURE NO:	DOMINANCE	PREVALENCE	OUTCOME
4A	100% dominant	2.1	Natural wetland - >50% dominant, <3 prevalence score
4B	100% dominant	1.5	Natural wetland - >50% dominant, <3 prevalence score
5A	100% dominant	2.1	Natural wetland - >50% dominant, <3 prevalence score
9	100% dominant	2.1	Natural wetland - >50% dominant, <3 prevalence score
10A	100% dominant	1.5	Natural wetland - >50% dominant, <3 prevalence score
10B	100% dominant	1.5	Natural wetland - >50% dominant, <3 prevalence score
10C	100% dominant	1.5	Natural wetland - >50% dominant, <3 prevalence score
11A	100% dominant	1.5	Natural wetland - >50% dominant, <3 prevalence score
11B	100% dominant	1.8	Natural wetland - >50% dominant, <3 prevalence score
11C	100% dominant	1.4	Natural wetland - >50% dominant, <3 prevalence score
16	100% dominant	1.3	Natural wetland - >50% dominant, <3 prevalence score
20A	100% dominant	2.4	Natural wetland - >50% dominant, <3 prevalence score
20B	100% dominant	1.7	Natural wetland - >50% dominant, <3 prevalence score
22	100% dominant	1.8	Natural wetland - >50% dominant, <3 prevalence score
23A	100% dominant	1.8	Natural wetland - >50% dominant, <3 prevalence score
24	100% dominant	2.1	Natural wetland - >50% dominant, <3 prevalence score
25	100% dominant	1.5	Natural wetland - >50% dominant, <3 prevalence score
26A	100% dominant	2.0	Natural wetland - >50% dominant, <3 prevalence score
33	50% dominant (fail)	2.5	Fails dominance test, passes prevalence test, proceed further
39	100% dominant	1.5	Natural wetland - >50% dominant, <3 prevalence score
40	100% dominant	1.5	Natural wetland - >50% dominant, <3 prevalence score
44B	100% dominant	1.5	Natural wetland - >50% dominant, <3 prevalence score
45	100% dominant	1.8	Natural wetland - >50% dominant, <3 prevalence score
46	50% dominant (fail)	2.5	Fails dominance test, passes prevalence test, proceed further

FEATURE NO:	DOMINANCE	PREVALENCE	OUTCOME
48	100% dominant	1.5	Natural wetland - >50% dominant, <3 prevalence score
50	66% dominant	2.0	Natural wetland - >50% dominant, <3 prevalence score
52A	100% dominant	1.5	Natural wetland - >50% dominant, <3 prevalence score
52B	100% dominant	1.6	Natural wetland - >50% dominant, <3 prevalence score
52E	Strong FAC (66%)	2.7	
52D	50% dominant (fail)	2.6	Fails dominance test, passes prevalence test, proceed further
55B	100% dominant	1.6	Natural wetland - >50% dominant, <3 prevalence score
56A	100% dominant	1.5	Natural wetland - >50% dominant, <3 prevalence score
56B	Strong FAC (50%)	2.4	
56C	100% dominant	1.5	Natural wetland - >50% dominant, <3 prevalence score
57	50% dominant (fail)	2.5	Fails dominance test, passes prevalence test, proceed further
58	100% dominant	1.5	Natural wetland - >50% dominant, <3 prevalence score
59A	100% dominant	1.5	Natural wetland - >50% dominant, <3 prevalence score
60	100% dominant	1.5	Natural wetland - >50% dominant, <3 prevalence score
61A	100% dominant	1.5	Natural wetland - >50% dominant, <3 prevalence score
63	100% dominant	1.5	Natural wetland - >50% dominant, <3 prevalence score
64	50% dominant (fail)	2.5	Fails dominance test, passes prevalence test, proceed further
67A	100% dominant	1.5	Natural wetland - >50% dominant, <3 prevalence score
67B	100% dominant	1.5	Natural wetland - >50% dominant, <3 prevalence score
67C	100% dominant	1.5	Natural wetland - >50% dominant, <3 prevalence score
68	100% dominant	1.4	Natural wetland - >50% dominant, <3 prevalence score
69A	100% dominant	1.8	Natural wetland - >50% dominant, <3 prevalence score
69B	100% dominant	1.5	Natural wetland - >50% dominant, <3 prevalence score
72	50% dominant (fail)	2.5	Fails dominance test, passes prevalence test, proceed further
74	50% dominant (fail)	2.5	Fails dominance test, passes prevalence test, proceed further
75	50% dominant (fail)	2.5	Fails dominance test, passes prevalence test, proceed further
79	50% dominant (fail)	2.5	Fails dominance test, passes prevalence test, proceed further
80A	100% dominant	1.5	Natural wetland - >50% dominant, <3 prevalence score
80B	50% dominant (fail)	2.5	Fails dominance test, passes prevalence test, proceed further
82B	100% dominant	1.6	Natural wetland - >50% dominant, <3 prevalence score
84	100% dominant	1.5	Natural wetland - >50% dominant, <3 prevalence score
86	100% dominant	1.6	Natural wetland - >50% dominant, <3 prevalence score
89	100% dominant	1.6	Natural wetland - >50% dominant, <3 prevalence score
92B	100% dominant	1.8	Natural wetland - >50% dominant, <3 prevalence score
92C	100% dominant	1.9	Natural wetland - >50% dominant, <3 prevalence score
93A	100% dominant		Natural wetland - >50% dominant, <3 prevalence score
93B	100% dominant		Natural wetland - >50% dominant, <3 prevalence score
93C	100% dominant		Natural wetland - >50% dominant, <3 prevalence score
93D	100% dominant		Natural wetland - >50% dominant, <3 prevalence score
93E	60% dominant		Natural wetland - >50% dominant, <3 prevalence score
TRANSMISSION LINES			
1	Strong FAC (50%)	2.5	
2	100% dominant	1.9	Natural wetland - >50% dominant, <3 prevalence score
3	100% dominant	2.1	Natural wetland - >50% dominant, <3 prevalence score
4	66% dominant	2.5	Natural wetland - >50% dominant, <3 prevalence score
5A	66% dominant	2.5	Natural wetland - >50% dominant, <3 prevalence score
5B	66% dominant	2.5	Natural wetland - >50% dominant, <3 prevalence score

FEATURE NO:	DOMINANCE	PREVALENCE	OUTCOME
5C	66% dominant	2.5	Natural wetland - >50% dominant, <3 prevalence score
7	Strong FAC (50%)	2.5	
8	100% dominant	2.0	Natural wetland - >50% dominant, <3 prevalence score
9	Strong FAC (50%)	2.1	
10	100% dominant	2.1	Natural wetland - >50% dominant, <3 prevalence score
11	66% dominant	2.5	Natural wetland - >50% dominant, <3 prevalence score
13	Strong FAC (50%)	2.0	
15	100% dominant	2.1	Natural wetland - >50% dominant, <3 prevalence score

The dominant species in many of the plots following the 20/50 rule (dominance test) were blue sweet grass, dwarf montia and sweet vernal (one is pasture, and all are exotic). Along the transmission line, the exception was the presence of *Isolepis prolifera*, a common native wetland plant.

Where wetland dominance is ambiguous (i.e., has a strong Facultative element), the next "test" then reflects on the presence of hydric soils in conjunction with hydrology. While we undertook a soil core at all plots, those in the mud sponges never returned a hydric soil condition. They returned deep, wet, high chroma, organic muds of recent development. Outside of the mud sponges, soils were all brown earths with no gleying, and no low chroma or mottling.

Analysis of the hydrology of these 16 features which were all determined to have deep, sedimented muds of a homogenous brown (not hydric) was then carried out. It was determined that none of these features contained true wetland hydrology. This is at odds with the hydrology guidance provided by MfE which contains a checklist of features to determine if an area has been wet at a point in time, but that tool has been found to be in error by hydrologists and not useable by the layperson. In these gullies the only reason a wet hydrology persists is because of the entrapment of the fine (non-hydric) sediments, without the sediment there would be no wetland hydrology.

After stepping through the analysis, of the 106 plots, 64 of these (representing 38 gullies) indicate the presence of a natural wetland within 100 m of the Turbine Envelope and Turbine Exclusion Zones. This is irrespective of their induced nature or exotic dominated vegetative cover. These natural wetlands are identified in Maps 11-13 as red, orange and yellow features.

5.3 Freshwater

The Mt Munro wind farm site is located in the watershed of the Makakahi and Kopuaranga rivers (refer to Map 14). The Makakahi River flows along the west of the study site, generally following along SH2 for 40 km before feeding into the Manawatu River between Pahiatua and Woodville. Six tributaries (with 15 first order branches) drain west off the site into the Makakahi River. The Kopuaranga River flows generally south from rough hill country southwest of Eketahuna, along the eastern side of the site, reaching its outflow into the Ruamahanga River, 5km north of Masterton.

The Kopuaranga River is listed in the Regional Freshwater Plan (Wellington Regional Council, 1999) as a waterbody of important amenity and recreational value (angling). The Kopuaranga River is listed in the PNRP as an important trout fishery river and spawning water (Greater Wellington Regional Council, 2019). Neither of the Kopuaranga tributaries within the site extent is identified in the PNRP as an important trout fishery.

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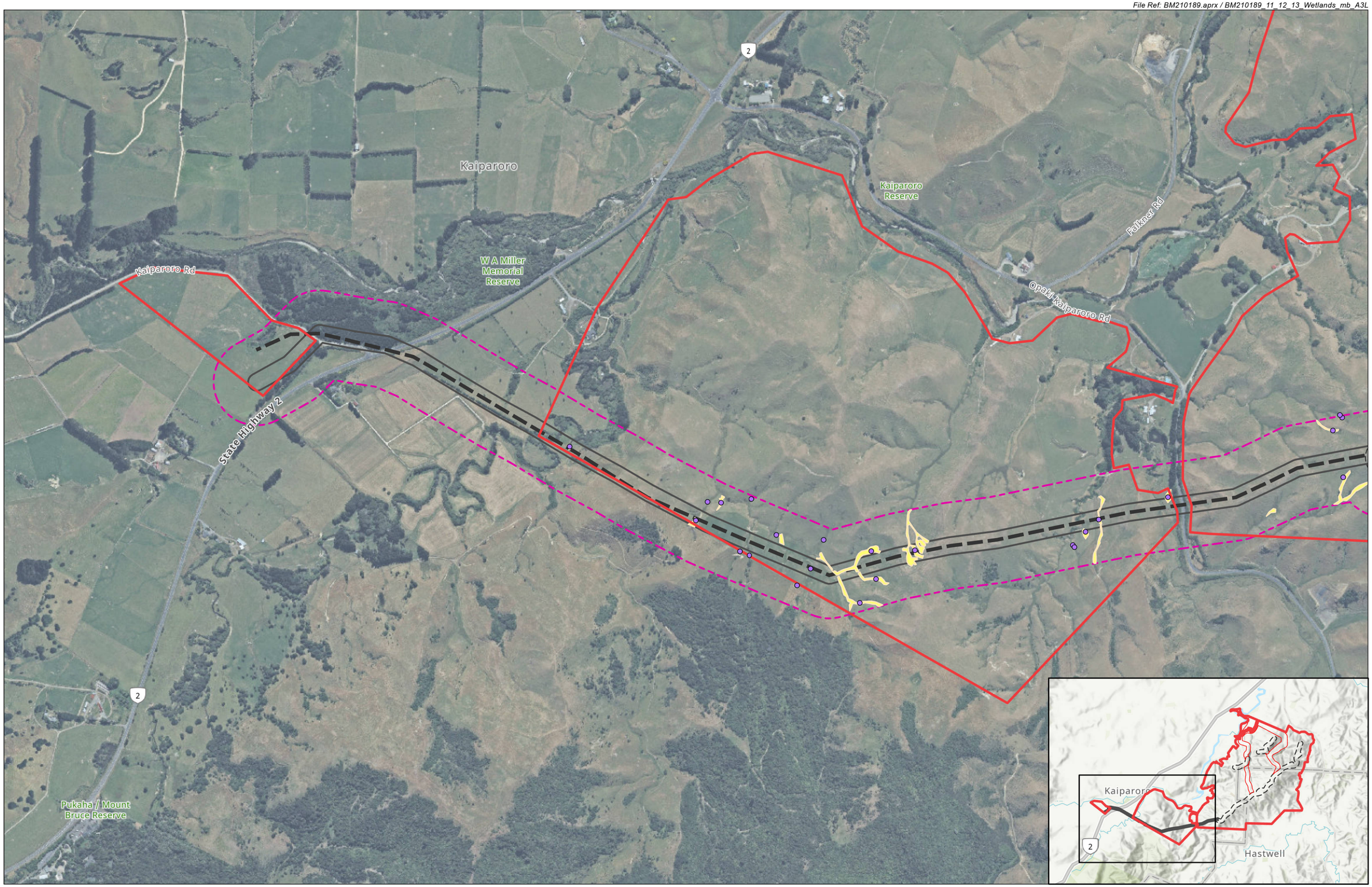

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Data Sources: Eagle Technology, LINZ, BML

Projection: NZGD 2000 New Zealand Transverse Mercator

LEGEND

- Site Boundary
- Transmission Line Route
- Transmission Corridor
- Turbine Envelope Zone
- Wetland survey area
- Surveyed Sites
- Proximity
- Near

MT MUNRO WIND FARM ECOLOGY ASSESSMENT

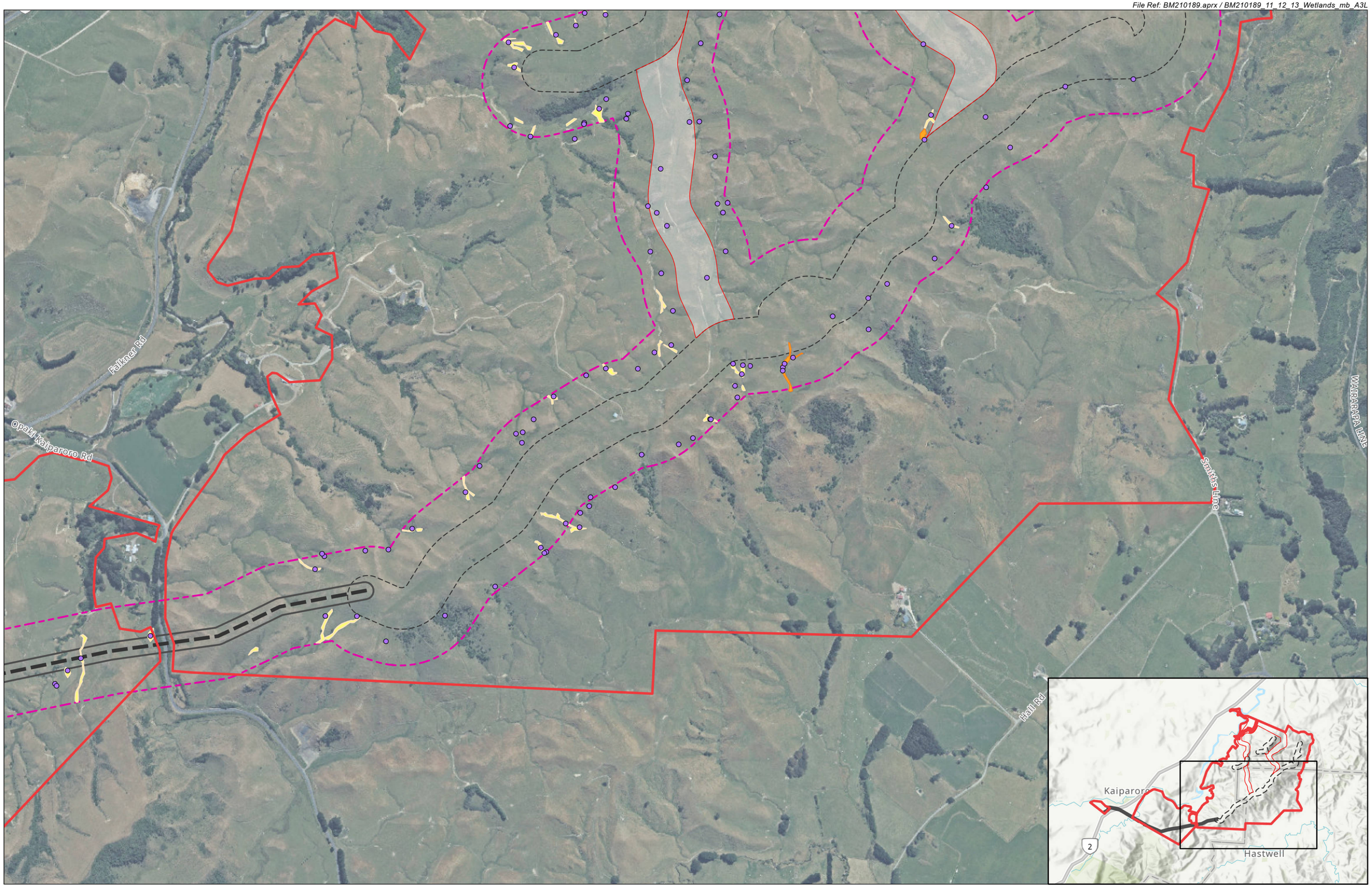
Wetland survey results

Date: 17 May 2023 | Revision: 1

Plan prepared for Meridian Energy Limited by Boffa Miskell Limited

Project Manager: Leigh.Bull@boffamiskell.co.nz | Drawn: KMa | Checked: LBu

Map 11



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Data Sources: Eagle Technology, LINZ, BML

Projection: NZGD 2000 New Zealand Transverse Mercator

LEGEND

- Site Boundary
- Transmission Line Route
- Transmission Corridor
- Turbine Envelope Zone
- Turbine Exclusion Zone
- Wetland survey area
- Surveyed Sites Proximity
- Near
- Partially within

MT MUNRO WIND FARM ECOLOGY ASSESSMENT

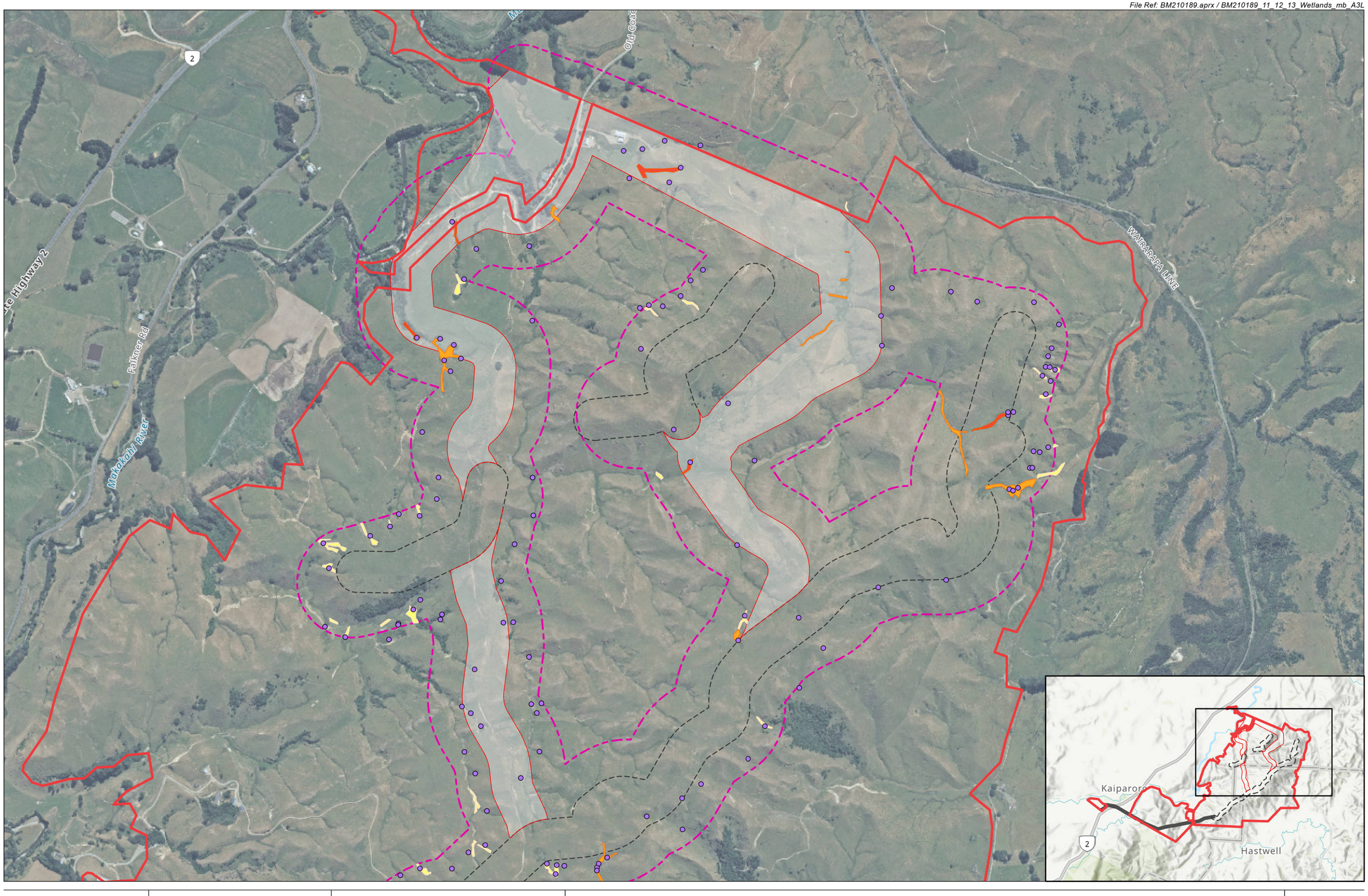
Wetland survey results

Date: 17 May 2023 | Revision: 1

Plan prepared for Meridian Energy Limited by Boffa Miskell Limited

Project Manager: Leigh.Bull@boffamiskell.co.nz | Drawn: KMa | Checked: LBu

Map 11



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Data Sources: Eagle Technology, LINZ, BML

Projection: NZGD 2000 New Zealand Transverse Mercator

LEGEND

- Site Boundary
- Turbine Envelope Zone
- Turbine Exclusion Zone
- Wetland survey area
- Surveyed Sites
- Proximity
  - Near
  - Within
  - Partially within

MT MUNRO WIND FARM ECOLOGY ASSESSMENT

Wetland survey results

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Map 11

Makakahi River is listed in Schedule B of Horizon's One Plan (Horizons Regional Council, 2014) as having the following values: a Site of Significance – Aquatic (SOS-A); a Regionally Significant trout fishery; and providing trout spawning habitat. With regard to the SOS-A status, this is attributed to the Makakahi River and several tributaries (including Bruce Stream) providing habitat for short-jaw kokopu (*Galaxias postvectis*), a species which is classified as being *At Risk-Declining* (Dunn et al. (2018). Within the site the headwater tributaries of each of the two main streams are attributed with the values of the main stem rivers and are therefore marked as regionally significant trout fishery but this is not because they are actually trout fisheries (they are far too small and of insufficient flow to be such) and so this value is put aside.

Of the 11 surveyed sites, two of those waterways form part of the Kopuaranga catchment, with the remaining 10 part of the Makakahi catchment (refer to Map 14). The survey sites reflect the topography, size of catchments and distributions of works between the two catchments. A notable aspect of these waterways is the altitude and inland distance from the sea (which has implications for migratory native species). The unnamed watercourses on the Mt Munro wind farm site are all highly modified by land clearance and farming. The sections of Bruce Stream that run through the site are also subject to modification by land clearance from farming and non-native vegetation planting.

The freshwater systems are complex with sections of waterways on site moving between perennial, intermittent and ephemeral states seasonally (refer to Map 15). For clarity, this freshwater assessment has focused on intermittent and perennial stream within the site as defined by the Resource Management Act and adopted as the definition by the Horizons One Plan (2014). This meant that the stream had to have a defined channel with flowing water. Areas on site that may be classified as ephemeral are covered under Section 5.2 due to the water-associated vegetation communities present on site.

There are no large freshwater ponds or lakes within the Turbine Envelope or Turbine Exclusion Zones.

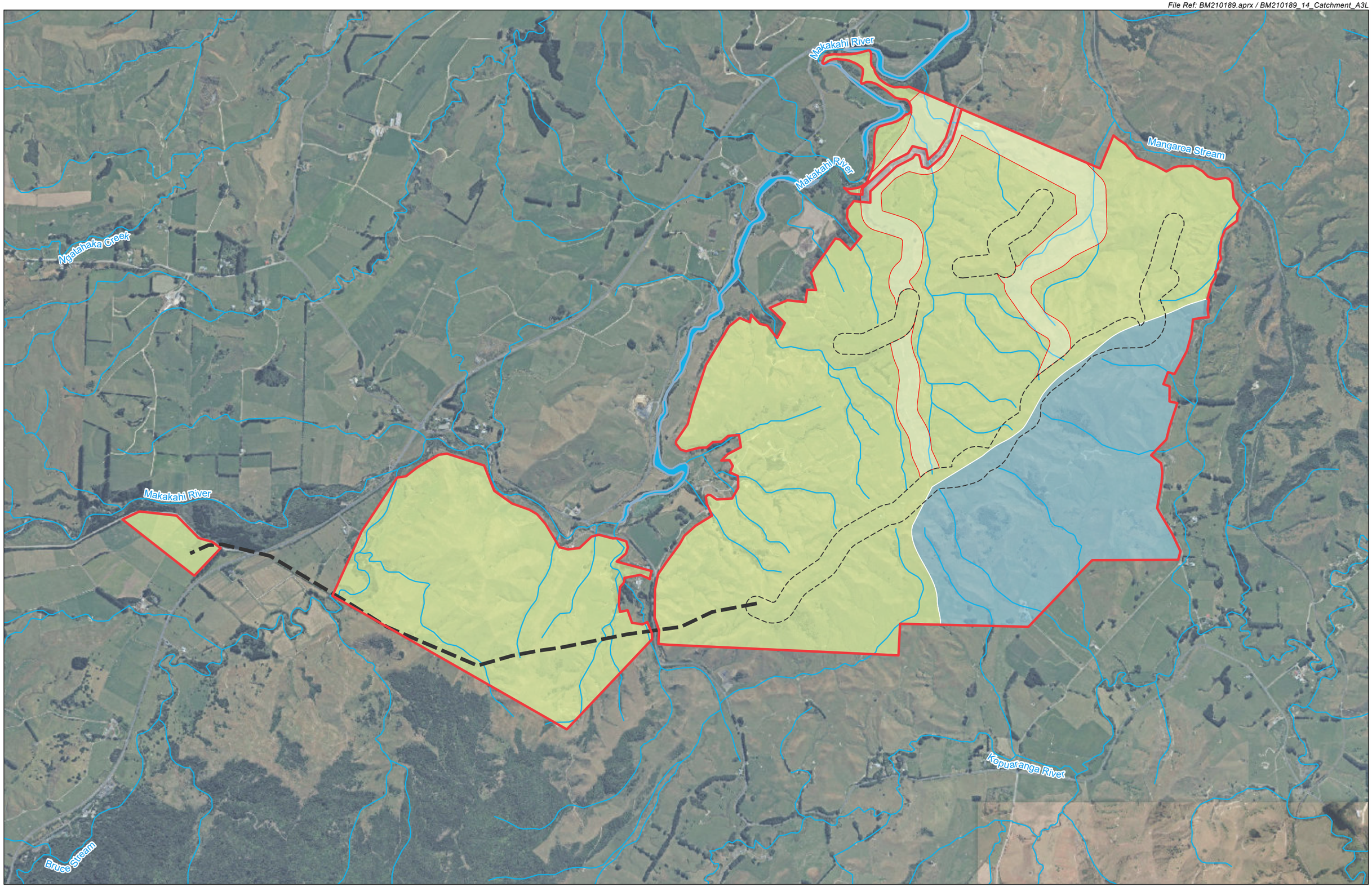
5.3.1 Physical habitat and morphology

The following section describes the physical habitat and morphology of the waterways where they were surveyed on the site (refer to Map 5). We have used 2021 descriptions in describing physical habitat and morphology as they provide the most up to date information, though where applicable descriptions combine information collected in 2011 (Boffa Miskell Ltd, 2011b) and 2021. We have noted any changes to the habitat and morphology of ecological note observed between the site visits in 2011 and 2021.

5.3.1.1 BRU1 – Bruce Stream

The Bruce Stream at BRU1 (Photo 14) has a narrow channel (approximately 0.3 m) in the pasture sections. Areas of the channel have been fenced off to exclude stock. The channel is slightly incised and meanders through a wide valley. Stream shading on average is around 40% due to topography and vegetation. Riparian vegetation is a mix of native regeneration and planting with exotic species common including blackberry.

The stream bed is composed of hard substrate with moderate to high fine sediment disposition. The substrate includes bedrock (10%), boulders (5%), cobbles (10%), pebbles (15%), gravels (10%) and fine sediments (50%). The stream habitats were made up of a series of riffles, runs and pools. Wetted width ranged between 0.7-1 m and 0.2-0.6 m water depth. A riparian section of BRU1 on the Phillips property has been planted with flax, as well as other native species up the slopes of the gully.



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Data Sources: Eagle Technology, Land Information New Zealand, GEBCO, Community maps contributors, BML

Projection: NZGD 2000 New Zealand Transverse Mercator

LEGEND

- Site Boundary
- Transmission Line Route
- Turbine Envelope Zone
- Turbine Exclusion Zone

Catchment

- Kopuaranga
- Makakahi
- Streams (LINZ)
- Rivers (LINZ)

MT MUNRO WIND FARM ECOLOGY ASSESSMENT

Catchment

Date: 17 May 2023 | Revision: 1

Plan prepared for Meridian Energy Limited by Boffa Miskell Limited

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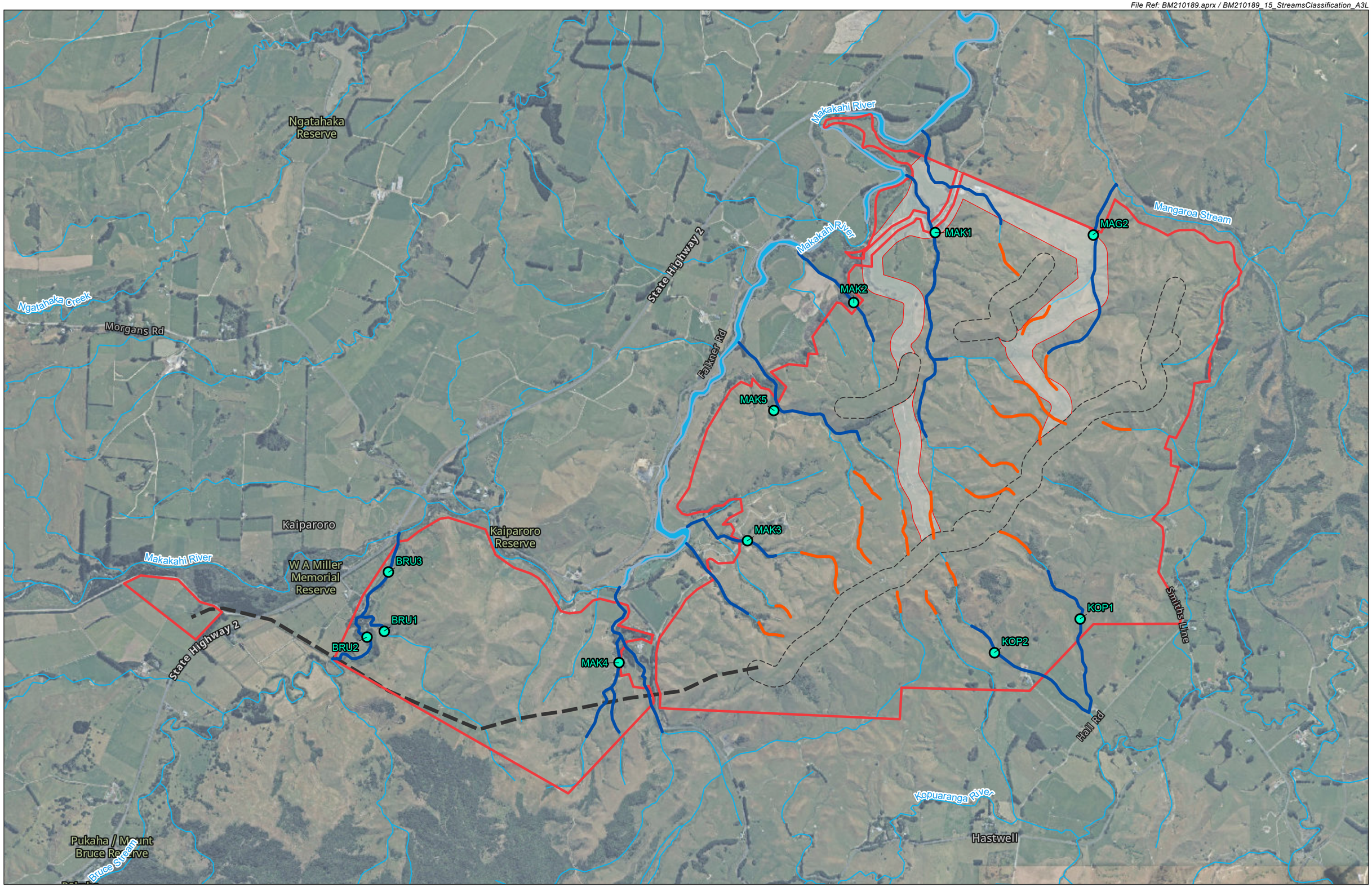
Map 14



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Data Sources: Meridian Energy Limited, Boffa Miskell, Eagle Technology, LINZ, StatsNZ, NIWA, Natural Earth, © OpenStreetMap contributors., Eagle Technology, Land Information New Zealand, GEBCO, Community maps contributors

Projection: NZGD 2000 New Zealand Transverse Mercator

LEGEND

- Site Boundary
- Transmission Line Route
- Turbine Envelope Zone
- Turbine Exclusion Zone
- Surveyed Sites

Stream Classification (BML)

- Ephemeral
- Perennial
- Streams (LINZ)
- Rivers (LINZ)

MT MUNRO WIND FARM ECOLOGY ASSESSMENT

Streams Classification

Date: 17 May 2023 | Revision: 1

Plan prepared for Meridian Energy Limited by Boffa Miskell Limited

Project Manager: Leigh.Bull@boffamiskell.co.nz | Drawn: KMa | Checked: LBu

Map 15

Photo 14: BRU1 freshwater survey site (refer to Map 16)

Photo 15: BRU2 freshwater survey site (refer to Map 16)

5.3.1.2 BRU2 – Bruce Stream

At BRU2 the Bruce Stream forms a wide channel with mixed riparian and stream habitat (Photo 15). The wetted width fluctuates from 10-15 m wide. At BRU2 the riparian vegetation was mixed with willows and native species present, with the width of the stream precluding complete shading by riparian vegetation. Leaf litter was present at the site throughout slower running areas. Parts of the bank edges were exposed and actively eroding.

The stream bed was composed with a mix of substrates (boulders, cobbles, gravels, sand) and habitats (riffles, runs, large pools up to 1 m deep, cascades). Of the hard bottomed substrate, most of it was covered in a diverse assemblage of periphyton. Macroinvertebrate opportunities within the stream were extensive but expected to be dominated by grazing taxon. Fish habitat availability at BRU2 were also diverse and abundant.

5.3.1.3 BRU3 – Bruce Stream

At BRU3 the Bruce Stream forms a wide channel with mixed riparian and stream habitat (Photo 16). BRU3 is located downstream of BRU1 and BRU2, and 100 m upstream of where the Bruce Stream enters the Makakahi River. The wetted width fluctuates from 5-10 m wide. At BRU3 the riparian vegetation was mixed with native species present, but both bank margins were dominated by rank pasture grasses. The width of the stream and dominance of grass as the type of riparian vegetation caused a low level of stream shading at BRU3. Leaf litter was present at the site throughout slower running areas. Parts of the bank edges were exposed and actively eroding.

The stream bed was composed with a mix of substrates (boulders, cobbles, gravels, sand) and riffle habitats (with some slow runs, and pooling). Of the hard bottomed substrate, most of it was covered in a diverse assemblage of periphyton. Macroinvertebrate opportunities within the stream were extensive but expected to be dominated by grazing taxon. Fish habitat availability at BRU3 were also diverse and abundant.

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Data Sources: Eagle Technology, LINZ, BML

Projection: NZGD 2000 New Zealand Transverse Mercator

LEGEND

- Site Boundary
- Transmission Line Route
- Turbine Envelope Zone
- Surveyed Sites

Stream Classification (BML)

- Perennial
- Streams (LINZ)
- Rivers (LINZ)

MT MUNRO WIND FARM ECOLOGY ASSESSMENT

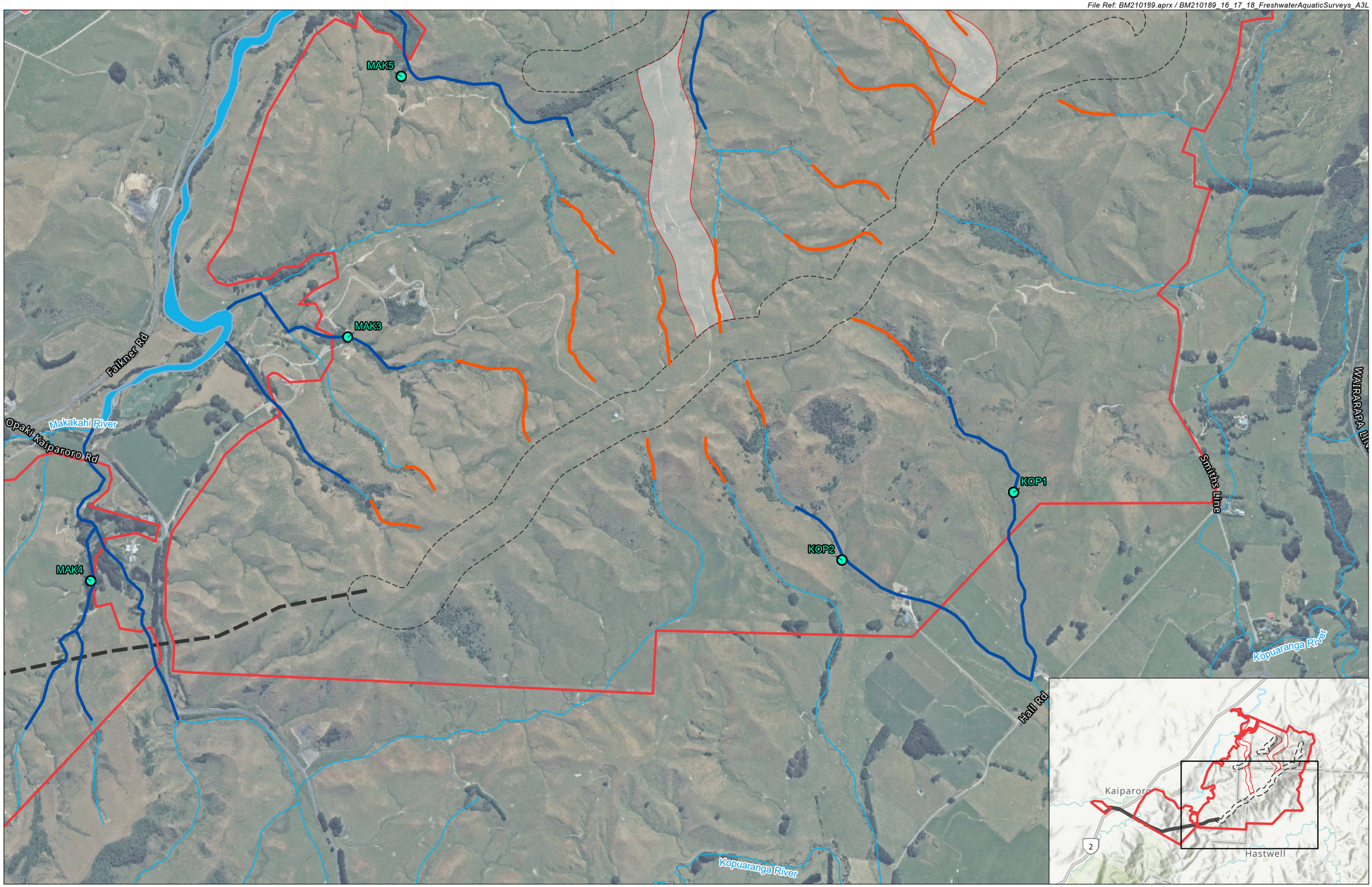
Freshwater aquatic surveys

Date: 17 May 2023 | Revision: 1

Plan prepared for Meridian Energy Limited by Boffa Miskell Limited

Project Manager: Leigh.Bull@boffamiskell.co.nz | Drawn: KMa | Checked: LBu

Map 16



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Data Sources: Eagle Technology, LINZ, BML

Projection: NZGD 2000 New Zealand Transverse Mercator

LEGEND

- Site Boundary
- Transmission Line Route
- Turbine Envelope Zone
- Turbine Exclusion Zone
- Surveyed Sites

Stream Classification (BML)

- Ephemeral
- Perennial
- Streams (LINZ)
- Rivers (LINZ)

MT MUNRO WIND FARM ECOLOGY ASSESSMENT

Freshwater aquatic surveys

Date: 17 May 2023 | Revision: 1

Plan prepared for Meridian Energy Limited by Boffa Miskell Limited

Project Manager: Leigh.Bull@boffamiskell.co.nz | Drawn: KMa | Checked: LBu

Map 17

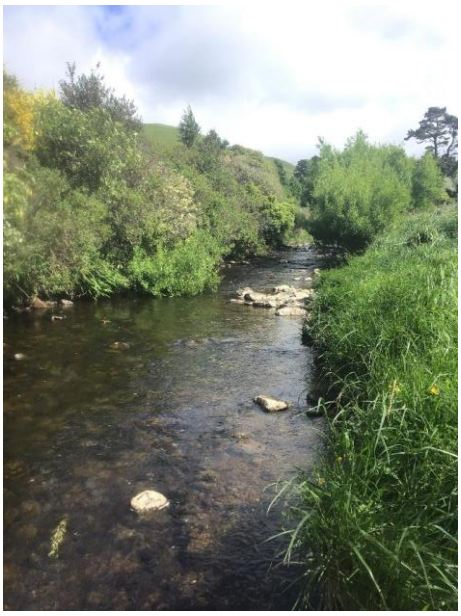


Photo 16: BRU3 freshwater survey site (refer to Map 16 for survey site location)

5.3.1.4 KOP1 – Kopuaranga tributary

The spring that feeds the tributary originates in fragments of native bush at top of gully (refer to Map 17). The stream averaged 0.4 m in width, but the channel was poorly defined and varies from having defined channels to surface water in pasture (Photo 17). Margins of the stream were observed to be heavily pugged. Streambed was dominated by hard substrate though fine sediment were prevalent.

Stream substrate is a mix of gravels (40%), cobbles (5%), pebbles (15%) and fine sediment (40%). The aquatic stream habitats are comprised of runs, riffles and pools. Large portion of the stream cross open pasture with scattered rushland. Stock has the ability to access most of the stream. Periphyton was common on hard substrate with minimal fish cover.

Photo 17: KOP1 freshwater survey site (refer to Map 17)

Photo 18: KOP2 freshwater survey site (refer to Map 17)

5.3.1.5 KOP2 – Kopuaranga tributary

The spring originates in fragment of native bush at top of gully (refer to Map 17). The stream ranges between 0.1-0.5 m in wetted width, and though contained within a channel, this is generally less well defined in places (Photo 18). Limited stream shading offered by surrounding topography, but extremely limited riparian cover. The small, planted patch of riparian cover by landowner buildings does offer some in-stream shading. Large portion of the stream crosses open pasture with scattered rushland. Stock access to much of the stream, with some recent stock fencing evident.

The substrate was predominately hard bottomed with a thin layer of fine sediment deposited on top. The streambed Stream substrate is a mix of gravels (15%), pebbles (30%), cobbles (15%) and fine sediments (50%). Stream habitat comprises runs, riffles, cascades and pools ranging from 0.3-0.4 m depth. Fish and macroinvertebrate habitat opportunity present but limited by deposited sediment.

5.3.1.6 MAG2 – Mangaroa Stream

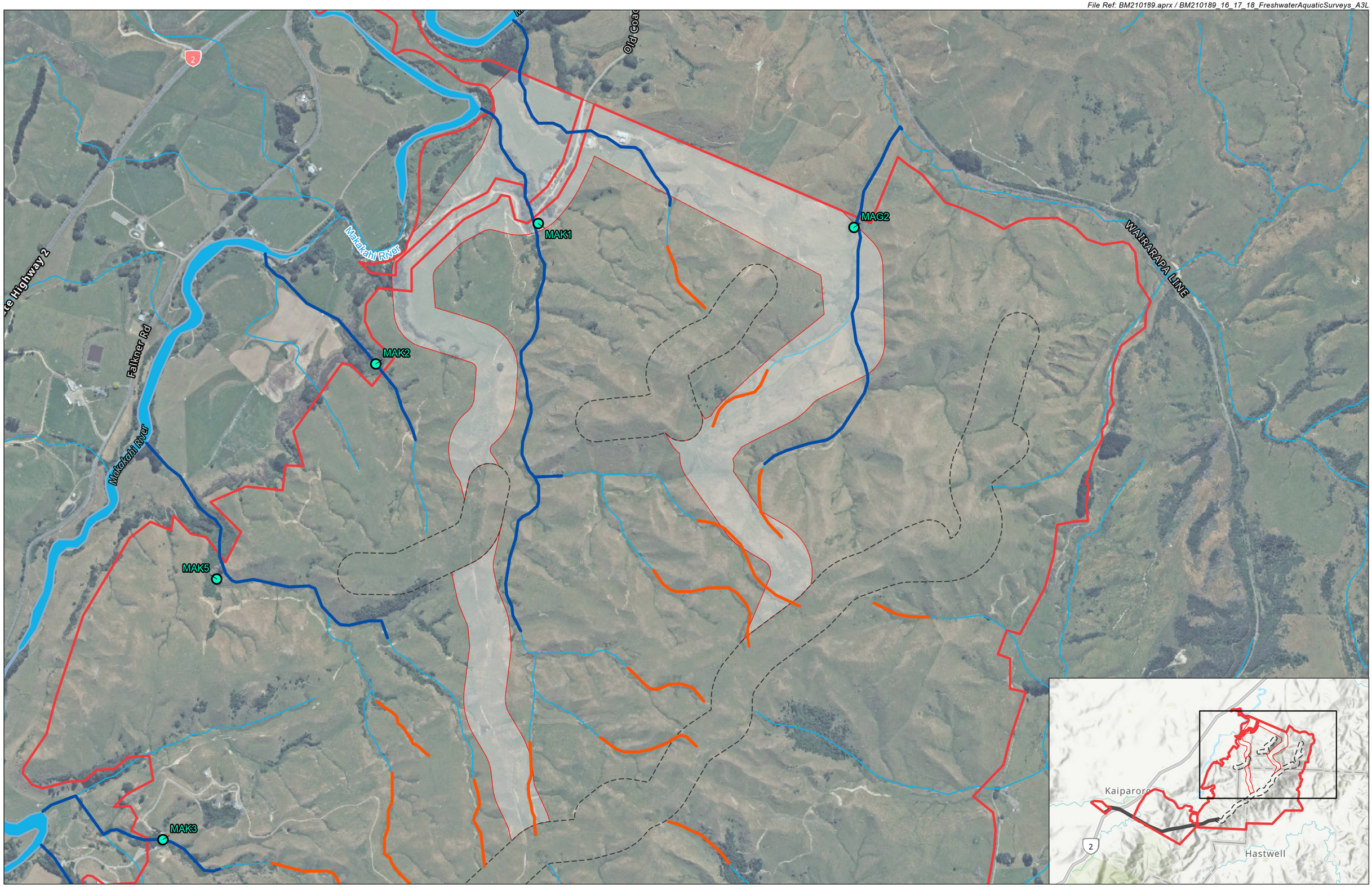
The spring originates in grazed pasture (refer to Map 18). Upstream of MAG2 two small gully streams feed the single tributary. At MAG2 the waterway has formed a defined channel with perennial flow (Photo 19). The substrate is composed of approximately 10% cobbles, 50% pebbles and 40% gravels. The bed had minimal compactness for fine sediments. The stream was made up of run and riffles, with limited pooling. The wetted-width was 0.5 m, bank-to-bank measured 5 m and the depth range from 0.1 to 0.15 m. The velocity of the stream was approximately 0.2m/s. The amount of deposited sediment was minimal. There was active erosion of banks with slumping evident. Stock was not excluded from the stream.

The stream showed limited opportunity for fish cover apart from the hyporheic zone. The opportunity for macroinvertebrate colonisation was good in regard to available substrate but limited for riparian influence.

Photo 19: MAG2 freshwater survey site (refer to Map 18 for survey site location)

5.3.1.7 MAK1 – Makakahi tributary

The spring originates in grazed pasture and the stream varies in width between an average of 0.2 m in the pastoral areas and 1.2 m in the lower sections of the tributary (Photo 20). The majority of the stream runs through pasture and scattered rushlands; however there are sections of the tributary where scattered native riparian vegetation (of good quality) and pine trees which provide organic input into the stream. Stock has access to much of the stream.



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Data Sources: Eagle Technology, LINZ, BML

Projection: NZGD 2000 New Zealand Transverse Mercator

LEGEND

- Site Boundary
- Turbine Envelope Zone
- Turbine Exclusion Zone
- Surveyed Sites

Stream Classification (BML)

- Ephemeral
- Perennial
- Streams (LINZ)
- Rivers (LINZ)

MT MUNRO WIND FARM ECOLOGY ASSESSMENT

Freshwater aquatic surveys

Date: 17 May 2023 | Revision: 1

Plan prepared for Meridian Energy Limited by Boffa Miskell Limited

Project Manager: Leigh.Bull@boffamiskell.co.nz | Drawn: KMa | Checked: LBu

Map 18

Stream substrate is a mix of bedrock (5%), boulders (10%), cobbles (15%), pebbles (20%), gravels (25%) and fine sediment (25%). Sediment compaction was moderate. Stream comprised of runs (15%), riffles (60%), cascades (10%) and pools (15%). Pools were typically 9 m^2 and 0.4-0.6 m deep. Riffles where typically 1.1 m wide (wedded width) and 0.1 cm deep. Runs were typically 1.2 m wide (wetted width) and 0.25-0.3 m deep.

Leaf litter was frequent and mostly made up of native vegetation. Woody debris were found through the reach, mostly small debris (<5cm) with some medium to large (5->10 cm) creating debris dams. Periphyton common throughout reach including vegetation under the canopy of riparian cover. The fish cover opportunity varied across the reach with limited cover provided from banks. Macroinvertebrate cover opportunities were good.

Photo 20: MAK1 freshwater survey site (refer to Map 18)

Photo 21: MAK2 freshwater survey site (refer to Map 18)

5.3.1.8 MAK2 – Makakahi tributary

The spring originates in a fenced section of mature native and exotic trees (some stock access). The canopy in the fenced area provides stream shading and organic input. The native canopy consisted of naturally regenerating vegetation though had a limited understory. The evident floodplain of the stream was approximately 10 m wide.

The stream averages 0.3 m in width and contained within a shallow channel and continuous flow (Photo 21). The streambed is characterised by hardbottom substrate overlain by fine sediments. Fine sediment was easily disturbed from the bed. Fine sediments can in some part reach 0.1m thick. Generally, the stream substrate was made up of gravels (10%), cobbles (5%), pebbles (5%) and fine sediments (80%). The wetted width of the reach ranged from 0.5-0.6 m, with depth ranging from 0.05-0.15 m. Stream habitat comprises runs, riffles and pools.

Leaflitter was common through the stream. Macroinvertebrate habitat opportunity was good for tolerant species, but some EPT species are expected. Woody debris were prevalent through the reach including large debris, and root mats were occasionally found in the stream. Fish habitat was very limited due to the prevalence of fine sediment filling interstitial spaces.

5.3.1.9 MAK3 – Makakahi tributary

The spring originates in grazed pasture and passes through scattered rushland before entering a fenced section of mature native and exotic trees (some stock access). The canopy in the fenced

area provides stream shading and organic input. At MAK3 the stream had a defined channel with a hardbottom substrate composition with limited deposited sediment (Photo 22). The channel is deeply incised in some of the pasture sections, and less defined in others.

Stream substrate is a mix of gravels, cobbles, and fine sediment. Stream habitat comprises runs, riffles, cascades and pools. The stream substrate comprised of boulder (5%), cobbles (10%), pebbles (30%), gravels (25%) and fine sediments (30%). The wetted width was on average 0.8 m and the depth ranged from 0.1-0.3 m in the riffles and runs. Pools ranged in depth from 0.2->1 m deep. Outside of the vegetated gorge the system became dominated by riffles and runs. The wetted width averaging 1.2 m and bank-bank 2-2.5 m.

Fish habitat within the stream was present, though level of fine sediment embeddedness, and water depth limited areas. Banks had limited undercuts which also reduced available habitat. Macroinvertebrate colonisation opportunities were good in sections of stream under canopy, with periphyton occasional and thin.

Photo 22: MAK3 freshwater survey site (refer to Map 17)

Photo 23: MAK4 freshwater survey site (refer to Map 16)

5.3.1.10 MAK4 – Makakahi tributary

Portions of this stream reach has overhanging native vegetation which contributes some organic matter to the stream. The stream has a narrow channel (approximately 0.4 m) in the pasture sections but widens (approximately 1 m) in the areas of native vegetation cover (Photo 23).

The stream bed is composed of hard substrate with fine sediments overlain up to 100% cover in disposition areas. The substrate included bedrock (1%), gravels (30%), cobbles (10%), pebbles (30%) and fine sediment (29%). The stream habitats were made up of a series of riffles, runs, pools and cascades. Given the number of stream habitats there was variation in the depth and wetted width of the stream. The wetted width ranged between 0.5-3.5 m, bank to bank 2.5-3 m and depth 0.05-0.4 m.

In-stream habitat for biota was prevalent and included root mats, leaf litter and some periphyton. EPT and fish habitat opportunities were good though the hyporheic zone was compacted. The culvert under the road was perched with a 5 m drop onto bedrock.

5.3.1.11 MAK5 – Makakahi tributary

The spring originates in grazed pasture and passes through mahoe dominated low forest and scattered rushland before entering a section of regenerating native scrub and exotic trees (some stock access). The canopy at MAK5 provides stream shading and organic input. At MAK5 the stream had a defined channel with a hardbottom substrate composition with limited deposited sediment (Photo 24).

Stream substrate is a mix of bedrock (1%), boulders (5%), cobble (20%), pebbles (20%), gravel (15%) and fine sediment (39%). Stream habitat comprises runs, riffles and pools, with limited cascades. The wetted width ranged between 0.7-2 m and the depth ranged from 0.05-0.2 m in the riffles and runs. Pools ranged in depth from 0.3-0.4 m deep.

Fish habitat within the stream was present, though level of fine sediment embeddedness, and water depth limited areas. Banks had limited undercuts which also reduced available habitat. Macroinvertebrate colonisation opportunities were good in sections of stream under canopy but was limited by the prevalence of fine sediment in the system.

Photo 24: MAK5 freshwater survey site (refer to Map 18 for survey site location)

5.3.1.12 In-stream sediment

In 2011 the visual inspection of sedimentation at each of the Mt Munro streams showed considerable variability across the site. Sediment cover, total suspended solids (TSS) and turbidity (NTU) were all recorded in 2011 (Appendix 4). The lowest levels of sedimentation were observed in the streams on the eastern side of Mt Munro (average of 6% cover at KOP1 and 10% at KOP2). The highest levels were observed on the western side at MAK2, where values ranged from 10-60% sedimentation with an average coverage of 32% along the sampled reach. These differences may in part be due to the differences in the gradient of the slopes and intensity of farming.

Total suspended solids (TSS) and turbidity (NTU) both indicate the amount of solids suspended in the water; high concentrations of particulate matter can cause increased sedimentation and siltation in a stream, which in turn can ruin important habitat areas for fish and other aquatic life. Low values for both NTU and TSS were recorded at all five wind farm streams that were sampled (Wellington Regional Council, 1999).

Visual assessment of the freshwater systems on site in 2021 confirmed the high prevalence of fine sediments within the systems. In the Bruce Stream and Kopuaranga sites fine sediment account for up to 50% of bed substrate. In the Makakahi sites fine sediment prevalence was more variable but also reach up to 80% of stream substrate composition.

5.3.2 Macroinvertebrate communities

The macroinvertebrate results from each site investigation are summarised in Table 14 and Table 15. The results below are broadly discussed in terms of the two catchments within the study area (Kopuaranga and Makakahi) and by each sampling year.

Table 14: Summarised macroinvertebrate results from 2011 site investigation

PARAMETER	BRU1	BRU2	KOP1	KOP2	MAK1	MAK2	MAK3	MAK4
Number of invertebrates	165	150	420	766	1129	258	1453	395
Number of taxa	13	17	11	11	22	13	18	17
Number of EPT taxa	6	6	5	6	10	5	8	7
% EPT invertebrates	39.3	21.3	25.2	39.5	42.4	78.2	24.3	15.7
MCI score	109	91.1	86.7	111.7	109.8	123.4	124.6	106.6
QMCI score	5	2.8	3.6	5.4	5.8	8.1	5.1	4.2

Table 15: Summarised macroinvertebrate results from 2021 site investigation

PARAMETER	BRU1	BRU2	KOP1	KOP2	MAG2	MAK1	MAK2	MAK3	MAK4	MAK5
Number of invertebrates	236	221	230	218	228	206	230	212	237	235
Number of taxa	21	23	29	33	33	27	30	27	33	29
Number of EPT taxa	9	9	12	12	13	12	8	12	12	11
% EPT invertebrates	38.1	22.2	13.9	14.2	36.4	78.6	31.3	85.	21.1	65.1
MCI score	104.8	101.7	103.4	100	95.8	105.9	102	117.8	100.6	106.2
QMCI score	5.6	3.3	4.2	3.6	4.3	6.8	4.6	7.4	4.3	6.7

Across the site the taxa richness was lowest in the Bruce Stream survey sites located in the Makakahi catchment with 21 and 23 taxa recorded respectively (Table 15); however, this is a typical taxa richness for small 1-2 order streams in rural settings. For the remainder of the Makakahi catchment survey sites, the taxa richness ranged between 27 and 33 (Table 15), which is on the high side for rural small streams. Taxa richness in the stream survey sites located within the Kopuaranga catchment (KOP1 and KOP2) were 29 and 33 respectively (Table 15). Within the Makakahi catchment taxa richness was greatest at MAG2 and MAK4 and lowest at BRU1 (Table 15). However sensitive EPT taxa account for the highest proportion of taxa at MAK3 (85.8%) of the Makakahi catchment sites (Table 15). Of the Kopuaranga sites KOP2 had the highest proportion of EPT taxa (14.2%) which is still low (Table 15). Of the EPT taxa present across the site, Ephemeroptera were the most common taxa both of the Kopuaranga and Makakahi catchment sites (Figure 5). Of the non-EPT taxa present across the site, Diptera were most common taxa group within the Kopuaranga sites and BRU1, BRU2, MAK2, MAK3 and MAK5 of the Makakahi catchment sites. The most common non-EPT taxa found at MAG1, MAK1 and MAK4 were Mollusca.

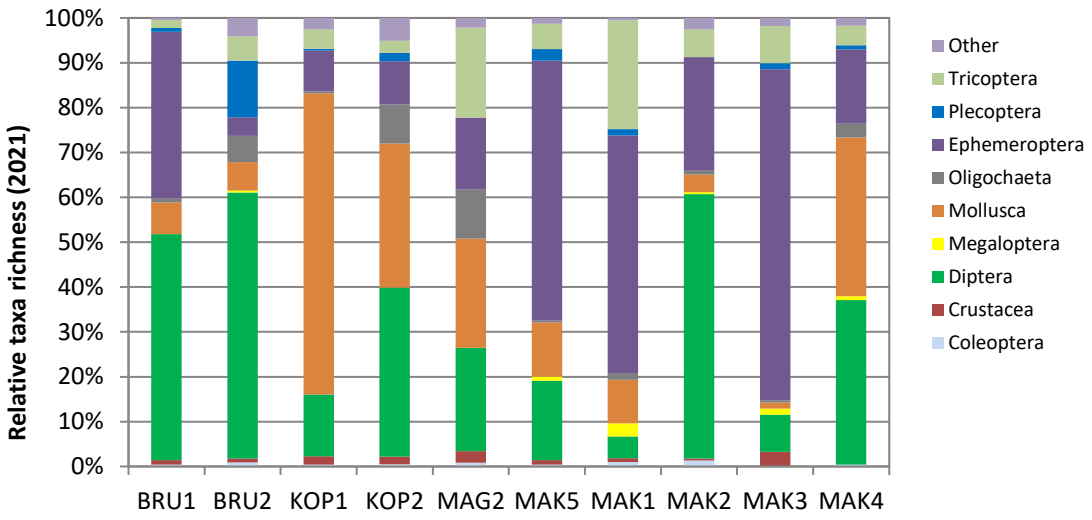


Figure 5: Relative macroinvertebrate taxa richness of each taxonomic group at each 2021 survey location

5.3.2.1 2011 and 2021 community MCI and QMCI

In order to aid in the assessment of the value of macroinvertebrate communities present on site, the differences between survey years are discussed below in regard to MCI and QMCI.

At all but two of the eight 2011 survey sites, MCI was indicative of good or excellent water quality (>100 MCI). QMCI in 2011 was indicative of good or excellent water quality (>5 QMCI) at only one of the eight sites (Stark & Maxted, 2007) (Figure 6 and Figure 7,).

In 2021, MCI was indicative of good or excellent water quality at seven of the 10 surveyed sites and the QMCI was indicative of good or excellent water quality at three of the 10 surveyed sites.

Between the two sampling dates the changes in MCI and QMCI are small and not all the same direction. The only sites that have had substantive change (repudiation) are MAK2 (decline) and for QNMCI MAK3 (increase).

Throughout the site and across all monitoring occasions, MCI and QMCI scores suggest water quality sits consistently within the fair-good bands with limited instances of excellent water quality. The consistency across sites and differences between sampling years is likely due to the land use (farming) remaining the same across the site. Of note is the reduction of the number of sites scoring 'excellent' MCI or QMCI in 2011 compared to 2021, of which both sites (MAK2, MAK3) were in the 'good' or 'fair' band in 2021.

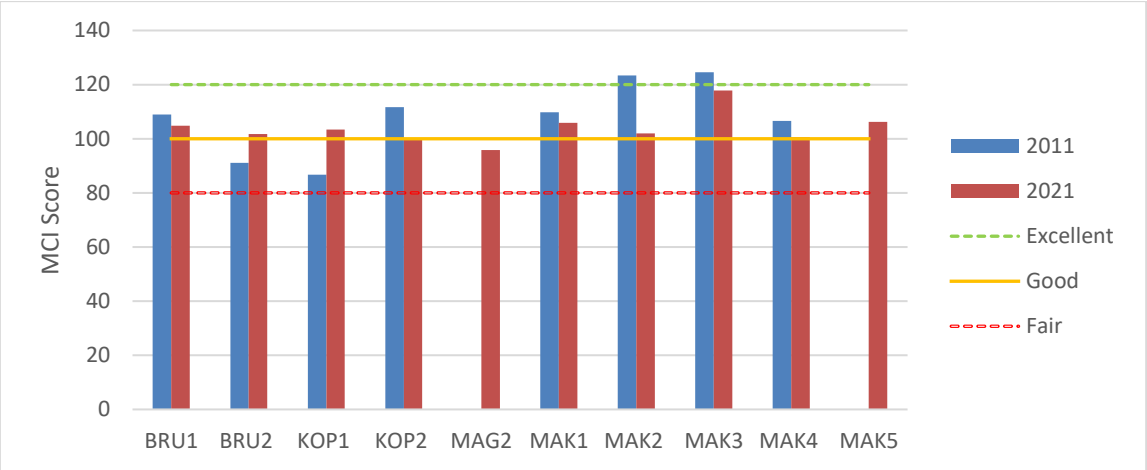


Figure 6: MCI scores as measured at each monitoring location in 2011 and 2021 and the water quality 'bands' as defined by Stark & Maxted, 2007

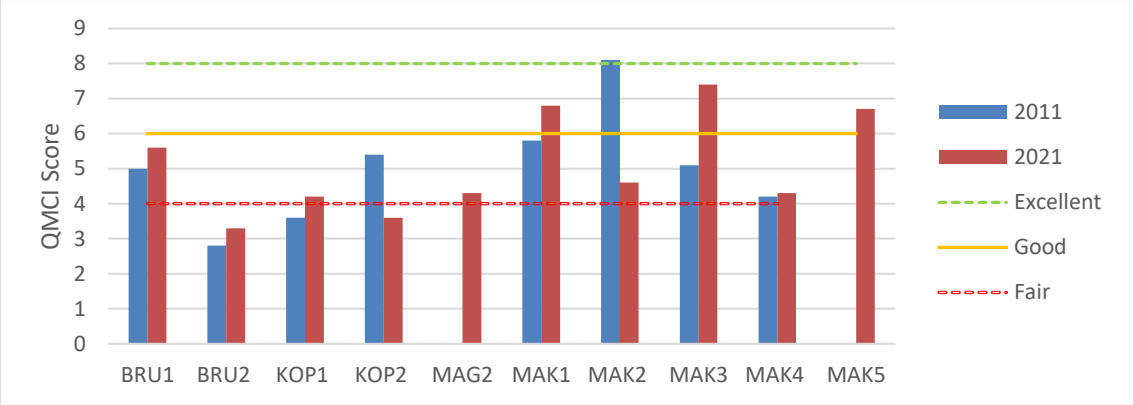


Figure 7: QMCI score as measured at each monitoring site in 2011 and 2021 and the water quality 'bands' as defined by Stark & Maxted, 2007

Comparing the relative richness of EPT taxa between sites and sampling dates indicates EPT fauna generally comprises <50% of the community apart from the MAK (1, 2, 3 and 5) sites where EPT comprised >50% of the community (Figure 8).

Within the Makakahi catchment sites %EPT ranges from 15.7% (MAK4, 2011) to 85.8% (MAK3, 2021). Within the Kopuaranga catchment sites %EPT has never exceeded 40% and ranged from 13.9% to 39.5%. The Mangaroa site is "average" and similar to the Kopuaranga tributaries, more so than the Makakahi tributaries.

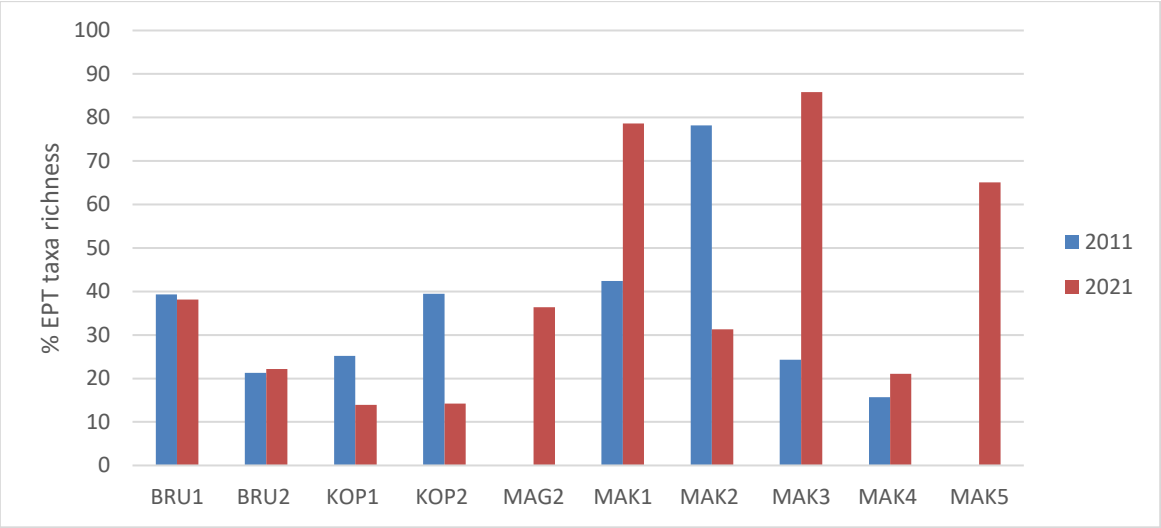


Figure 8: Relative EPT taxa at each monitoring site between 2011 and 2021

5.3.3 Freshwater fish

The nearest records of fish surveys (NIWA NZFFD) are the Makakahi River, Bruce Stream and an associated tributary; nine species are recorded in the NIWA NZFFD from 1918 to 2016 including two introduced species (Catchment 325.201) (Table 16).

Fish surveys have also been recorded in the Kopuaranga River and unnamed tributaries; 10 species were recorded in the NZFFD between 1965 and 2019 including three introduced species (Catchment 292.380) (see Table 17).

Table 16: Fish species recorded in NZFFD (NIWA) for Manawatu Catchment (325.201) excluding this study's records

SPECIES		THREAT CLASSIFICATION[9]	YEAR LAST RECORDED
Anguilla australis	Shortfin eel	Not Threatened	2010
Anguilla dieffenbachia	Longfin eel	At Risk – Declining	2013
Galaxias postvectis	Shortjaw kokopu	At Risk – Declining	2013
Geotria australis	Lamprey*	Threatened – Nationally Vulnerable	1918
Gobiomorphus breviceps	Upland bully	Not Threatened	2010
Gobiomorphus cotidianus	Common bully	Not Threatened	2010
Gobiomorphus sp.	Unidentified bully		1981
Paranephrops sp.	Koura	Not Threatened [10]	2012
Oncorhynchus mykiss	Rainbow trout	Introduced	2015
Salmo trutta	Brown trout	Introduced	2016
Salmo sp.	Unidentified salmonid	Introduced	2012

** Record from 1918 approximately 30km downstream of site*

[9] Dunn et al., 2018

[10] Grainger et al. (2018)classification used as koura is a freshwater invertebrate (not fish).

Table 17: Fish species recorded in NZFFD (NIWA) for Kopuaranga River catchment (292.380) excluding this study's records

SPECIES		THREAT CLASSIFICATION	YEAR LAST RECORDED
Anguilla australis	Shortfin eel	Not Threatened	2019
Anguilla dieffenbachia	Longfin eel	At Risk – Declining	2019
Anguilla sp.	Unidentified eel		2019
Cheimarrichthys fosteri	Torrentfish	At Risk – Declining	1986
Gobiomorphus basalis	Crans bully	Not Threatened	2019
Gobiomorphus breviceps	Upland bully	Not Threatened	2019
Gobiomorphus cotidianus	Common bully	Not Threatened	2019
Paranephrops sp.	Koura	Not Threatened	2019
Carassius auratus	Goldfish	Introduced	2016
Perca fluviatilis	Perch	Introduced	2019
Salmo trutta	Brown trout	Introduced	2019

During the 2011 Mt Munro freshwater surveys, freshwater fish were recorded at six of the seven surveyed sites (Table 18); these included longfin eel, unidentified eel species and common bully. No fish were caught at MAK3. Koura were also recorded as part of those fish surveys. Table 18 shows a summary of the number and type of species caught at each site in 2011.

Table 18. Results of the number each species caught as part of electric fishing survey 2011

SPECIES	BRU1	BRU2	KOP1	KOP2	MAK1	MAK3	MAK4
Longfin eel	2		3	8	2		1
Unidentified eel sp.	3		1	4	2		
Elver	1		1		1		1
Common bully		11	5				7
Koura	47	1	3	7		1	

Freshwater fish were recorded at all four sites that were spotlighted in 2021 (Table 19). These included longfin eel, shortfin eel, unidentified eel species and common bully. In addition to spotlighting, incidental catches as part of macroinvertebrate sampling were recorded. At KOP1 and MAG1 upland bully were caught in macroinvertebrate sampling. Koura were also recorded as part of the fish surveys.

Table 19. Results of the number of each species caught as part of spotlight fishing survey 2021

SPECIES	BRU1*	BRU3	KOP1*	KOP2	MAG2*	MAK1	MAK2*	MAK4	MAK5*
Longfin eel		7		2		12		10	
Shortfin eel				1				3	
Unidentified eel sp.		2							
Elver									
Common bully		>>6						8	
Upland bully			2		7				
Unidentified bully		1							
Koura	1	1		>9			2	4	1

**Recorded in macroinvertebrate sampling net not spotlighted*

5.4 Herpetofauna

The DOC Herpetofauna database (BioWeb) held records for six species of lizard within 20 km of the site. Of these, five species could potentially be present within the project footprint (Table 20); there is a single record for the Newman's speckled skink (*Oligosoma newmani*) from 1969, which are restricted to the South Island, and so their presence here is considered likely to be a misidentification, and given its age has therefore been excluded.

Table 20: The native lizard species recorded as being present within 20 km of the proposed wind farm.

COMMON NAME	SCIENTIFIC NAME	CONSERVATION STATUS[11]	DESCRIPTION[12]
Potentially present within the study site			
Northern grass skink	*Oligosoma polychroma*	*Not Threatened*	Diurnal, terrestrial, strongly heliothermic
Copper skink	*Oligosoma aeneum*	*At Risk - Declining*	Diurnal, terrestrial, cryptozoic
Ornate skink	*Oligosoma ornatum*	*At Risk - Declining*	Predominantly crepuscular, terrestrial, heliothermic
Barking gecko	*Naultinus punctatus*	*At Risk - Declining*	Diurnal, arboreal
Raukawa gecko	*Woodworthia maculatus*	*Not Threatened*	Nocturnal, arboreal and terrestrial

5.4.1 Habitat assessment

As described in Section 5.1, the dominant vegetation type within the site is improved, grazed pasture. This is considered to be unsuitable habitat for indigenous herpetofauna species, as it lacks refugia and is frequently disturbed.

The potential herpetofauna habitats present within the site include rank grass/weedlands, indigenous shrublands/forests, rock outcrops, and boulder/debris fields. These habitat types have potential to provide habitat for all of the species described in Table 20.

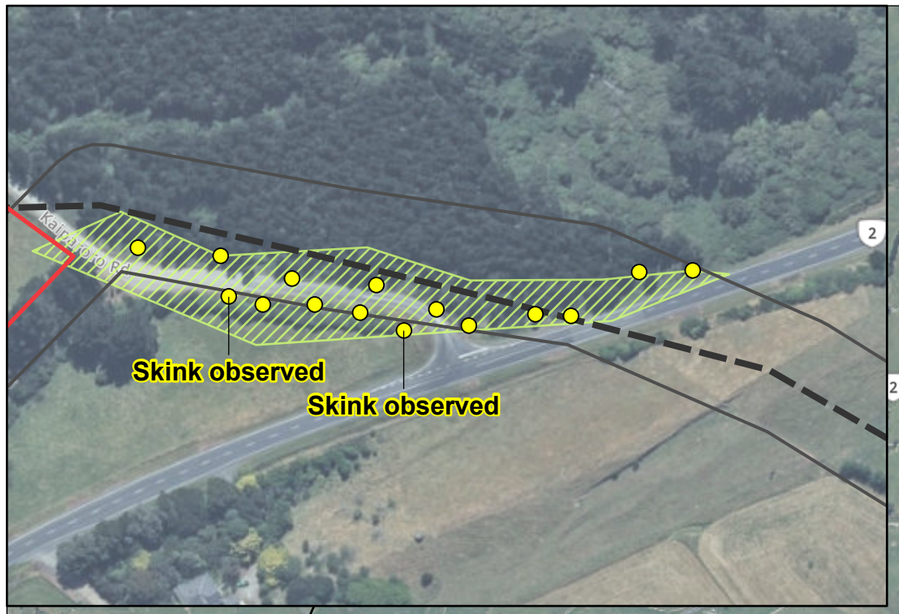
Rank grass/weedlands provide habitat for terrestrial skink species, primarily the northern grass skink. These areas were targeted during ACO surveys where they fall within the potential project footprint (Map 19), and are present at the western end of the transmission line (at the Kaiparoro Road margin) and the edges of the ornamental garden to the north-west of the site. There is also lower quality blackberry weedland at the margin of the regenerating forest that falls within the potential footprint of the lower access track; this area is grazed and the ground layer beneath the blackberry is largely barren so is less likely to provide suitable refugia.

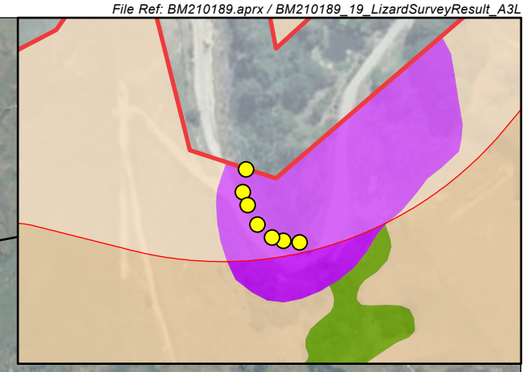
Crevices within the rock outcrops on site could potentially provide habitat, especially for the Raukawa gecko. However, on inspection most crevices within the outcrops were found to be packed with soil, and so were unsuitable for supporting lizard populations. These outcrops were also typically very small, and were within areas that are heavily grazed and disturbed.

A few small boulder and/or debris fields were found onsite – generally these were comprised of scattered, embedded rocks within grazed pasture, which provide very little lizard habitat. One small boulderfield was found within the potential footprint (and was searched) that a small amount of rock layering that may provide refugia; however, this was observed within an ephemeral flow

[11] Hitchmough et al. (2021)

[12] Van Winkel et al. (2018)





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Projection: NZGD 2000 New Zealand Transverse Mercator

MT MUNRO WIND FARM ECOLOGY ASSESSMENT

Lizard survey results

Date: 17 May 2023 | Revision: 1

Plan prepared for Meridian Energy Limited by Boffa Miskell Limited

Project Manager: Leigh.Bull@boffamiskell.co.nz | Drawn: KMa | Checked: LBu

Map 19

path and is likely inundated with water during heavy rainfall. It was also within a heavily grazed and disturbed area and searching of the area yielded no lizard observations. Generally, the boulder and/or debris fields within the footprint were found to be unsuitable to support lizard populations. Several larger boulderfields with more layering/stacking were observed on the site outside of the footprint, but as these are to be avoided, they were not searched.

There are several areas of regenerating native forest within the wider site, though only one of these falls within the potential footprint of works. These patches are typically small, young, and isolated within the grazed farmland. They are also unfenced and grazed underneath. As such, it is unlikely that arboreal lizards have been able to colonise these vegetation patches, and the grazed ground layer provides very little or no habitat for terrestrial lizards.

5.4.2 Field surveys

No lizards were observed in any of the rock outcrops or boulder fields searched on the site, nor were any arboreal lizards seen while spotlighting.

During ACO surveys, two skinks were observed. Both were seen within the areas of rank grass/weeds at the western end of the proposed transmission line, at the road margin (Map 19). The skinks cannot be definitively identified without handling (which would require a Wildlife Act Authority); however, based on their markings and the habitat in which they were found, they appeared to be northern grass skink.

These results indicate that the northern grass skink is present on the site in low densities. Given the low detectability of many lizard species, these results do not confirm the absence of other species listed in Table 20. They do, however, indicate that any other species present are likely to be in very low/undetectable densities, and the general lack of suitable habitat on the site further reduces the likelihood of their presence.

5.5 Avifauna

Based on the desktop investigation, there are 55 species that use, or potentially use, the proposed wind farm site (Appendix 5). By excluding species that do not have primary habitat within the project site (e.g. black swan, New Zealand dabchick) or primary habitat of sufficient size to support them (e.g. North Island kokako, whitehead[13]), this list is reduced to 40 species. This includes 20 introduced species and 20 indigenous species. The 20 indigenous species comprise two *Threatened* species (bush falcon and long-tailed cuckoo), two *At Risk* species (North Island kaka and New Zealand pipit) and 16 *Not Threatened* species (Table 21).

This list of 40 species includes four species that were not observed on site during the 2010-2012 survey: tui, bush falcon, bellbird and eastern rosella. A conservative approach has been taken, whereby the species list also includes four species that were observed on site during the 2010-2012 survey but were not seen during the current (2021-22) survey: long-tailed cuckoo, morepork, redpoll and dunnock. Morepork are likely present on site but were not detected because a nocturnal survey was not conducted during the current survey. If still present on site, long-tailed cuckoo, redpoll and dunnock are likely only present in low abundances.

[13] These species, and some other species of forest bird, are present in the Mt Bruce forest block but the wind farm site does not provide habitat for them due to the pastoral-dominated landscape that is interspersed with only small, scattered native forest fragments.

There have been no records of national or international migrant shorebirds with Threatened or At Risk classifications on the Mt Munro site or in the wider landscape (refer to Appendix 5). Furthermore, the Mt Munro site does not lie within any known migratory pathways (Figure 9).

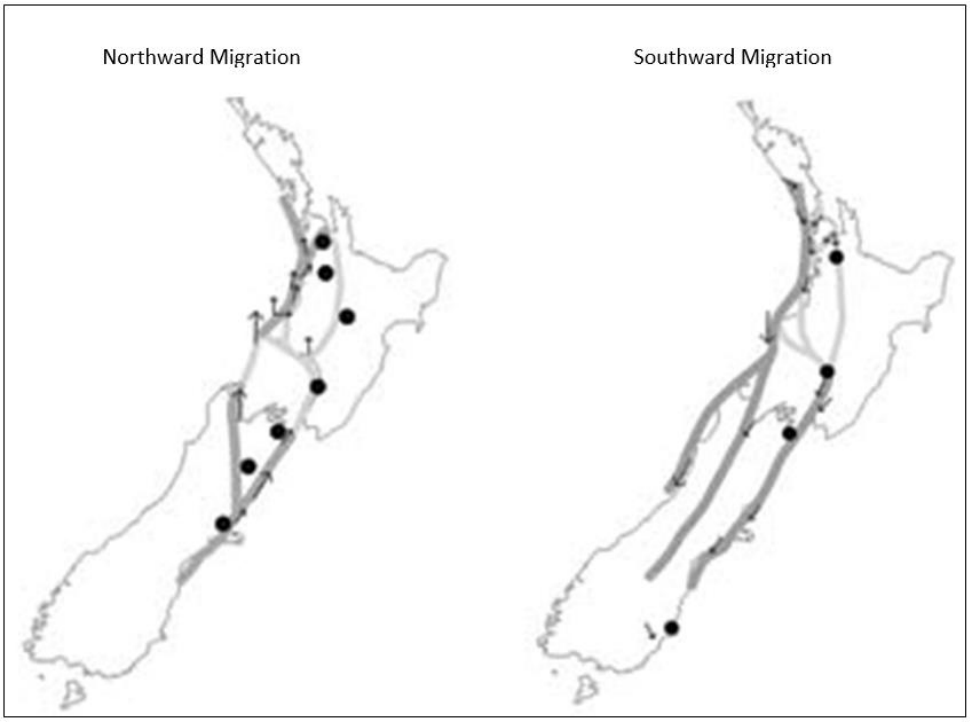


Figure 9: Predicted migration routes for national migrants (Southey, 2009).

Table 21: Refined list of species that use, or may potentially use, the Mt Munro project site based on the desktop and field data . The dark green cells indicate primary habitat used by each species and the light green cells indicated secondary habitat used by each species.

SPECIES		CONSERVATION STATUS (H. A. ROBERTSON ET AL., 2021)	HABITAT								DATA SOURCE				
			Native forest	Exotic Forest	Scrub / shrubland	Farmland / open country	Freshwater / wetlands	Coastal / Estuary	Oceanic	Urban/ Residential	OSNZ Atlas 1999-2004	eBird atlas effort Map data 2022	2010-2012 surveys (Combined)	2021/22 point counts & Incidental obs.	2021/22 Transmission line surveys & Incidental Obs.
Tui	*Prosthemedera novaeseelandiae*	Not Threatened									Y	Y			Y
North Island fantail	*Rhipidura fuliginosa placabilis*	Not Threatened									Y	Y	Y	Y	Y
Kereru	*Hemiphaga novaeseelandiae*	Not Threatened									Y	Y	Y	Y	Y
North Island kaka	*Nestor meridionalis septentrionalis*	At Risk - Recovering									Y	Y	Y		Y
Shining cuckoo	*Chrysococcyx lucidus*	Not Threatened									Y	Y	Y	Y	Y
Bush falcon	*Falco novaeseelandiae*	Threatened - Nationally Increasing									Y	Y		Y	Y
Kingfisher	*Todiramphus sanctus vagrans*	Not Threatened									Y	Y	Y		Y
Bellbird	*Anthornis melanura*	Not Threatened									Y	Y			Y
Long-tailed cuckoo	*Eudynamys taitensis*	Threatened - Nationally Vulnerable									Y	Y	Y		
Morepork	*Ninox novaeseelandiae*	Not Threatened									Y	Y	Y		
Silvereye	*Zosterops lateralis*	Not Threatened									Y	Y	Y	Y	Y
Eastern rosella	*Platycercus eximius*	Introduced										Y			Y
Blackbird	*Turdus merula*	Introduced									Y	Y	Y	Y	Y
California quail	*Callipepla californica*	Introduced										Y			
Pheasant	*Phasianus colchius*	Introduced									Y				
Grey warbler	*Gerygone igata*	Not Threatened									Y	Y	Y	Y	Y
Redpoll	*Cardeulis flammea*	Introduced									Y		Y		
Rook	*Corvus frugilegus*	Introduced											Y	Y	
Swamp harrier	*Circus approximans*	Not Threatened									Y	Y	Y	Y	Y

SPECIES		CONSERVATION STATUS (H. A. ROBERTSON ET AL., 2021)	HABITAT								DATA SOURCE				
			Native forest	Exotic Forest	Scrub / shrubland	Farmland / open country	Freshwater / wetlands	Coastal / Estuary	Oceanic	Urban/ Residential	OSNZ Atlas 1999-2004	eBird atlas effort Map data 2022	2010-2012 surveys (Combined)	2021/22 point counts & Incidental obs.	2021/22 Transmission line surveys & Incidental Obs.
House sparrow	*Passer domesticus*	Introduced				■				▫	Y	Y	Y	Y	
Goldfinch	*Cardeulis cardeulis*	Introduced			▫	■				▫	Y	Y	Y	Y	Y
Spur-winged plover	*Vanellus miles novaehollandiae*	Not Threatened				■	▫				Y	Y	Y	Y	Y
Magpie	*Gymnorhina tibicen*	Introduced		▫		■				▫	Y	Y	Y	Y	Y
Welcome swallow	*Hirundo neonexa*	Not Threatened				■	▫				Y	Y	Y	Y	Y
Dunnock	*Prunella modularis*	Introduced	▫	▫	▫	■				▫	Y	Y	Y		
Starling	*Sturnus vulgaris*	Introduced				■				▫	Y	Y	Y	Y	Y
Chaffinch	*Fringilla coelebs*	Introduced	▫	▫	▫	■				▫	Y	Y	Y	Y	Y
Song thrush	*Turdus philomelos*	Introduced	▫	▫	▫	■				▫	Y	Y	Y	Y	Y
Yellowhammer	*Emberiza citronella*	Introduced			▫	■					Y	Y	Y	Y	Y
Skylark	*Alauda arvensis*	Introduced				■					Y	Y	Y	Y	Y
Greenfinch	*Carduelis chloris*	Introduced		▫	▫	■				▫	Y	Y	Y	Y	Y
Wild turkey	*Melleagris gallopavo*	Introduced				■					Y	Y			
Canada goose	*Branta canadensis*	Introduced				■	▫	▫			Y	Y			
New Zealand pipit	*Anthus novaeseelandiae*	At Risk - Declining				■	▫	▫					Y	Y	
Paradise shelduck	*Tadorna variegate*	Not Threatened				▫	■				Y	Y	Y	Y	Y
Pukeko	*Porphyrio melanotus*	Not Threatened				▫	■				Y	Y	Y		Y
Mallard	*Anas platyrhynchos*	Introduced				▫	■				Y	Y	Y		Y
White-faced heron	*Egretta novaehollandiae*	Not Threatened				▫	▫	■			Y	Y	Y		
Black-backed gull	*Larus dominicanus*	Not Threatened				▫		■			Y	Y	Y	Y	Y
Rock pigeon	*Columba livia*	Introduced				▫				■	Y	Y	Y	Y	Y

5.5.1 Wind farm point count surveys (2021-2022)

5.5.1.1 Species observed and abundances

In total, 2960 bird observations[14], comprising 23 different species, were made during the 2021-2022 point count surveys conducted on site. This included 12 introduced species and 11 indigenous species. The indigenous species comprised one *Threatened* species (bush falcon), one *At Risk* species (New Zealand pipit) and nine *Not Threatened* species (Table 22).

The most common species observed during the point count surveys on the wind farm was starling, followed by magpie; both are introduced species. Together these two species made up 73% of all observations (Table 22). Eight species made up 95% of all observations; this included only one indigenous species, harrier hawk, which contributed 4.9% of all observations (Table 22). In total, indigenous species made up only 7.8% of all observations on the wind farm site.

The only *Threatened* species observed during the point counts was bush falcon. Five observations were made of this species, comprising 0.17% of all point count survey observations (Table 22). One observation was made in March 2022 (PC2; refer to Map 6), two observations were made on the same day in August 2021 (PC5 and PC6; refer to Map 6) and two observations were made on the same day in April 2022 (PC1 and PC2; refer to Map 6). We assume these same day observations were of the same individual given that the observations were at nearby survey sites within a short time of each other. For four of the observations, the falcon was observed traversing across site and (two traversing north and two traversing south); during the other observation the falcon was observed feeding in the air.

The only *At Risk* species observed during the point counts was New Zealand pipit. Sixteen observations were made of this species comprising 0.54% of all point count survey observations (Table 22). Observations were made in five of the survey months and across site in grassland habitat. Behaviours observed include traverses, departures, arrivals, short flights and feeding on the ground.

Table 22: Abundance of individual species observed during point counts conducted at the Mt Munro wind farm site 2021-2022.

SPECIES	THREAT STATUS	TOTAL OBSERVATIONS	%	50%	75%	90%	95%
Starling	Introduced	1523	51.45				
Magpie	Introduced	654	22.09				
Goldfinch	Introduced	185	6.25				
Harrier	Not Threatened	145	4.90				
Greenfinch	Introduced	114	3.85				
Skylark	Introduced	87	2.94				
Rook	Introduced	70	2.36				
Yellowhammer	Introduced	38	1.28				
Black-backed gull	Not Threatened	26	0.88				
Finch sp.	Introduced	24	0.81				
Chaffinch	Introduced	17	0.57				

[14] This total is for birds identified to species and bird group (e.g. finch species). An additional 55 birds were observed distantly during the point count surveys that could not be identified. These birds are excluded from further analysis.

SPECIES	THREAT STATUS	TOTAL OBSERVATIONS	%	50%	75%	90%	95%
New Zealand pipit	At Risk - Declining	16	0.54				
Welcome swallow	Not Threatened	16	0.54				
Rock Pigeon	Introduced	11	0.37				
Kereru	Not Threatened	7	0.24				
Paradise shelduck	Not Threatened	5	0.17				
Song thrush	Introduced	5	0.17				
Bush falcon	Threatened - Nationally Increasing	5	0.17				
Spur-winged plover	Not Threatened	4	0.14				
Silvereye	Not Threatened	2	0.07				
Grey warbler	Not Threatened	2	0.07				
Blackbird	Introduced	2	0.07				
Shining cuckoo	Not Threatened	1	0.03				
House sparrow	Introduced	1	0.03				
Total		**2960**	**100**				

As expected, based on the farmland-dominated landscape with limited habitat heterogeneity, species diversity was reasonably similar across site with between 10 and 16 species observed at each point count (PC) location (average of 14 species). Diversity was lowest at PC3 with 10 species recorded and is likely a product of this site having a smaller field of view than the other sites (Figure 10).

Introduced and *Not Threatened* indigenous bird species represented the majority of observations across site (and all observations at PC3 and PC4; Figure 10). As expected, pipit, an *At Risk* species that uses grassland as its primary habitat (the dominant habitat across the site) was observed at most sites. Bush falcon, a *Threatened* species was observed at three sites spread across the project area.

The total number of birds observed during the point count surveys was highly variable between point count locations. The highest total number of birds recorded was at PC4, with a total of 679 birds observed, and the lowest number of birds was recorded at PC3, with a total of 175 birds observed (Figure 11). Across all point count stations, the majority of birds observed were introduced species; the proportion of introduced birds observed between sites ranged between 84-95%, with an average of 92%. The proportion of *At Risk* and *Threatened* birds observed at each point count station was low and ranged between 0 and 1.9%, with an average of 0.7%.

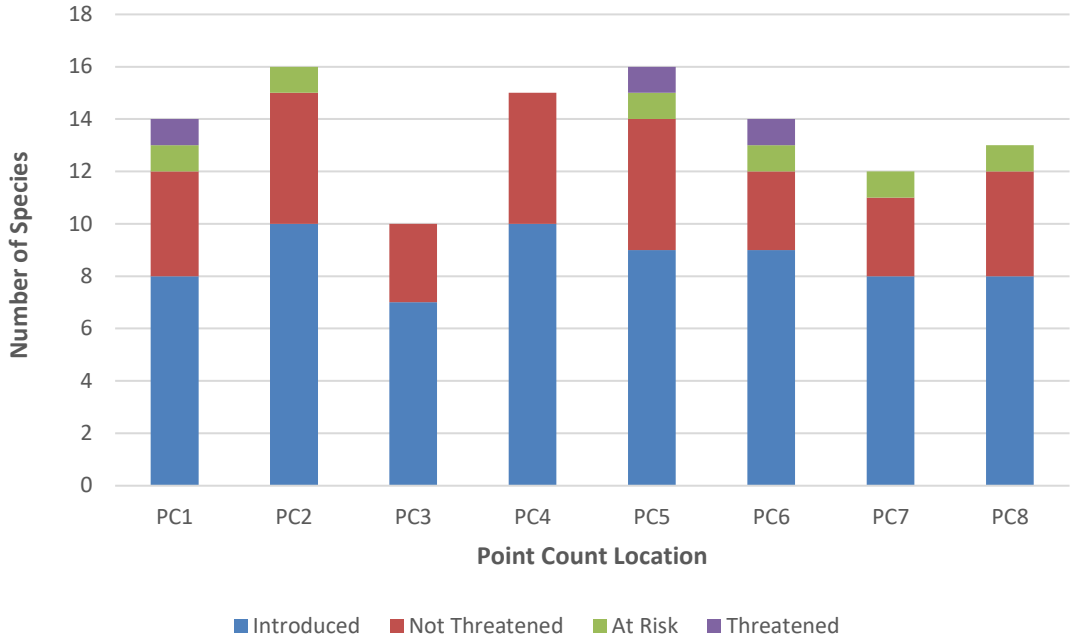


Figure 10: Total number of bird species observed at each point count location during the 2021-2022 wind farm point count surveys.

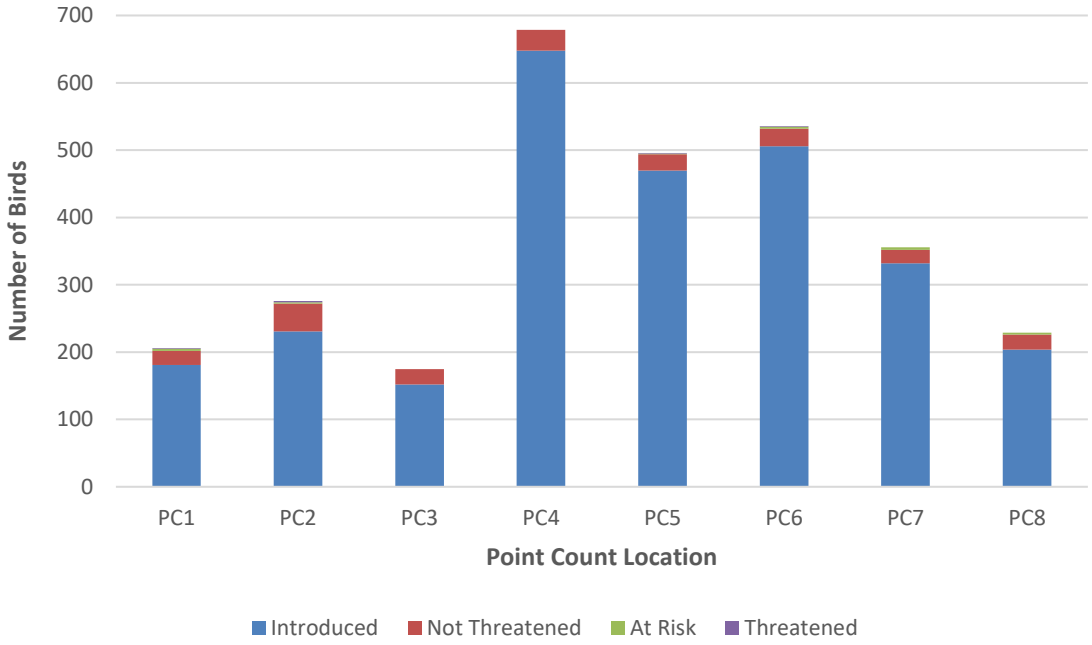


Figure 11: Total number of birds observed at each point count location during the 2021-2022 wind farm point count surveys.

5.5.1.2 Habitat Use

The primary habitats of species recorded during the point count surveys are represented visually in Figure 12. In this report, primary habitat refers to the habitat in which a species spends most of its time. It should be noted that this interpretation of primary habitat has been provided in order to present the data in a meaningful way but does not suggest that these species confine their use to a

single habitat type; information regarding the variety of habitats used by each of the species is provided above in Table 21.

The primary habitat of 61% of the species observed during the point count surveys is farmland and open country; the majority (71%) of these species are introduced. Farmland / open country is the primary habitat for one *At Risk* species, New Zealand pipit.

Twenty-six percent of the species observed use native forest (including bush falcon) or scrub / shrubland as their primary habitat; the majority of these species are indigenous, including one Threatened species (bush falcon).

As expected, based on the habitats present on site, very few species associated with freshwater, urban and coastal habitats were recorded (one species per habitat type; Figure 12).

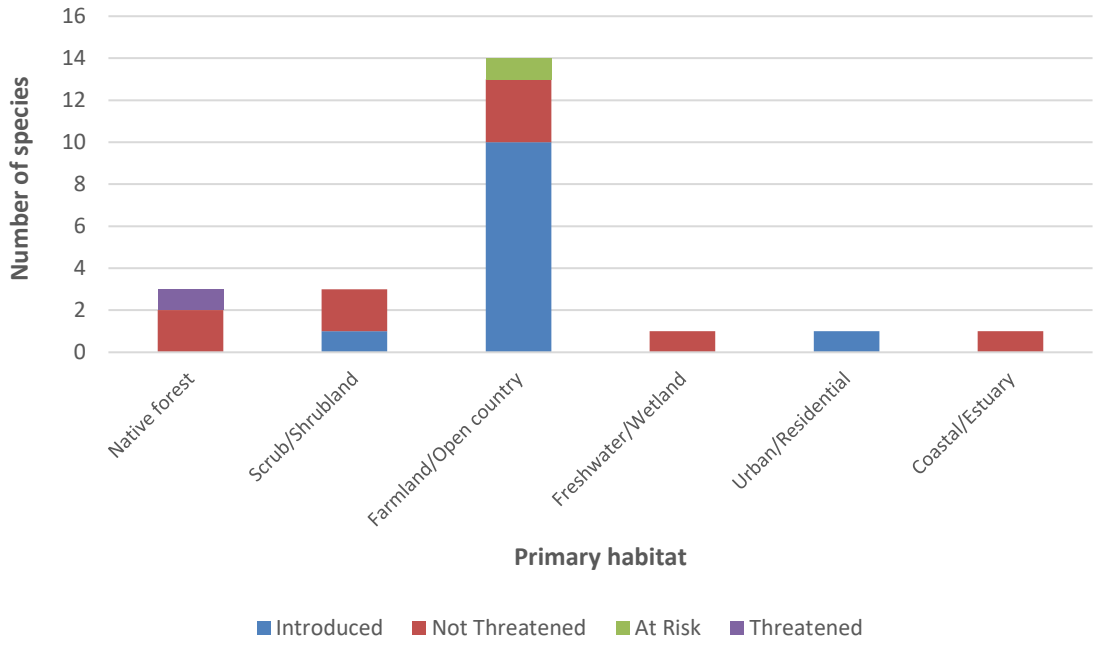


Figure 12: Primary habitat and conservation status of species recorded at the Mt Munro wind farm site during the 2021-2022 point count surveys.

5.5.1.3 Flight Heights

The flight heights of indigenous birds observed during the wind farm point count surveys are presented in Table 23 in relation to the zone within which the turbine rotors move (i.e. the zone within which birds are at risk from bird strike). 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 that is 24 m above the ground and an upper blade tip sweep of 160 m above the ground (this is based on a turbine blade with a 136 m and a hub height of 92 m). 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 flight risk for both the true RSA and the widened RSA. For the true RSA, birds observed flying between 24 m and 160 m at a relative height above the height of the observer, are considered to be at risk of collision. For the widened RSA, birds observed flying between 20 m and 170 m at a relative height above the height of the observer, are considered to be at risk of collision.

We note that the two grey warbler and two silvereye observations made during the point count surveys are excluded as they were heard calling during the counts but not seen (as such no flight heights could be recorded); however, behaviourally they are both low flying species that generally take short flights within vegetation and would not fly at heights that would put them at risk of turbine strike. Similarly, the one shining cuckoo observation is also excluded as it also was heard not seen. Likewise, three of the four two spur-winged plover observations are excluded. Based on general observations of spur-winged plovers and data collected from other wind farms, spur-winged plovers may fly within the RSA.

Table 23 shows that a number of the native birds observed on site were observed flying at heights that may potentially put them at risk of turbine strike. With regard to *Not Threatened* bird species observed on site, black-backed gulls and harrier hawks are most at risk of strike. With regard to *Threatene*d and *At Risk* species, all falcon observations were at a height that may potentially put them at risk of strike, whereas no New Zealand pipit flight observations were within the risk zone for the RSA and only 13% (2 observations) were within the risk zone for the widened RSA. Of note is that these two New Zealand pipit observations within the risk zone for the widened RSA had a maximum flight height of 20 m so were right on the minimum threshold of the risk zone (20-170 m).

Table 23: Native bird observations in relation to the rotor swept area (RSA, 24-160 m) and the widened RSA (20-170 m; widened to account for observer inaccuracies when estimating flight heights) during the fixed point-fixed period counts conducted in 2021-2022 at the proposed Mt Munro wind farm location.

SPECIES	CONSERVATION STATUS	TOTAL COUNT	TOTAL COUNT WITHIN RSA	% WITHIN RSA	TOTAL COUNT WITHIN WIDENED RSA	% WITHIN WIDENED RSA
Black-backed gull	Not Threatened	26	21	81%	21	81%
Bush falcon	Threatened – Nationally Increasing	5	5	100%	5	100%
Harrier hawk	Not Threatened	145	92	63%	95	66%
Kereru	Not Threatened	7	2	29%	2	29%
NZ pipit	At Risk – Declining	16	0	0%	2	13%
Welcome swallow	Not Threatened	16	5	31%	5	31%
Paradise shelduck	Not Threatened	5	3	60%	3	60%
Spur-winged plover	Not Threatened	1	0	0%	0	0%

5.5.2 Transmission line flight path surveys (2021-2022)

In total, 200 observations were made of the three target species during the 2021-2022 transmission line surveys, comprising 168 kereru, 21 falcon and 11 kaka (Figure 13). The maximum number of kereru, falcon and kaka observations made in any one session was 35 (November 2021, seven (April 2022) and four (September 2021) respectively.

Seasonally, the most kereru observations were made in autumn (n=54); observations in other seasons were reasonably similar (n=39 in spring, n=34 in summer and n=41 in winter). The most

falcon were observed in summer and autumn (n=9 for both seasons); few observations were made in winter (n=3) and spring (n=2). There were too few kaka observations to determine seasonal trends (Figure 13).

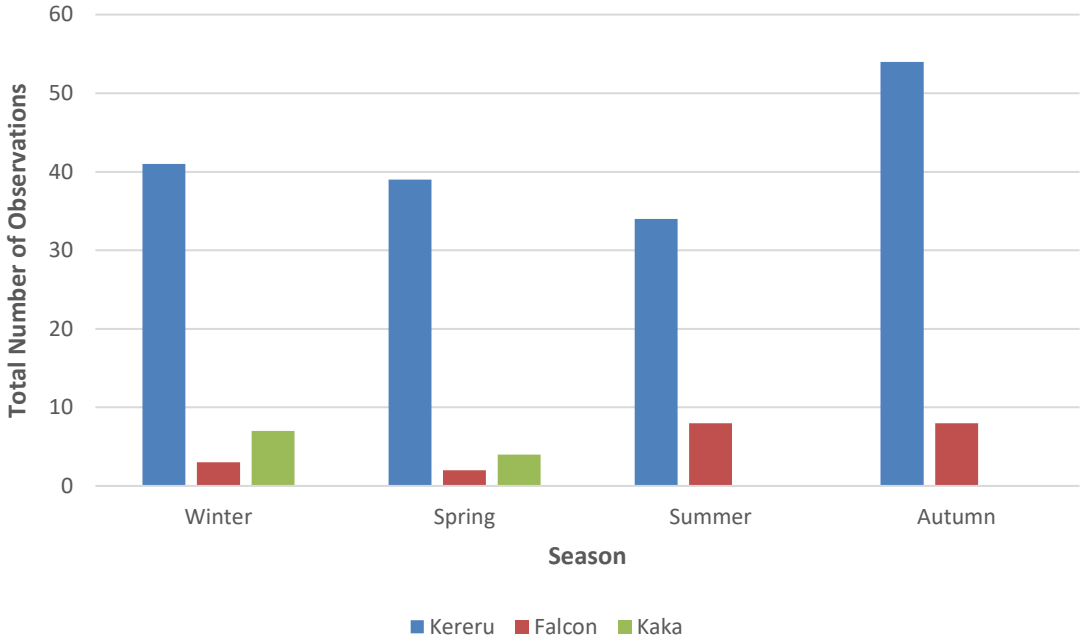


Figure 13: Seasonal records of NZ falcon, kereru and kaka during the Mt Munro transmission line monitoring.

The flight path data collected for NZ falcon, kereru and kaka are provided on Map 20, Map 21 and Map 22 respectively. In general, the main flight paths were short flights within the Mt Bruce forest block and traverses between this habitat and small, nearby fragments of vegetation in the surrounding landscape, such as the WA Miller Scenic Reserve north of SH1 and native and exotic vegetation along the riparian edge of Bruce Stream.

Ten percent (n=20) of the flight observations (comprising 10 falcon and 10 kereru) crossed the route of the proposed transmission line. Twelve of these observations were at a height where they may be at risk of collision with the transmission line (seven kereru and five falcon); this represents 4.2% of all kereru observations and 23.8% of all falcon observations (Figure 14).

We note that the transmission line is proposed to be 19 m above ground, but the risk zone was broadened to 17-21 m above ground to account for observer inaccuracies when estimating flight heights.

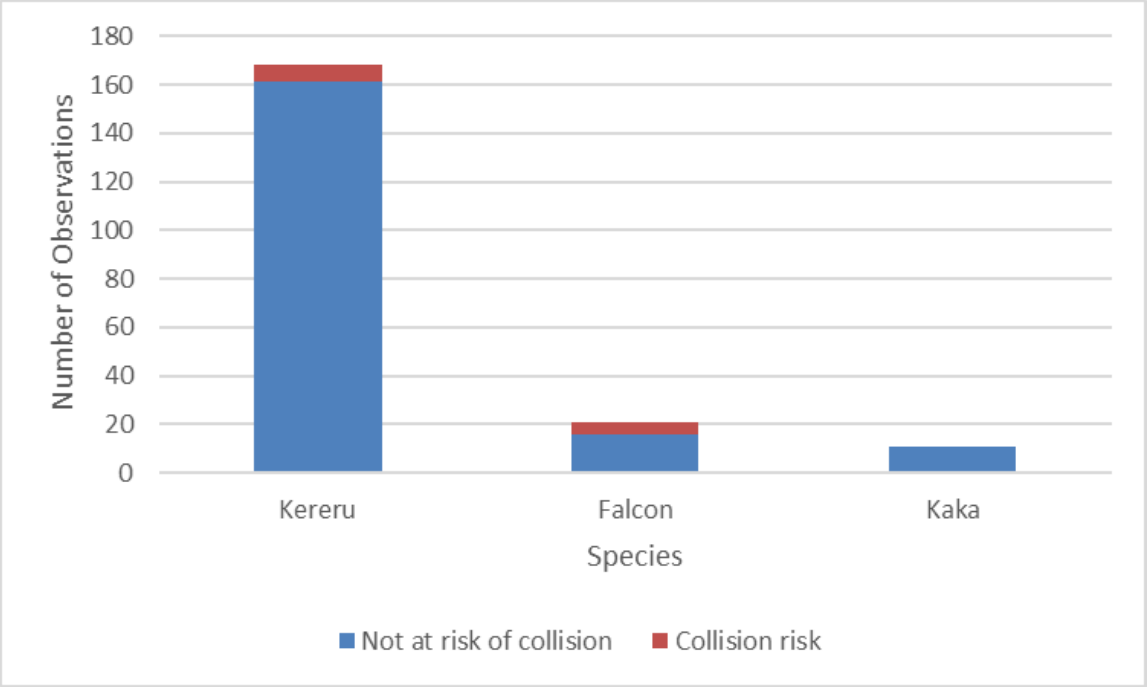
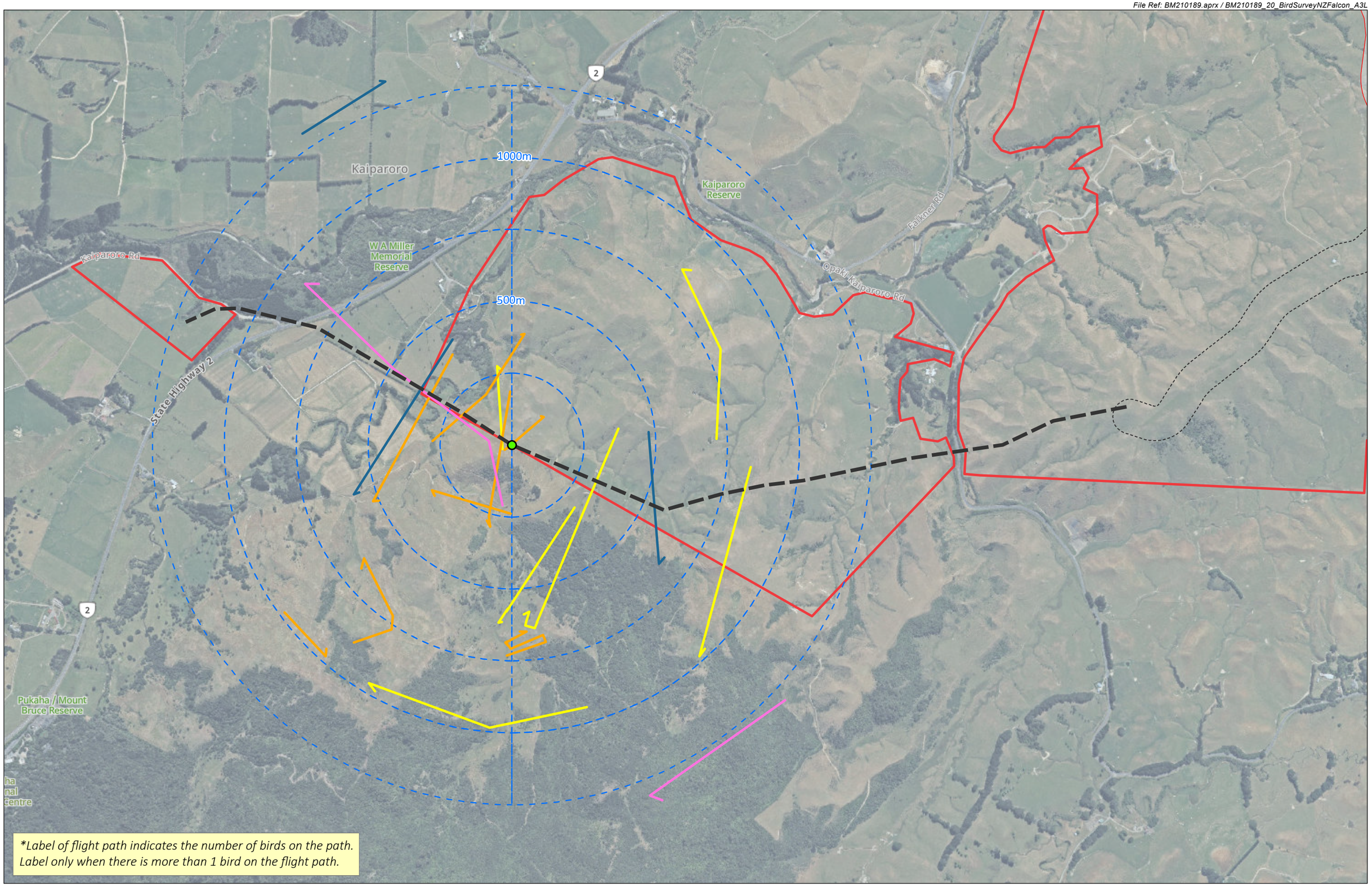


Figure 14: Collision risk for kereru, falcon and kaka observed during the 2021-2022 transmission line surveys at the Mt Munro wind farm site.



Label of flight path indicates the number of birds on the path. Label only when there is more than 1 bird on the flight path.

Boffa Miskell

www.boffamiskell.co.nz

0 200 m

1:12,000 @ A3

Data Sources: Eagle Technology, LINZ, StatsNZ, NIWA, Natural Earth, © OpenStreetMap contributors., Eagle Technology, Land Information New Zealand, GEBCO, Community maps contributors, BML

Projection: NZGD 2000 New Zealand Transverse Mercator

LEGEND

- Site Boundary (1)
- Transmission Line Route (1)
- Turbine Envelope Zone
- Turbine Exclusion Zone
- Transmission line monitoring site (1)
- Monitoring Zone

Flight Path (Bird Count)

- Spring (2)
- Summer (6)
- Autumn (8)
- Winter (3)

MT MUNRO WIND FARM ECOLOGY ASSESSMENT

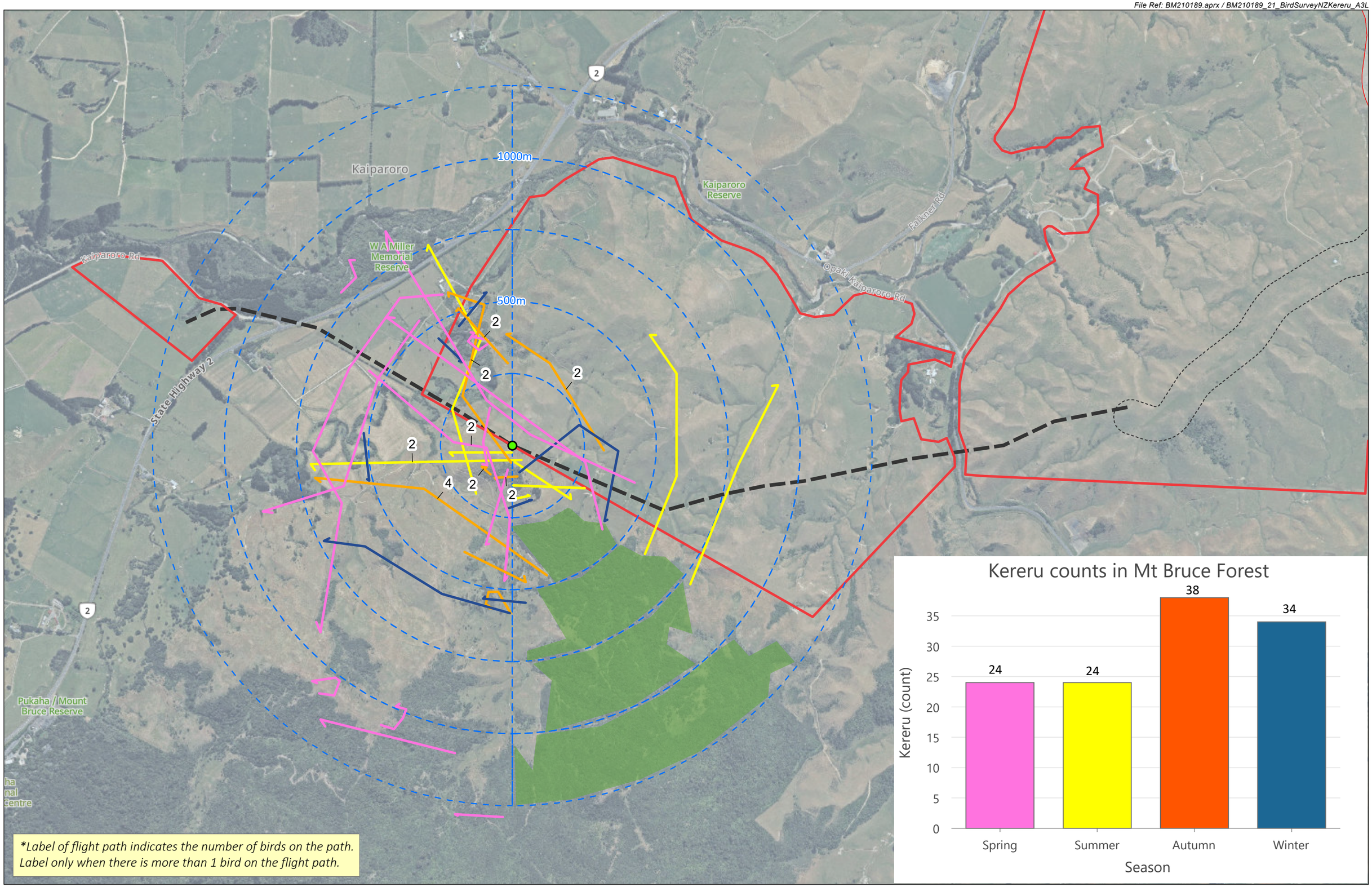
Transmission line survey (2021-2022): NZ Falcon

Date: 17 May 2023 | Revision: 1

Plan prepared for Meridian Energy Limited by Boffa Miskell Limited

Project Manager: Leigh.Bull@boffamiskell.co.nz | Drawn: KMa | Checked: LBu

Map 20



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Data Sources: Eagle Technology, LINZ, StatsNZ, NIWA, Natural Earth, © OpenStreetMap contributors., Eagle Technology, Land Information New Zealand, GEBCO, Community maps contributors, BML

Projection: NZGD 2000 New Zealand Transverse Mercator

LEGEND

- Site Boundary
- Transmission Line Route
- Turbine Envelope Zone
- Turbine Exclusion Zone
- Transmission line monitoring site
- Monitoring Zone

Flight Path (Bird Count)

- Spring (15)
- Summer (10)
- Autumn (16)
- Winter (7)
- Mt Bruce Forest (120)

MT MUNRO WIND FARM ECOLOGY ASSESSMENT

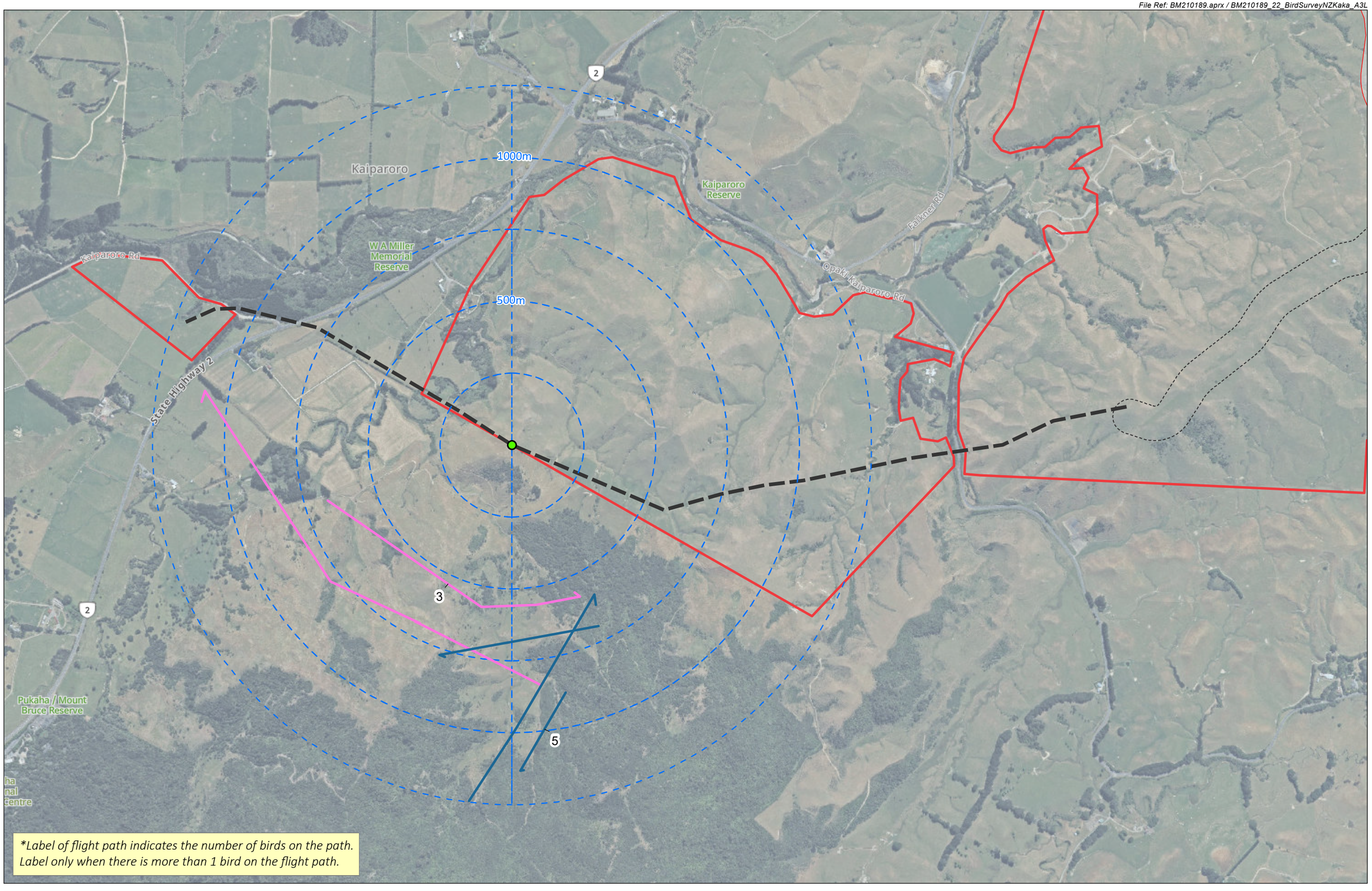
Transmission line survey (2021-2022): Kereru

Date: 17 May 2023 | Revision: 1

Plan prepared for Meridian Energy Limited by Boffa Miskell Limited

Project Manager: Leigh.Bull@boffamiskell.co.nz | Drawn: KMa | Checked: LBu

Map 21



*Label of flight path indicates the number of birds on the path. Label only when there is more than 1 bird on the flight path.

Boffa Miskell

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0 200 m

1:12,000 @ A3

Data Sources: Eagle Technology, LINZ, StatsNZ, NIWA, Natural Earth, © OpenStreetMap contributors., Eagle Technology, Land Information New Zealand, GEBCO, Community maps contributors, BML

Projection: NZGD 2000 New Zealand Transverse Mercator

LEGEND

- Site Boundary
- Transmission Line Route
- Turbine Envelope Zone
- Turbine Exclusion Zone
- Transmission line monitoring site
- Monitoring Zone

Flight Path (Bird Count)

- Spring (4)
- Winter (7)

MT MUNRO WIND FARM ECOLOGY ASSESSMENT

Transmission line survey (2021-2022): Kaka

Date: 17 May 2023 | Revision: 1

Plan prepared for Meridian Energy Limited by Boffa Miskell Limited

Project Manager: Leigh.Bull@boffamiskell.co.nz | Drawn: KMa | Checked: LBu

Map 22

6.0 Ecological Values

6.1 Terrestrial vegetation

The vegetation within the envelope is almost entirely improved pasture, compiled of exotic species. It is not representative of the estimated previous coverage. It is the most common vegetation cover in the district (Boffa Miskell Ltd, 2011b) and ecologically is valued as **Negligible** (this does not include the lower gully indigenous remnants).

Where other vegetation is present, it is in scattered edge amounts or standalone trees. While this does provide habitat and resources for some birds, it is not likely a relied upon source of food given the proximity of the site to large, protected areas such as Pūkaha/Mt Bruce. It is acknowledged that these remnant areas of gully vegetation provide a seed source for future regeneration opportunities, however in no case are central gullies with these indigenous woodlands being affected. In all, the vegetation on the site within the Turbine Envelope and Turbine Exclusion Zones is valued ecologically **Negligible**.

6.2 Wetlands

We do not value each and every natural wetland feature in the following analysis; rather, we group the four broad wetland types that were identified on the site. This is because in general, most of the mud sponges (for example) are the same species assemblages in slightly different situations and slightly different proportions. Thus, we assess the generic mud sponge, seepage slumps, stream terraces, and gully head and hollows as follows (Table 24).

Table 24. Mt Munro wetland ecological value assessment

CRITERIA[15]	GULLY MUD SPONGE	GULLY HEAD / HOLLOW	STREAM TERRACE	SEEPAGE SLUMPS
Representativeness	Low. Poor species richness, largely exotic, does not resemble any natural native wetland assemblage. Induced situation.	Negligible. Poor species richness, largely exotic, does not resemble any natural native wetland assemblage.	Low. Limited species richness, largely exotic, often grazed, does not resemble any natural native wetland assemblage	Negligible. Very limited species assemblage. Does not resemble a natural fen, marsh, or other native natural assemblage. Induced by farming.
Rarity and distinctiveness	Negligible. Common, not rare or threatened taxa. These hill slope features are very common in the ED.	Negligible. Common, not rare or threatened taxa. These hill slope features	Negligible. Common, not rare or threatened taxa. These hill slope features	Negligible. Common, not rare or threatened taxa. These hill slope features are very common in the ED.

[15] As outlined in Appendix 2

CRITERIA[15]	GULLY MUD SPONGE	GULLY HEAD / HOLLOW	STREAM TERRACE	SEEPAGE SLUMPS
		are very common in the ED.	are very common in the ED.	
Diversity and pattern	Negligible. Very uniform.	Negligible. Simple limited gradients or plant responses.	Low. Reflecting sediment accrual, stream flow and flood patterns, but very limited mosaic.	Negligible. Simple uniform state and pattern.
Ecological context	Low. Some filtration and sediment entrapment.	Negligible. Small, often isolated or disjunct, no wetland functions of note.	Low. Some filtration in floods, supports retention of stream flow in a minor way.	Negligible. Too small and diffuse to have any wetland functions.
OVERALL VALUE	**Negligible**	**Negligible**	**Negligible**	**Negligible**

There are no natural inland wetland values on site greater than **Negligible** ecological value. All of the features are simple, uniform, exotic dominated and exist on artificial induced wet sediment trapped in old stream channels or pasture-seepages. None of the features bare any resemblance to a comparable indigenous fen, marsh or seepage assemblage. The only wetland "functions" are the retention and filtration of hill country rain runoff, but this is limited by size and current fullness of the gullies. Also, there is minimal stream habitat protected by these gullies from such runoff.

6.3 Freshwater

Ecological values of the freshwater systems on site were assessed for the Makakahi catchment (excluding Bruce Stream), the Kopuaranga catchment and Bruce Stream[16]. Specific details for each of the assessment criteria are provided in Appendix 6, and summarised in Table 25 below.

Table 25: Summary of the ecology value of each assessed catchment/sub-catchment system

CRITERIA[17]	MAKAKAHI TRIBUTARIES	MANGAROA STREAM	BRUCE STREAM MAIN STEM	BRUCE STREAM TRIBUTARY	KOPUARANGA TRIBUTARIES
Representativeness	Moderate	Moderate	Low	Moderate	Moderate
Rarity & distinctiveness	Low	Low	Low	Moderate	Low
Diversity and pattern	Low	Low	Low	Moderate	Low

[16] Bruce Stream was assessed separately given the condition and divergence in land-use compared to the other streams within the Makakahi catchment.

[17] As outlined in Appendix 2

CRITERIA[17]	MAKAKAHI TRIBUTARIES	MANGAROA STREAM	BRUCE STREAM MAIN STEM	BRUCE STREAM TRIBUTARY	KOPUARANGA TRIBUTARIES
Ecological context	Very Low	Low	Moderate	Moderate	Very Low
Ecological integrity	Low	Low	Low	Moderate	Low
OVERAL ECOLOGIAL VALUE	**Low**	**Low**	**Low**	**Moderate**	**Low**

6.4 Herpetofauna habitat

There are challenges with confirming the presence or absence of low densities of lizard species; therefore, in this current assessment the habitats have be valued as a proxy, based on their likelihood of supporting stable lizard populations.

The dominating grazed pasture on the site is considered unsuitable as lizard habitat, and so is considered to be of **Negligible** value.

The rock outcrops and scattered boulderfields within the potential footprint were surveyed and found to have insufficient refugia (due to embeddedness and/or lack of cavities) to support lizard populations. These are also heavily disturbed by grazing. They are also considered to have **Negligible** value.

The regenerating native scrub present within the project footprint is young, isolated within a wider landscape of grazed pasture, and is grazed throughout. There is little or no ground layer to provide habitat for terrestrial skinks, and it is considered very unlikely that arboreal lizards would have been able to colonise these areas. It is also worth considering that there is no pest control in any of these areas, which is known to be a significant factor in the presence and densities of arboreal species. The regenerating native scrub within the footprint is considered to have **Low** value as lizard habitat.

The ornamental garden to the north-west of the site (the northernmost ACO survey location on Map 19) does have potentially suitable habitat for a number of terrestrial lizard species, in small, unmanaged, grassy areas at the margins of an otherwise well managed garden. No lizards were observed here during surveys, so it is expected that if they are present, they are in very low numbers. Given the small area of the potential habitat and the lack of lizard observations, this area is considered to have **Low** value as lizard habitat.

The rank grasslands/weedlands along the road margin at the western end of the transmission line are the only habitat where lizards have been observed, albeit in low densities (only two observations across 180 ACO “trap nights”). This habitat is subject to regular disturbance (including mowing and weed control) and are unlikely to support sensitive species; it is considered likely that only northern grass skink would inhabit these areas, in what appears to be reasonably low densities. Overall, this area is considered to have **Low-Moderate** value as lizard habitat.

6.5 Avifauna

The ecological value of avifauna present, or potentially present on site, is presented in Table 26.

Table 26: Ecological value of avifauna species present, or potentially, present on site.

SPECIES	CONSERVATION STATUS	ECOLOGICAL VALUE
Long-tailed cuckoo	Threatened – Nationally Vulnerable	Very High
Bush falcon	Threatened – Nationally Increasing	Very High
New Zealand pipit	At Risk – Declining	High
North Island kaka	At Risk – Recovering	Moderate
Various indigenous species (n=16)	Not Threatened	Low
Various exotic species (n=20)	Introduced	Negligible

6.6 Summary of ecological values

A summary of the ecological values identified on the project site are provided in Table 27 below.

Table 27: Summary of values assigned to ecological entities on or associated with the Mt Munro project

ECOLOGICAL ENTITY		ECOLOGICAL VALUE ASSIGNED
TERRESTRIAL VEGETATION	Pasture	Negligible
	Scattered treelands	Negligible
WETLANDS	Gully mud sponge	Negligible
	Gully heads / hollows	Negligible
	Stream terraces	Negligible
	Steep hill seepage slumps	Negligible
FRESHWATER	Makakahi tributaries	Low
	Mangaroa stream	Low
	Bruce stream main stem	Low
	Bruce stream tributary	Moderate
	Kopuaranga tributaries	Low
HERPETOFAUNA HABITAT	Grazed pasture	Negligible
	Rock outcrops & scattered boulderfields	Negligible
	Regenerating native scrub	Low
	Rank grasslands / weedlands	Low-Moderate
AVIFAUNA	Long-tailed cuckoo	Very High
	Bush falcon	Very High
	New Zealand pipit	High
	North Island kaka	Moderate
	Native Not Threatened species (n=16)	Low
	Introduced species (n=20)	Negligible

7.0 Summary of Ecological Significance

7.1 Terrestrial vegetation

With regard to the terrestrial indigenous vegetation communities occurring on the wind farm site, their fragmented nature and species composition means that none of these trigger the Horizon's criteria for being Rare, Threatened or At Risk (i.e. Schedule F) and as such are not significant.

7.2 Wetlands

We do not, for any of the Ca 44 natural wetland features, consider them to be "natural" wetlands as a matter of fact. This is supported in the definitions Natural wetland foot note in the PNRP ("*ecosystems and habitats with significant indigenous biodiversity values managed under Policy P42*"), and by Schedule F of the One Plan F1 and F2, based largely on the absence of indigenous biological diversity. In Table 28 below we have tested the Mt Munro "natural" wetlands against the One Plan Schedule F1 criteria for identifying *Threatened* or *Rare* habitat within region. Our analysis shows that none of the Mt Munro natural wetlands meet these criteria. These findings negate the need to further interrogate Schedule F2 of the One Plan.

Table 28: Consideration of the relevant wetland types in the One Plan Schedule F1 (comprised predominantly of indigenous species) in relation to those identified on the Mt Munro site

SCHEDULE F1 NAME	DESCRIPTION	MT MUNRO 'WETLANDS'
Ephemeral wetland: Wetland that supports indigenous turf (<3 cm tall) species, indigenous* rushland* and indigenous* scrub*, and are most frequently found in depressions	Ephemeral wetlands are found on sand country (although they also occur elsewhere) and may comprise a mosaic of indigenous vegetation and bare sand. Fluctuations between aquatic and terrestrial plant species often occur and exotic species are frequently present.	Not sand country, all features recognised have more permanent water supplies, vegetation is largely exotic. None present on site.
Bog wetlands: These support indigenous mosses, lichens, cushion plants, sedges, grasses, restiads, ferns, shrubs and trees and are formed on peat with rainwater the only source of water.	Bog wetlands can be found on relatively level or gently sloping ground including hill crests, basins, terraces and within other wetland classes. Bog wetlands are nutrient poor, poorly drained and aerated, and usually acid. The water table is often close to or just above the ground surface.	There are a number of moss cushions in a few mud sponges on more solid ground, but none are on peat, all are spring fed, not just rain fed. All are high nutrient not low nutrient, are generally on steep slopes, and are not notably acidic, although some of the muds are poorly aerated. No bogs present on site
Fen wetlands: Support indigenous restiads, sedges, ferns, tall herbs, tussock grasses and scrub and are on predominantly peat. Fen wetlands	Fen wetlands can be found on slight slopes (e.g., fans), toes of hillsides, or on level ground without much accumulation of peat. Fen wetlands can grade into swamp wetland. Fen	Steep slopes (aside from some lower gully areas), no peat, a mosaic of indigenous / native species, but mostly exotic.

SCHEDULE F1 NAME	DESCRIPTION	MT MUNRO 'WETLANDS'
receive inputs from groundwater and nutrients from adjacent mineral soils.	wetlands are of low to moderate acidity and fertility and the water table is usually close to or just below the surface.	Possible fen but unlikely due to the level of exotic cover
Pakihi wetlands: These support indigenous restiads, sedges, fernland, shrubland and heathland. Pakihi are rain-fed systems on mineral or peat, or mature, skeletal soils.	Pakihi wetlands can be found on level to rolling or sloping land in areas of high rainfall. Pakihi wetlands are of very low fertility and low pH and are frequently saturated, but can be seasonally dry.	Not predominantly indigenous sedges etc. Too steep, too fertile, wrong species assemblages. No Pakihi wetlands present on site.
Seepage and spring wetland: Seepage wetlands support indigenous sedgeland, cushionfield, mossfield or scrub, occur on slopes, and are fed by groundwater.	A spring wetland occurs at the point that an underground stream emerges at a point source. Seepage and spring wetlands are often small and can occur as isolated systems or in association with other wetland types. The volume of water within a seepage system is less than that within a spring system. Seepage and spring wetlands are dominated by indigenous species, but exotic species can also be present.	Most gullies appear to have at some point an emergence of water form under the ground. The features present are not indigenous dominated. Exotic examples of seepages are present. Most of the springs present are subsumed by fens.
Swamp wetland: Swamp wetlands support indigenous sedges, rushes, reeds, flaxland, tall herbs, herbfield, shrubs, scrub and forest.	Swamp wetlands are generally of high fertility, receiving nutrients and sediment from surface run-off and groundwater	Not indigenous dominated and wrong species (grasses and herbs) assemblages to represent swamp although sediment levels and fertility does fit the swamp profile.
Marsh wetlands: Marsh wetlands are mineral wetlands with good to moderate drainage that are mainly groundwater or surface water fed and characterised by fluctuation of the water table.	Standing water and surface channels are often present, with the water table either permanently, or periodically, above much of the ground surface.	Little to no standing water, channels uncommon or absent, water levels too seasonally varied and vegetation still predominantly exotic. No marshes present on site.

In regard to the PNRP, Policy 42 reflects that natural wetlands only automatically trigger significance if they are predominantly indigenous.

> Policy 42 (Ecosystems and habitats with significant indigenous biodiversity values) –
> Note- *"All natural wetlands in the Wellington Region are considered to be ecosystems and habitats with significant **indigenous biodiversity** values as they meet at least two of the criteria listed in Policy 23 of the Regional Policy Statement 2013 for identifying indigenous ecosystems and habitats with significant indigenous biodiversity values; being representativeness and rarity.*"

Thus, no wetland identified on site can be considered a significant natural wetland.

7.3 Freshwater

As noted in Section 5.3 above, Schedule B of the Horizons One Plan identifies aquatic, riparian and cultural “sites of significance”. As part of Schedule B the headwaters of the Makakahi River as well as Bruce stream (upstream of the site) are identified as a Site of Significance – Aquatic for shortjaw kokopu. Additionally, under Schedule B the Makakahi River (but not the tributaries within the site) is identified as have Trout Spawning Value.

Under Schedule I of the PNRP (2019), GWRC identifies the Kopuaranga River as an important trout fishery river.

However, none of the values which have caused this Council evaluation are present or in force in the headwater tributaries of any of these main stem systems on the project site, and as such no tributary on site is considered to be “significant” freshwater habitat.

8.0 Assessment of Potential Ecological Effects

8.1 Terrestrial Vegetation

8.1.1 Construction - Physical loss of vegetation

The potential effects of the Mt Munro project on terrestrial vegetation relate to the permanent loss under the footprint during construction. The amount and composition of terrestrial vegetation located within the Turbine Envelope and Turbine Exclusion Zones, and therefore potentially lost, is outlined in Table 11 (and Map 9); approximately 97% of the terrestrial vegetation within the project footprint is pasture. One area of non-pasture vegetation which is affected will be the riparian vegetation of one of the lower Makakahi tributaries which will have small areas removed on either side for the installation of the bridge abutments.

The pasture on site is extremely common, not just on site and in the region, but throughout the entire country, and ecologically provides little function or habitat, and is a highly modified, exotic-based community not representative of previous forest communities. When assessed at the catchment scale, this loss of pasture does not appear significant or impactful upon the wider communities. The single trees and shrubs within the footprint, when taken with the context of the nearby significant areas of vegetation show that there is preferable nearby habitat and seed source. Those native vegetation species present are locally common, and not representative.

With respect to the Makakahi tributary, around 200 square meters of upper riparian vegetation may be required to be removed (100m^2 either side). This vegetation is a mix of exotic weeds (wattle, blackberry, gorse, broom) and native serial species: mahoe, karamu, tree fern and bush lawyer). This level of clearance does not even sum to a 1% of the local mixed exotic native riparian vegetation (within 500m). There is an appreciable extent of riparian vegetation down the slope to the stream which is not affected. We deem the magnitude of effect to this riparian area to be negligible, without functional issue, and while ethe value is greater than the pasture (ecologically) it is no more than moderate. This effect then equates to a **Very Low** level.

The overall effects upon terrestrial vegetation associated with the Mt Munro project are considered **Very Low**, based on Negligible value and a Low magnitude of effect.

8.1.2 Operational effects

There are not expected to be any effects from wind farm operation on terrestrial vegetation.

8.2 Wetlands

With respect to natural inland wetlands, the potential adverse effects are primarily related to some areas of infill for the roading, and the potential for surface discharges of stormwater containing sediments during construction, or changes to the hydrology of those features because of diversions or land shape changes that cause redirection of surface water. The hydrology changes, if they

occur, could lead to a drying effect in at least the upper portions of those natural inland wetlands affected. A drying effect may result in the loss of natural inland wetland state.

The other adverse effect is infilling of natural wetland resulting in a loss of extent, where and if earthworks and infrastructure overlap with areas of natural inland wetland.

Once the roading network is established, and given where the turbines are to be located, there will be no operational effects to natural inland wetlands.

We have identified (in both the windfarm site and transmission line) Ca. 44 natural inland wetlands. Of those 44, 6 lie under proposed infrastructure and 6 lie within 50m of the infrastructure, the rest are within 100m but outside of the 50m zone. These are label yellow (within 100), orange (within 50) and red (under infrastructure) in Maps 11-13.

The gullies, which in part or in whole contain natural inland wetlands that are within the 100 m of the Turbine Envelope and Turbine Exclusion Zones could potentially receive earthworks generated sediments or incur a hydrological change in the wetlands.

8.2.1 Construction - Physical loss of wetlands

There are six natural wetland features (identified in Map 13 as red features) that are within the consent envelope (on the likely road alignment) and exclusion zone. As such, we have assumed that these will be directly impacted through filling and loss. This area of wetland directly impacted sums to approximately 0.32 ha of low quality (**Negligible** value) exotic dominant natural inland wetland.

Then there are six natural inland wetland features that are within 50m of the current road alignment, but which do not lie underneath the road but may be within a berm or construction affected area. These sum to 0.84 ha of natural inland wetland.

The total area of natural wetland within the 100 m zone of the Turbine Envelope and Turbine Exclusion Zones is 3.26 ha; at the scale of the wetland survey area, 9.8% of the natural wetlands identified will be lost. We only have this close proximity total because the assessment does not cover the entire gully wetlands the length of the hills or the entire farm or landscape or Ecological District. At any of these wider and more appropriate scales, the magnitude of effect of this loss of the six small natural wetland areas would be much less than 1%. This level of loss we assess as being of a Negligible magnitude, which combined with Negligible value of the features results in a Very Low level of effect overall.

Such a Very Low level of effect does not require management and can be accepted without any loss of indigenous biological diversity or meaningful loss of wetland function on site (discussed further in Section 9.2 below). We do not consider the NPS FM's direction to Councils to avoid the loss of extent of natural inland wetland to refer to therse types of "wetland".

8.2.2 Construction - Potential effects of sediment discharges

Hill country sheep farming in New Zealand normally releases a level of sediment into its gullies and streams every year, and in noticeable amounts under heavy rains; research suggests that between 900 and 3200 Kg/ha/yr can be expected (Quinn & Stroud, 2002). This has meant that most

waterways and waterbodies over the last 200 years in farmed landscapes have experienced considerable sedimentation, and the current flora and fauna have adapted to that benthic change and persistent frequent suspended sediment loading.

At Mt Munro, all of the gully wetland features (described in Sections 5.2.1.1 and 5.2.1.2 above) are a product of land-based sediments being channelled to and caught up in those gullies, allowing water to be retained and wet grasses and herbs to grow (holding the sediments). The seepage slumps and hollows (described in Sections 5.2.1.4 and 5.2.1.2 respectively) are likewise sediment developed. There are no peat or mineral substrates, only recent sediment and organic material related wetlands on site. This means that where the various earthwork defences fail, if they do, and depending on the degree of failure, a worst-case scenario would see a level of sediment discharged to lower slope gully mud sponges and wetlands, but likely only one or two over the 60 or so present on site.

We note that there are Ca. 44 natural wetlands within a 100 m range of potential earthworks. Such a discharge could cover over an area of a mud sponge (for example) smothering the existing vegetation. This, for a period of months, would remove that portion of the wetland. After several months the sweet blue grass and dwarf montia, as well as the Yorkshire fog, creeping buttercup and chickweed will re-establish, and the wetland will recover to its existing state.

Because of the type, nature, location and history of the wetlands present, sediment discharge is both the reason why they are present but also why there is no ecological concern over such a process involving repeat sedimentation and recolonisation of the largely exotic wetland species present.

In any case the sediment management process (Ridley Dunphy, 2022) puts in place a range of sediment defences and predicts that the loss of sediment will be infrequent and minor.

Based on the above, we consider the overall effects of potential sediment discharges during construction on the natural wetlands to be **Very Low** given the Negligible value of the wetlands and a Low magnitude of effect.

8.2.3 Construction - Potential effects of hydrological change

Given all of the wetlands identified on site are down gradient of most earthworks, the potential for there to be drainage caused by those earthworks highly unlikely.

The only potential of the proposed works to change any wetland feature would be the installation of diversion of clean water away from the earthworks locations which might then divert water away from any wetland; and any earthworks that changes the ground surface such that rain fall direction is changed away from any wetland feature. Both are unlikely effects which can be managed by ensuring that worked surfaces will continue to discharge surface flows to the same sub-catchments and that diversion drains also still deliver clean water to the same sub-catchment after passing the open works area.

Thus, on the assumption of clean water discharge location management during and post-earthworks, we consider the potential overall effect of hydrological changes to be **Very Low** based on the Negligible value of the wetlands and a Negligible magnitude of effect.

8.2.4 Operational effects

There are not expected to be any effects from wind farm operation on wetlands.

8.2.5 Summary of potential effects

A summary of the potential effects on freshwater values, as assessed in the proceeding sections, is provided in Table 29 below.

Table 29: Summary of the potential overall effects on natural wetlands.

POTENTIAL EFFECT	WELTAND VALUES	MAGNITUDE OF EFFECT	OVERALL LEVEL OF EFFECT
Physical loss of wetlands	Negligible	Negligible	Very Low
Sediment discharges	Negligible	Low	Very Low
Hydrological change	Negligible	Negligible	Very Low
Operational	Negligible	-	-

8.3 Freshwater

The following potential construction and operational phase effects (both direct and indirect) were considered for this assessment:

- Loss of stream habitat (culverts / infilling)
- Sediment release during construction
- Contaminant release during construction
- Impediment to fish passage

8.3.1 Construction - Loss of aquatic habitat

8.3.1.1 Culvert replacement of aquatic habitat

Given the access required to build and maintain the turbines, the access ways across the site will require upgrades and a new route which will involve installing or upgrading existing culverts.

The proposed road passes over the Makakahi yard tributary at two locations, one a new culvert (30 m) the other an upgrade of an existing one and appears to require around 10m of benthic habitat loss. The proposed road then will likely require two culverts in the Mangaroa side tributary (total of Ca. 210 m) to cross one of the Mangaroa side tributaries (survey site MAG2). There will also be a bridge crossing at around survey site MAK1 which will cause no loss of aquatic habitat.

The crossing of one of the Mangaroa tributaries sub-tributary (the survey site MAG2) will be culverted (at two locations of crossing (210 m)) for the purposes of an access road. The system here is perennial and upland bully have been recorded present (refer to Table 19 on page 52) as well as a good macroinvertebrate community although the system is assessed as of low value. The affected sub tributary is 3000 m in length, for which the 210 m long pair of culverts represent 7% loss of aquatic benthic habitat.

This loss of aquatic habitat effect equates to a Low magnitude of effect at the local (sub catchment) scale, but a Negligible magnitude of effect at the larger Mangaroa tributary scale. We consider the Mangaroa catchment the most relevant test scale (not the sub-catchment) and on this basis, there will be a Low magnitude of effect on the Mangaroa tributary (low value), which results in a **very Low** overall level of effect. That said continued stream loss (and fish passage disruption) have strong directives in national and regional policy (NPS FM (2020)) to be avoided (see below).

There will also be an additional length of culvert installed in one of the un-named tributaries to the Makakahi which is north of MAK 1 survey site and runs through the farm stock yards and sheds (Makakahi yards tributary). This stream is more linear wetland than open flowing stream and has elements of both a gully mud sponge and open flowing stream. An approximately 10m long culvert is proposed and following NES culvert installation guidance will ensure fish passage, not that fish are likely in the headwater. The extent of "wetland" loss that will occur is negligible and the value of such a linear mud sponge water cress feature is very low as a wetland or low as a stream habitat, meaning an effect in level of very low.

The level of effects to the specific waterways are summarised in Table 30.

Table 30. Effect level outcome for affected stream where loss of habitat may occur.

CATCHMENT OR SUB - CATCHMENT	ECOLOGICAL VALUE	MAGNITUDE OF EFFECT	LEVEL OF EFFECT
Makakahi yards tributary	Low	Negligible	Very Low
Mangaroa tributary	Low	Low	Very Low
Bruce Stream tributary	Moderate	None	-
Bruce Stream main stem	Low	None	-
Kopuaranga	Low	None	-

8.3.2 Construction - Sediment release

Two aspects of the construction phase have the potential to release sediment into the various aquatic systems: constructing the access tracks and the turbine platforms.

We have assumed good practice erosion and sediment control measures will be implemented during the construction phase of the wind farm (as outlined in RidleyDunphy (2022)). This includes an assumption that excavated material will not be side-cast into any ephemeral, intermittent, or perennial watercourse. RidleyDunphy (2022)conclude that sediment loss affecting receiving environments will be minor and unlikely. However, there remains a residual risk, especially during adverse weather events, of these controls being compromised and extraneous material entering the aquatic system(s). Currently, all waterways have a natural level of fine sediments as part of the stream substrate. It is therefore unlikely any fine sediment discharge would cause a measurable change to the physical benthic condition. Furthermore, the macroinvertebrate community composition is reasonably good, indicating the community is well adapted to sediment loading, including the addition of new sediments during high flow events (Quinn & Stroud, 2002) for measured levels of sediment in waterways on rural hill country).

BML has measured discharge events in rural land uses across New Zealand over the last 20 years and they are typically between 100 and 1000 NTU (and up to 3000 NTU) in an event. NIWA in a report on a number of Bay of Plenty systems measured annual event turbidity's and they ranged from five to a little over 1500 SSC (mg/l) and typically several 100 (Hicks et al., 2019). A raised level of several 100 NTU is not at all adverse to sediment experienced New Zealand benthic assemblages in a rain event. Fish and invertebrates have a range of adaptive techniques to reduce dirty water impacts and do not suffer physically until nearer 10,000 NTU for fish (Rowe, 2002) and 20,000 NTU for most invertebrates (Suren et al., 2005). The pattern of reduced communities is related more to the streams' total loading of sediment over a long period, as opposed to any one event, with a greater loading of sediment correlated with fewer species of fish (Richardson & Jowett, 2002).

While New Zealand streams should, and in native forests do, sustain a lower NTU / sediment in suspension rise in rain events (from 1-50 NTU), these streams are now rare and generally in conservation land. It is these "naive" streams (with numerous sensitive species) that suffer the damage and change reported by Blöcher et al. (2020), when faced with more than a 20% rise in sediment deposition. Other impacts are not obvious; for example, pastural streams have often better (richness, abundance, density) benthic macroinvertebrate assemblages than those of nature tussock grassland streams (relating to nutrient inputs) despite greater sediment loading in the pastural situation (Matthaei et al., 2006). Likewise a range of species increase in abundance after sediment deposition, some of them EPT taxa, and it is often only Deleatidium that are reduced (Magbanua et al., 2013). We see this in the Mt Munro streams, with relatively high species richness but low EPT taxa richness (refer to Table 15 on page 48).

The only *Threatened* or *At Risk* fish species recorded within the potentially affected waterways is the longfin eel (At Risk - Declining); this species can tolerate a range of habitats, including systems with high fine sediment components as evidenced by their presence in both catchments on site.

Any sediment release into the streams during construction is expected to have a Low magnitude of effect on the Low or Moderate freshwater values that are present; thus resulting in a Low to Very Low overall level of effect (Table 31).

Table 31. Summary of potential overall level of adverse effects on the assessed streams from a substantive sediment discharge event

CATCHMENT OR SUB - CATCHMENT	ECOLOGICAL VALUE	MAGNITUDE OF EFFECT	LEVEL OF EFFECT
Makakahi	Low	Low	Very Low
Mangaroa	Low	Low	Very Low
Bruce Stream tributary	Moderate	Low	Low
Bruce Stream main stem	Low	Low	Very Low
Kopuaranga	Low	Low	Very Low

No measurable operational effects are expected as the tracks are proposed to be lined with loose metal (or sealed) and will not discharge sediment beyond what is already, and typically, released on farmed land.

8.3.3 Construction - Contaminant release

As outlined above in Section 2.10 (page 7), a 30,000 litre diesel tank is proposed within the Turbine Envelope or Turbine Exclusion Zones. We have assumed that it will not be located, nor will machinery be refuelled, within 50 m of any waterway. On this basis, we consider the potential for fuel spills into the waterways to be highly unlikely.

Contaminant runoff in the form of concrete (powder or slurry), though rare in occurrence, is the most likely contaminant that could be released during construction for the project. It is assumed measures will be in place (similar to erosion and sediment control measures) to completely isolate downstream / downslope aquatic systems from any area where concrete is being used or stored or made, including at any concrete batching locations.

Lime (which is a major component of cement) is readily and easily soluble in water and increases the pH of the water to 11-13. Most freshwater fauna cannot tolerate pH >10, meaning high alkalinity from concrete (lime) discharges is fatal to aquatic fauna. The possible effect relates mainly to a large change in the pH of the receiving aquatic environment. Potential diluting on concrete inputs only exacerbates the problem as lime particles/pollutants dissolve and spread, increasing the pH throughout (i.e. the water is not readily returned to neutral / pH 7). Most fish mortality cases from concrete discharges relate to eel populations. However, adverse (including mortality) affects from high pH is expected on all aquatic fauna (other fish and macroinvertebrates) from excessive stress.

Therefore, though unlikely, a concrete discharge event to any intermittent or perennial system can be expected to have a High magnitude of effect on aquatic fauna (predominantly the macroinvertebrate communities). Based on the ecological values of the waterways, the overall level of potential effect ranges between Low to Moderate (Table 32). We note however, that any such effect would be short term and would be resolved through natural remedial processes within six months of any such event.

Table 32: Summary of potential overall level of adverse effects on the assessed streams from a concrete discharge event

CATCHMENT OR SUB - CATCHMENT	ECOLOGICAL VALUE	MAGNITUDE OF EFFECT	OVERALL LEVEL OF EFFECT
Makakahi	Low	High	Low
Mangaroa	Low	High	Low
Bruce Stream tributary	Moderate	High	Moderate
Bruce Stream main stem	Low	High	Low
Kopuaranga	Low	High	Low

8.3.4 Impediments to fish passage

Culverts function to convey water under constructed roading or areas of fill and where installed correctly generally do not interrupt fish passage. That said, even when installed correctly in terms of bed levels and flow velocities, the length of the culvert itself (as a dark tunnel) has a bearing on its success for fish passage. Culverts over approximately 150m are known to limit or reduce most fish species passage.

Migrating fish have been recorded in both the Makakahi and Kopuaranga catchment stream on site but the infrastructure does not require new instream culverts in these systems. At least one species has been recorded in the Mangaroa tributary (red fin bully, but eel are also likely). The two proposed culverts in the Mangaroa are 100 m and 110 m long; both these culverts are of a length that will not cause migration passage issues. At the wider Mangaroa tributary scale, the effect of culvert installation is considered to be a Low magnitude of effect on fish passage. Therefore, a Low magnitude of effect in a Low value tributary results in a Very Low overall effect.

The NES-FM (2020) has culvert type and installation guidance that is required to be followed if the installation is to be a permitted activity (Section 70)(2a-g). The placement and/or upgrade of any proposed culvert in accordance with these standards will avoid the issue of impeded fish passage where the culvert upgrades are short (less than 50m).

Table 33: Summary of potential overall level of adverse effects on the fish passage from correct installation of culverts

CATCHMENT OR SUB - CATCHMENT	ECOLOGICAL VALUE	MAGNITUDE OF EFFECT	LEVEL OF EFFECT
Makakahi tributary	Low	None (bridge)	Very Low
Makakahi yards tributary	Low	Negligible	Very Low
Mangaroa tributary	Low	Low	Very Low
Bruce Stream tributary	Moderate		
Bruce Stream main stem	Low		
Kopuaranga	Low		

Despite the level of effect of the loss of passage of 30% of the Mangaroa tributary an offset for that loss of fish habitat will be required and will reduce the level of effect to very low.

8.3.5 Summary of potential effects

A summary of the potential effects (prior to effects management) on freshwater values, as assessed in the proceeding sections, is provided in Table 34 below.

Table 34: Summary of the potential overall effect on each catchment or sub-catchment from each potential effect (prior to effects management).

POTENTIAL EFFECT	CATCHMENT	ECOLOGICAL VALUE	MAGNITUDE OF EFFECT	OVERALL LEVEL OF EFFECT
Aquatic habitat loss	Mangaroa tributary	Low	Moderate	Low
Sediment release	Makakahi	Low	Low	Very Low
	Mangaroa tributary	Low	Low	Very Low
	Bruce Stream main stem	Low	Low	Very Low
	Bruce Stream tributary	Moderate	Low	Low
	Kopuaranga	Low	Low	Very Low
Contaminant release	Makakahi	Low	High	Low
	Mangaroa tributary	Low	High	Low
	Bruce Stream tributary	Moderate	High	Moderate

POTENTIAL EFFECT	CATCHMENT	ECOLOGICAL VALUE	MAGNITUDE OF EFFECT	OVERALL LEVEL OF EFFECT
	Bruce Stream main stem	Low	High	Low
	Kopuaranga	Low	High	Low
Impediment to fish passage	Makakahi tributary	Low	N/A (bridge)	
	Makakahi yard tributary- culvert	Low	Negligible	Very Low
	Mangaroa tributary - culvert	Low	Low	Very Low
	Bruce Stream tributary	Low	-	-
	Bruce Stream main stem	Moderate	-	-
	Kopuaranga	Low	-	-

8.4 Herpetofauna

8.4.1 Construction effects

The areas of the site that are to be potentially affected are dominated by grazed pasture, which is considered to be unsuitable habitat for lizards. The main areas within the potential footprint which may harbour lizards include the rank grasslands/weedlands at the western end of the transmission line (where two skinks were observed), and potentially the ornamental garden to the northwest of the site (refer to Map 19). It is also possible (though the likelihood is much lower) that the regenerating vegetation that falls within the footprint could have low densities of lizards present.

The scale of potential clearance in these habitats is low relative to available surrounding habitat, as illustrated in Section 8.1, and it is considered likely that only common and robust species would persist in these areas, and any impact to these species from the proposed works would be very unlikely to have a measurable effect on the wider population. If any sensitive or rare species are present within the proposed footprint, they likely would be in very low numbers and would not constitute a stable population. So, overall, the magnitude of effect on lizards is expected to be Low, and the level of effect to be **Very Low**.

Regardless of level of effect, all lizards are protected under the Wildlife Act 1953, and disturbance of potential populations cannot be carried out without a Wildlife Act Authorisation from the Department of Conservation. It is very likely that a requirement of the permit will be some form of lizard management (e.g. lizard salvage and/or sensitive clearance methods), which will further minimise any effects to lizards.

8.4.2 Operational effects

There are not expected to be any effects from wind farm operation on lizards.

8.5 Avifauna

The following potential construction and operational phase effects (both direct and indirect) were considered for this assessment:

- Permanent habitat loss;
- Disturbance and displacement;
- Mortality / strike risk and displacement

8.5.1 Construction – Permanent habitat loss

Avifauna habitat loss is a direct and permanent effect that results from the construction of wind farms. In general, this effect seems to have a minor impact on birds, as typically the total area of habitat loss at a wind farm site that results from turbine installation and construction of associated infrastructure (buildings, roads, transmission lines), is only approximately 2-5% of the total wind farm area (Powlesland, 2009). This small-scale impact is lessened further if the habitat loss on site is of habitat types that are common and abundant in the wider area. However, conversely, the loss of sensitive or rare habitats can have significant impacts on bird populations or species. Impacts can also be increased if multiple large developments are sited together (cumulative loss impacts), and / or if the site/s are in areas with large bird populations (Percival, 2005).

With respect to the Mt Munro project site, there are three vegetation communities present that variously provide foraging, roosting and breeding habitat for avifauna species in the area: improved pasture / farmland, wetlands and remnant fragments of indigenous forest / treeland.

The majority of the project footprint lies within improved pasture / farmland (refer to Table 11 on page 29), a very abundant habitat found throughout New Zealand. The only *Threatened* or *At Risk* species that was recorded on site and which may be reliant on pasture habitat is the New Zealand pipit, which is known to form woven nests under tussocks and grass clumps. Not surprisingly, heavily grazed pasture and drained wetlands are known to hold fewer pipits than rough pasture with patches of fern, and marshes or bogs. Thus, the grazed nature of the Mt Munro site means that it will provide limited opportunity for nesting pipit. In terms of abundance on site, a total of 16 observations were recorded during the 2021 / 2022 point count sessions, with the maximum birds recorded during any one session being three. Based on these low numbers, their ability to disperse elsewhere, and the prevalence of similar habitat nearby, we have determined the magnitude of effect on NZ pipit associated with permanent habitat loss from the Mt Munro project will be Negligible (*i.e. Having negligible effect on the known population or range of the element / feature*). This magnitude of effect, when combined with a High value, will result in a Very Low overall effect. We also note for New Zealand pipit, that although some habitat will be lost on site, the construction of gravel roads and infrastructure will create bare patches and / or short sward that will likely provide new habitat suitable for New Zealand pipit.

With respect to natural wetlands, the construction will result in the loss of approximately 1.6% of this habitat present within the Turbine Envelope and Turbine Exclusion Zones (refer to Section 8.2.1). The wetland features that will be lost do not have any standing water and are degraded (grazed by stock). The only indigenous bird species observed on site that have freshwater as a primary habitat are pukeko, paradise shelduck and kingfisher (all Not Threatened species). These species may occasionally use the wetlands for foraging, but the wetlands do not provide core or seasonal habitat for them. Given that only a small amount of wetland habitat will be lost on site, and that induced gully wetlands are common in the wider landscape, we consider that permanent loss of wetland habitat associated with the project is likely to have a Negligible magnitude of effect on the Not Threatened bird species using this habitat type (*i.e. Having negligible effect on the*

known population or range of the element / feature). A negligible magnitude of effect on Low value species (Not Threatened), results in a Very Low overall level of effect.

With respect to regenerating shrublands and remnant fragments of indigenous forest / treeland in site, the project footprint will result in the loss of approximately 1.36 ha (refer to Table 11 page 29). This habitat is used by forest species such as long-tailed cuckoo, grey warbler, silvereye. Given the small quantity that will be lost and that these species are mobile species that can use alternative habitat when lost, we consider that permanent loss of regenerating shrubland and indigenous forest / treeland associated with the project is likely to have a Negligible magnitude of effect on these species (*i.e. Having negligible effect on the known population or range of the element / feature*). A negligible magnitude of effect on Low (Not Threatened) and Very High (Threatened) value species, results in Very Low to Low overall levels of effect.

A further consideration to make for all species on site for which habitat will be lost, is that the wider surrounding landscape is predominantly pastoral or undeveloped, with the nearest wind farms (Tararua and Te Apiti) sufficiently far enough away (approximately 60 km away) for there to be no cumulative wind farm habitat loss effects to consider.

A summary of the potential effects associated with permanent habitat loss for the Mt Munro wind farm on native avifauna is provided in Table 34.

Table 35: Potential ecological effect of habitat loss on native avifauna species within the project area.

SPECIES	ECOLOGICAL VALUE	MAGNITUDE OF EFFECT	LEVEL OF EFFECT
Long-tailed cuckoo	Very High	Negligible	Low
Bush falcon	Very High	n/a	n/a
New Zealand pipit	High	Negligible	Very Low
North Island kaka	Moderate	Negligible	Very Low
Native Not Threatened species	Low	Negligible	Very Low

8.5.2 Construction - Disturbance

People, activities and noise associated with construction of wind farms can disturb birds and displace them from the project area. This disturbance is temporary and is restricted to the construction phase of the project.

A study of falcon conducted at White Hill wind farm in Southland from 2007-2017 recorded two pairs of falcon using the site during baseline bird surveys as well as during construction, and for seven of the following eight years during operation. One pair successfully raised a fledgling to adulthood in four of the nine years monitored (Boffa Miskell Ltd, 2017). The results of that study indicate that falcon were not displaced from the site during construction and operation of the wind farm, and in fact were able to successfully forage, mate and breed at the site. Similarly, avifauna monitoring at Harapaki wind farm during construction has recorded the continued presence of NZ falcon on the site, again demonstrating that the construction disturbance does not displace these birds.

At Mt Munro, a total of 26 falcon observations were made on site during the 2021-2022 surveys (during both the point count and transmission line surveys); no breeding pairs were detected. Five of these observations (all of individual birds) were on the wind farm site and the remaining 21 were

on the transmission line site (also all individual birds). Based on the findings of the above studies, and the number of falcon observations recorded, we have determined that falcon will not be displaced by the construction activities associated with the Mt Munro wind farm project. As such, we consider the magnitude of effect of construction disturbance will be Negligible for falcon (*i.e. Having negligible effect on the known population or range of the element / feature*). A Negligible magnitude of effect on a Very High value species results in a Low overall level of effect.

New Zealand pipit (an *At Risk* species) was recorded on the wind farm site and may be exposed to disturbance associated with the construction activities. However, based on the low numbers of birds recorded on site, the ability to widely disperse and the presence of similar habitat elsewhere nearby, we consider the magnitude of effect of construction disturbance on this species will be Negligible (*i.e. Having negligible effect on the known population or range of the element / feature*). A Negligible magnitude of effect on a High value species results in a Low overall level of effect.

A total of 11 kaka (an *At Risk* species) were recorded during the transmission line monitoring, with no birds recorded on the wind farm site. As such, given the relatively low level of construction activity associated with the transmission line, and the large range over which kaka disperse, we consider the magnitude of effect of construction disturbance on this species will be Negligible (*i.e. Having negligible effect on the known population or range of the element / feature*). A Negligible magnitude of effect on a Moderate value species results in a Very Low overall level of effect.

The other native bird species on site that may be exposed to construction disturbance are all common Not Threatened species that can occupy alternative habitat in the surrounding landscape if displaced. Displacement, however is considered unlikely based on the results of two construction and post-construction (i.e. operational) wind farm studies (Te Uku and West Wind), whereby variation in post-construction species diversity and abundance (relative to control sites for the Te Uku study and relative to baseline data for the West Wind study) was not attributed to the presence of turbines (Boffa Miskell Ltd, 2013, 2014). Furthermore, given that the project site is a working farm, we assume that these species will already be highly tolerant of human activity, vehicles, stock movement, top dressing, dogs and quad bikes / all-terrain vehicles, and so are unlikely to be displaced during construction works. As such we consider the magnitude of effect of construction disturbance on these species to be Negligible (*i.e. Having negligible effect on the known population or range of the element / feature*). A Negligible magnitude of effect on Low value species results in a Very Low overall level of effect.

A summary of the potential effects associated with construction disturbance on native avifauna is provided in Table 36.

Table 36: Potential ecological effect of construction disturbance on native avifauna species within the project area.

SPECIES	ECOLOGICAL VALUE	MAGNITUDE OF EFFECT	LEVEL OF EFFECT
Long-tailed cuckoo	Very High	n/a	n/a
Bush falcon	Very High	Negligible	Low
New Zealand pipit	High	Negligible	Very Low
North Island kaka	Moderate	Negligible	Very Low
Native Not Threatened species	Low	Negligible	Very Low
Introduced species	Negligible	Negligible	Very Low

8.5.3 Operational – Collisions with structures

8.5.3.1 Wind Turbines

International and national studies have shown that wind farms have the potential to kill birds through turbine strikes (Bull et al., 2013; W. P. Erickson et al., 2001; Garvin et al., 2011; Kunz et al., 2007).

Risk factors for birds often relate to the location of wind turbines in or near avifauna habitat, the flight behaviour of the species present, migration patterns, the time of year, and weather conditions (Barrios & Rodriguez, 2004a; Kunz et al., 2007). These risk factors may also be influenced by the surrounding landscape and topography. Table 37 identifies specific features of wind farms and wind turbines that have been implicated in bird strike and displacement and provides information on these factors in relation to the Mt Munro project site. Internationally, the avifauna groups that have been found to be most often impacted by wind farm developments have been swans, geese, ducks, waders, gulls, terns, large soaring raptors, owls and nocturnally migrating passerines (Barrios & Rodriguez, 2004b; de Lucas et al., 2008; Drewitt & Langston, 2006; Langston & Pullan, 2003; Madders & Whitfield, 2006; Percival, 2005; Smales, 2015).

Table 37. Generic risk factors of wind farms for bird collision.

RISK FACTORS	MT MUNRO WIND FARM
Large concentrations of turbines	No, only 20 turbines
Closely spaced turbines (<30 m)	No, spaced widely apart
Turbines in uniform rows across the landscape (barrier)	14 turbines along a single main ridge and 2 groups of 3 turbines on lower hill tops to the northwest of the main ridge
Turbines within a steep valley, across saddles	No, all located on ridges and hill tops
Turbines that lie across a migratory route	No known migratory routes (refer to Figure 9, page 55)
Turbines in close proximity to habitats where birds congregate (wetlands, lakes, estuaries, staging areas)	No
Turbines within a site where threatened or at-risk species are resident or are local and regularly utilise habitat	Yes – but in very low numbers
Frequent fog and low cloud common (esp. during migration season)	No
Large prey base (attracting raptors)	Yes, many passerines present in the pastoral landscape

In New Zealand, Te Uku (Waikato) and West Wind (Wellington) wind farms both modelled avian post-construction mortality at approximately 7 birds per turbine / per year (rounded to the nearest whole number), while allowing for different size classes and seasonal variability associated with the removal rates of very small birds (Boffa Miskell Ltd, 2013, 2014). Post-construction monitoring at those sites, as well as at Te Apiti wind farm (Boffa Miskell Ltd, 2008), have recorded mortalities of 24 species (Table 38). Waterfowl species (paradise shelduck and mallard) make up 14% of the recorded mortalities at those three sites. Notably, there has only been one record of an At Risk species at these three sites, that being a single fairy prion (an oceanic seabird) at the West Wind wind farm, on Wellington's south coast.

Table 38: Avifauna species recorded in turbine collisions at three NZ wind farms (Te Apiti, West Wind and Te Uku).

SPECIES	NATIVE OR INTRODUCED	PROPORTION OF RECORDED TURBINE COLLISIONS
Harrier	Native – Not Threatened	23%
Magpie	Introduced	14%
Skylark	Introduced	8%
Paradise shelduck	Native – Not Threatened	7%
Mallard	Introduced	7%
Chaffinch	Introduced	7%
Black-backed gull	Native – Not Threatened	6%
Goldfinch	Introduced	3%
Yellowhammer	Introduced	3%
Redpoll	Introduced	3%
Finch sp.	Introduced	2%
Silvereye	Native – Not Threatened	2%
Spur-winged plover	Native – Not Threatened	2%
Tui	Native – Not Threatened	2%
Song thrush	Introduced	2%
Starling	Introduced	1%
Greenfinch	Introduced	1%
Welcome swallow	Native – Not Threatened	1%
Dunnock	Introduced	1%
Blackbird	Introduced	1%
Eastern rosella	Introduced	1%
California quail	Introduced	1%
Fairy prion	Native – At Risk	1%
Feral turkey	Introduced	1%

As shown in Table 37, the characteristics and proposed layout of the Mount Munro wind farm presents a reasonably low level of collision risk to avifauna. The main risk is associated with the large prey base present on site for raptors (harrier hawks and falcon). As identified in Table 38, the greatest number of mortalities have been recorded for harriers, and it is likely that this species will be at the greatest risk of turbine collision at Mt Munro. Nevertheless, the risk of turbine collision for a number of native species that were identified on the wind farm site is discussed further and assessed in the following paragraphs.

In relation to wetland birds, paradise shelduck (*Not Threatened*) is the only species recorded on site that may be at risk from turbine collision; six paradise shelduck carcasses were detected during post-construction monitoring at West Wind (Boffa Miskell Ltd, 2013). Five paradise shelduck flight observations were made on the Mt Munro site during the point count surveys (Table 22), three of

which (60%) were within the rotor swept area, i.e. at a height that would potentially put them at risk of collision (Table 23). However, based on the very low numbers of paradise shelducks observed on site, we also conclude that the site does not provide core or seasonal habitat for this species. Furthermore, this species is widespread and common, and any potential mortality effects associated with the wind farm would not affect local or national populations. As such the magnitude of effect from turbine strike on paradise shelduck is considered to be Negligible (*i.e. Having negligible effect on the known population or range of the element / feature*). A Negligible magnitude of effect on Low value species results in a Very Low overall level of effect.

Black-backed gulls (*Not Threatened*) were observed flying above the ridgelines during the point count surveys conducted on site. Eighty-one percent of the observations made (21/26) were within the rotor swept area (Table 23). Turbine mortalities of black-backed gull have been recorded at New Zealand wind farm sites (refer to Table 38 above). At West Wind, while six black-backed gull carcasses were detected during post-construction monitoring (6.7% of all carcasses found), a 5% increase in the abundance of this species was reported post-construction (relative to the baseline), suggesting that strike-induced mortalities were not having a negative impact on the local population of black-backed gulls (Boffa Miskell Ltd, 2013). While black-backed gulls are susceptible to turbine strike, this species is widespread and common, and any potential mortality effects associated with the wind farm would not affect local or national populations. As such the magnitude of effect from turbine strike on black-backed gull is considered to be Negligible (*i.e. Having negligible effect on the known population or range of the element / feature*). A Negligible magnitude of effect on Low value species results in a Very Low overall level of effect.

Tui (*Not Threatened*) and kereru (*Not Threatened*) conduct aerial displays and travel at height across the landscape between forest patches. These behaviours suggest that unless they learn to avoid turbines they would be at risk from strike. No tui were observed on site during the point count surveys, but they may occasionally frequent the site. Seven kereru were observed during the point count surveys (Table 22), two of which were within the widened (conservative) rotor swept area and as such at a height of potential collision risk (Table 23). While no kereru have been reported in post-construction mortality studies, very low numbers of tui have been recorded (refer to Table 38 above). Both species are classified as Not Threatened, and are relatively common and widespread, and any potential mortality effects associated with the wind farm would not affect local or national populations. As such, we consider the magnitude of effect of bird strike for these species to be Negligible (*i.e. Having negligible effect on the known population or range of the element / feature*). A Negligible magnitude of effect on Low value species results in a Very Low overall level of effect.

No kaka were observed on the wind farm site during the point count surveys, however 11 kaka were observed during the transmission line surveys. The flight paths observed were not across the wind farm site (i.e. where the turbines are proposed to be constructed) but south of the transmission line, to and from the Mt Bruce forest block; some movements are likely between the Tararua Ranges and the forest block (Map 22). It is possible that kaka may very occasionally traverse the wind farm, however this is likely to occur infrequently due to the predominantly pastoral nature of the site and lack of suitable native forest habitat (their primary habitat). We note that Powlesland (2009) reported no collision fatalities at the Brooklyn wind turbine in Wellington despite kaka from nearby Zealandia dispersing into the valley floors and across to Makara. A study of avifauna movements across the Zealandia fenceline from the bottom of the valley up to the Brooklyn wind turbine recorded high numbers of kaka dispersing at the lower end of the ridgeline

and across obvious saddles to an area of tall pines, with very few birds recorded at the top of the ridgeline by the turbine (Boffa Miskell Ltd, 2012). Such behaviour would suggest that kaka favour moving across vegetated areas than unforested spurs and ridgelines. Based on these factors, we consider the risk of collision by kaka at the Mt Munro wind farm site to be low and that the magnitude of effect of bird strike for kaka is Negligible (*i.e. Having negligible effect on the known population or range of the element / feature*). A Negligible magnitude of effect on a Moderate value species results in a Very Low overall level of effect.

With regard to cuckoo species, one shining cuckoo (*Not Threatened*) was heard (not seen) during the current point count surveys conducted on the wind farm site and one long-tailed cuckoo (*Threatened*) was observed during the 2010-2012 transmission line surveys (none were recorded during the current surveys). Given that these species are associated with forests and the proposed turbine locations are not close to forest edges, that they have been recorded very rarely on site, and there have been no recorded mortalities of these species during post-construction monitoring (refer to Table 38 above), we consider that any potential mortality effects associated with the wind farm would not affect local or national populations of these species. As such the magnitude of effect of turbine strike on shining cuckoo and long-tailed cuckoo is considered to be Negligible (*i.e. Having negligible effect on the known population or range of the element / feature*). A Negligible magnitude of effect on Low (shining cuckoo) and Very High (long-tailed cuckoo) value species results in Very Low and Low overall level of effect respectively.

With regard to spur-winged plover, four observations were made during the point count survey; one seen and three heard (Table 22). Low numbers of turbine mortalities have been recorded (refer to Table 38 above), however, this species is classified as *Not Threatened,* is widespread and common, and any potential mortality effects associated with the wind farm would not affect local or national populations. As such the magnitude of effect of bird strike for spur-winged plover is considered to be Negligible (*i.e. Having negligible effect on the known population or range of the element / feature*). A Negligible magnitude of effect on a Low value species results in a Very Low overall level of effect.

New Zealand falcon, morepork and harrier hawk are considered to be at risk from collision due to their feeding and flight behaviour, whereby they are unable to divide their attention between hunting and scanning the horizon for obstacles. This is particularly the case during the pursuit of prey and can result in failure to detect objects in front of them, such as turbine blades (Boffa Miskell Ltd, 2013; Powlesland, 2009; Seaton, 2007). All three species have been recorded on site.

In total there were 145 harrier hawk observations during the point count surveys at Mt Munro (Table 22), 63% of which were within the proposed rotor swept area (RSA) and 66% within the more conservative widened RSA (Table 23). As noted above, harrier hawk is the species for which the greatest number of turbine mortalities have been recorded in New Zealand (refer to Table 38 above). However, at West Wind wind farm, while harrier hawk was the species for which the most mortalities occurred, the number of harrier observations at West Wind increased by 133% between baseline (pre-construction) and year three post-construction counts. This suggests that the level of mortality that occurred there was not having a negative impact on the local population of the species (Boffa Miskell Ltd, 2013). Based on these findings, and that fact that the harrier hawk is a *Not Threatened*, common and widespread species, we consider turbine strike at Mt Munro is likely to occur but will have a Negligible magnitude of effect on the local and national harrier hawk

population (*i.e. Having negligible effect on the known population or range of the element / feature*). A Negligible magnitude of effect on a Low value species results in a Very Low overall level of effect.

In total there were five falcon observations during the point count surveys conducted on site (Table 22), all comprising single bird observations. All of these observations were within the proposed rotor swept area (RSA) and the widened RSA (Table 23). There were also 21 falcon observations at the southern end of the site at the Mt Bruce forest block during the transmission line surveys (Map 20). These results indicate that falcon are resident in the landscape encompassing the project site and traverse it at a height that puts them at risk of turbine collision. No nesting behaviour was observed on site. We note that although a number of falcon observations have been made on site, these observations are likely to have been repeat observations of a small number of individuals given that falcon have large home ranges (between 9 and 75 km^2 have been reported; (N. C. Fox, 1977; Seaton, 2007) and are territorial birds (i.e. the site is likely to support few falcon). With regard to other projects, during three years of post-construction monitoring conducted at West Wind wind farm no falcon moralities were recorded (Boffa Miskell Ltd, 2013). At White Hill wind farm, two falcon pairs were recorded on site prior to the development of the wind farm and were recorded successfully inhabiting and breeding at the site during construction and for many years during operation of the wind farm (Boffa Miskell Ltd, 2017). Furthermore, at Te Uku wind farm, no falcon mortalities were reported during post-construction mortality monitoring. Thus, there have been no records of any New Zealand falcon mortalities at operating wind farms in New Zealand, despite their known presence and the undertaking of post-construction monitoring at these sites. Internationally, peregrine falcons, which are the closest relative to bush falcon, are known to be susceptible to strikes at transmission lines, but in California where many thousands of turbines are in operation, there has never been a reported strike at a wind turbine (W. Erickson et al., 2002; Gipe, 1995). Peregrine falcon have been known to nest near wind farms in Europe with no fatalities recorded (Percival, 1998). The only reference we have been able to find of a peregrine falcon fatality by a turbine was a single bird strike in the Orkney Islands (Meek et al., 1993). Thus, based on all these factors, and including the low number of individual birds observed on site (assumed to be a single bird) we conclude that the likely risk of turbine collision is very low, and if it were to occur would have a Negligible magnitude of effect on falcon (*i.e. Having a minor effect on the known population or range of the element / feature*). A Negligible magnitude of effect on a Very High value species results in a Low overall level of effect.

With regard to morepork (*Not Threatened*), nocturnal surveys were not conducted during the current surveys, however they were detected in forest fragments during the 2010-2012 surveys and are assumed to still be present on site (Boffa Miskell Ltd, 2011b). Given that moreporks are associated with forests and the proposed turbine locations are not close to forest edges, we consider that any potential mortality effects associated with the wind farm would not affect local or national populations of these species. Furthermore, there have been no recorded morepork mortalities in post-construction monitoring undertaken at New Zealand wind farms (refer to Table 38 above). As such the magnitude of effect of bird strike for morepork is considered to be Negligible (*i.e. Having negligible effect on the known population or range of the element / feature*). A Negligible magnitude of effect on a Low value species results in a Very Low overall level of effect.

Sixteen observations of New Zealand pipit have been recorded on the wind farm site (Table 22). They were observed in grassland habitat, some in close proximity to the proposed turbine locations. No pipit flight observations were within the risk zone for the rotor swept area (RSA) and only 13% (two observations) were within the risk zone for the widened RSA (Table 23); of note is

that these two pipit observations had a maximum flight height of 20 m so were right on the minimum threshold of the risk zone (20-170 m). Furthermore, there have been no recorded pipit mortalities in post-construction monitoring undertaken at New Zealand wind farms (refer to Table 38 above). At West Wind wind farm, although present in reasonable numbers, no pipit mortalities were recorded in three years of post-construction monitoring conducted (Boffa Miskell Ltd, 2013). At Waverley wind farm, during pre-construction monitoring, all 39 pipit flight observations were significantly below the RSA (maximum flight height was 3 m) (Boffa Miskell Ltd, 2016). Based on these factors, we consider that there is a very low risk of collision for pipit during operation of the wind farm. Given the small number of pipit observed on site, if collision were to occur this would not affect local or national populations of this species. As such the magnitude of effect of turbine strike for New Zealand pipit is considered to be Negligible (*i.e. Having negligible effect on the known population or range of the element / feature*). A Negligible magnitude of effect on a High value species results in a Very Low overall level of effect.

In addition to the species discussed above, a number of *Not Threatened* native bird species have been observed on site (e.g. welcome swallow, silvereye, grey warbler, kingfisher, fantail). The risk of collision for these species is considered to be low based on their flight patterns and behaviours (low flying and for the forest species, generally short flights within and between vegetation rather than on open ridgelines), their high abundances and *Not Threatened* conservation statuses. Furthermore, if collisions were to occur, they would not be at a level that would affect local or national populations of these species. As such the magnitude of effect of turbine strike for these native Not Threatened species is considered to be Negligible (*i.e. Having negligible effect on the known population or range of the element / feature*). A Negligible magnitude of effect on Low value species results in a Very Low overall level of effect.

8.5.3.2 Transmission Line

Internationally, bird mortality from collisions with power lines and electric-utility structures has been documented for nearly 350 species (Gehring et al., 2009). Birds with low manoeuvrability (i.e. high wing loading and low aspect) or narrow visual fields have a high probability of colliding with power lines (Bevanger, 1998; Janss, 2000; Martin & Shaw, 2010). Furthermore, birds which regularly fly between roosting and feeding grounds, undertake regular migratory or nomadic movements, fly in flocks, or fly during low-light conditions are also vulnerable (Kessels & Associates Ltd, 2008). Other factors which can influence collision frequency include the age of the bird (younger birds are less experienced fliers), weather factors (decreased visibility, strong winds), terrain characteristics and power line placement (lines that cross the flight paths of birds), power line configuration (the larger structures are more hazardous), human activity (which may cause birds to panic and fly into the overhead lines) and familiarity of the birds with the area (Kessels & Associates Ltd, 2008).

Electrocution of birds may occur where a bird lands on transformer boxes or bridge transmission lines that have not been insulated when they attempt to perch on lines or pylons (i.e. birds acting as a contact between phase wires, or between a phase wire and earth). Thus, birds can be at greater risk of electrocution on smaller distribution poles and in substations where the electric phases are closer together, rather than on larger transmission structures where they are further apart.

Species known to be affected in New Zealand include falcon, harrier, kea, kereru and kaka (N. Fox, 2010). Fifty percent of falcon released in Marlborough (Falcons for Grapes Project) were electrocuted by landing on un-insulated power poles or transformer boxes (N. Fox, 2010).

The transmission pole and lines to be used for the Mt Munro 33kV line does not use standard pin type insulators on top of the cross arms, or have pole-mounted transformers or switch gear. An overhead earth wire has also been incorporated into the pole design. Furthermore, at the substation, the 33kV equipment will be underground / indoors and the 110kV equipment has spacings and insulators large enough to reduce the potential risk of electrocution. Thus, while the risk of electrocution has been reduced through the transmission pole design, the potential still exists for bird collisions.

During the current transmission line surveys conducted on site, 168 kereru, 21 falcon and 11 kaka observations were recorded. None of the kaka observations, seven of the kereru observations (4.2%) and five of the falcon observations (23.8%) crossed the route of the proposed transmission line at a height where they may be at risk of collision with the line (refer to Figure 14 on page 64).

With regard to kaka (refer to Map 22), we consider that collision risk is likely to be low given that they are forest birds and are unlikely to regularly traverse northeast across the proposed transmission line route to the open, pastoral-dominated landscape of the wider project site. While no observations were made of kaka traversing the proposed transmission line route, if they do make this traverse, collision risk will likely be reduced given that powerlines already exist in the surrounding landscape and birds have habituated to their presence. Based on these factors and the small number of kaka observed in the area, we consider that potential mortality of kaka as a result of collision with the transmission line is low and will have a Negligible magnitude of effect on local and national populations of kaka (*i.e. Having negligible effect on the known population or range of the element / feature*). A Negligible magnitude of effect on a Moderate value species results in a Very Low overall level of effect.

With regard to kereru, the majority of flight observations were short flights within, or to and from the Mt Bruce forest complex from nearby bush remnants (refer to Map 21) and few flights (<5%) were at a height that would put them at risk of collision with the proposed transmission line. Based on these factors, the *Not Threatened* conservation status of kereru and that powerlines already exist in the surrounding landscape (and thereby birds have a degree of habituation to these structures), we consider that the likelihood of potential mortality of kereru as a result of collision with the Mt Munro transmission line is low and will have a Negligible magnitude of effect on local and national populations (*i.e. Having negligible effect on the known population or range of the element / feature*). A Negligible magnitude of effect on a Low value species results in a Very Low overall level of effect.

With regard to falcon, a number of observations were made of birds crossing the transmission line route, but given the large territories of falcon, the observations are likely to have been of a small number of individuals. Although there is potential for collision risk, particularly when falcon prey-fix when hunting, we consider that risk is sufficiently reduced by the presence of powerlines in the existing, wider environment. Falcon in the area will have habituated to their presence and learnt appropriate avoidance behaviours. Based on these factors, if transmission line collision mortality were to occur, we consider that this would have a Negligible magnitude of effect on local and national populations of falcon (*i.e. Having a minor effect on the known population or range of the*

element / feature). A Negligible magnitude of effect on a Very High value species results in a Low overall level of effect.

8.5.4 Summary of potential effects

A summary of the potential effects on avifauna identified in Section 8.5 is provided in Table 39 .

Table 39. Summary of potential construction and operational effects of the project to indigenous avifauna that use, or potentially use the site.

SPECIES	ECOLOGICAL VALUE	POTENTIAL OVERALL LEVEL OF EFFECT		
		Habitat Loss	Disturbance	Mortality/bird strike
Tui	Low	Very low	Very low	Very low
North Island fantail	Low	Very low	Very low	Very low
Kereru	Low	Very low	Very low	Very low
North Island kaka	Moderate	Very low	Very low	Very low
Shining cuckoo	Low	Very low	Very low	Very low
Bush falcon	Very high	Low	Low	Low
Kingfisher	Low	Very low	Very low	Very low
Bellbird	Low	Very low	Very low	Very low
Long-tailed cuckoo	Very high	Low	Low	Low
Morepork	Low	Very low	Very low	Very low
Silvereye	Low	Very low	Very low	Very low
Grey warbler	Low	Very low	Very low	Very low
Harrier hawk	Low	Very low	Very low	Very low
Spur-winged plover	Low	Very low	Very low	Very low
Welcome swallow	Low	Very low	Very low	Very low
New Zealand pipit	High	Very low	Very low	Very low
Paradise shelduck	Low	Very low	Very low	Very low
Pukeko	Low	Very low	Very low	Very low
White-faced heron	Low	Very low	Very low	Very low
Black-backed gull	Low	Very low	Very low	Very low

9.0 Effects Management& Measures to Address Residual Effects

9.1 Terrestrial

There are unlikely to be any adverse effects and therefore no effects management is required, nor any mitigation or offsetting.

9.2 Wetland

The requirement to provide mitigation and / or offset for the loss of natural wetlands is dependent on which statutory document, or combination documents, is enforced (i.e. Horizons One Plan, GWRC PNRP and / or NPS-FM (2020)). Given the nature and extent of these and the limited effects on them we do not consider the ecological value or condition of the NPS FM process derived classifications of the farmed gullies as "natural" inland wetlands warrants any remedy, mitigation or offset consideration.

Under the Horizons One Plan, the identified natural wetlands do not trigger Schedule F1 wetland criteria (refer to Section 7.2), and therefore (based on an absence of ecological significance) no mitigation or offset should be required. The exotic dominance, history, condition and future potential under the current land use ecologically support that conclusion.

Under the NPS-FM (2020) (and ostensibly the GWRC PNRP), avoidance of 'loss of extent of natural wetland' is a directive to Councils granting consents. However, given wind farms are recognised as nationally and regionally specified infrastructure, a consent pathway exists under Section 3.22(b)(1)[18]. Under that section, Meridian is required to follow the effects management hierarchy (as outlined in Section 3.8). No matter how small, Meridian Energy would be required to remedy or offset or compensate for those small losses of natural wetland.

Where an offset is determined to be required, then the loss where the current road alignment is proposed would be 0.32 ha of "natural inland wetland". Given the condition and absence of indigenous values, ecosystem health values, or functional values and based on other offset examples (M2PP, TG) a 1:1 ratio of offset is appropriate. The offset then would be in the order of 320m^2 of creation or restoration of indigenous wetland. Ordinarily an enhancement rather than creation of a new feature would demand a higher ratio but the current mud sponges (both affected and the offset areas) have no value as representative indigenous wetlands and we consider the restoration of the features we have identified are in effect creations of new natural features not enhancements of existing value.

Figure 15 below identifies those feature we consider the best targets for wetland offset actions. We have identified rough 1 hectare of opportunity, and favour the feature adjacent to the yards as the best most cohesive larger option.

[18] i.e., avoidance of loss of extent is not mandatory

Figure 15. Recommended area of offset wetland creation using existing linear wet areas.

Potential effects of sediment discharge or temporary diversion of rain surface flows will not have more than temporary effects which do not require mitigation or offset but may require some form of remedial actions such as weed management or ensuring surface flow redirection occurs.

9.2.1.1 Wetland recommendations

- Ensure the management of earthworks and water discharge is well maintained and monitored;
- Continue to refine the width and placement of access roads to minimise or avoid any wetland;
- Where the planning regime requires it, offset the area of natural inland wetland lost through the restoration of some of the natural inland wetlands on site at a ratio of 1: 1 (i.e. for every $1m^2$ lost, restore $1m^2$). We do not fix the area of effect or the offset as yet because we understand that the placement of infrastructure is not fully developed and a consent condition using this offset ratio related to actual effect could be used to enable the flexibility required.

9.3 Freshwater

9.3.1.1 Aquatic habitat loss

The approximate 240 m of aquatic habitat that is the perennial Mangaroa tributary or Makakahi yard tributary will be culverted to allow roading. This loss of aquatic habitat requires an offset. Ordinarily an offset will involve either creating an equivalent length, size and better-quality

waterway and so approximate a 1:1 compensation ratio. Or the offset may focus on enhancement of remnant / other streams within the catchment or sub catchment and under such circumstances require a large ratio of compensation / offset because no new replacement stream length is being created. We suspect that the nature of the roading and the gully the tributary sits in will preclude a new stream channel being created and that the offset will require the enhancement of one of the other tributaries. However, it may be plausible to enhance the up-stream continuance of the MAG2 tributary.

Without undertaking an SEV ECR[19] modelled offset calculation (Storey et al., 2011) we know from considerable experience with these calculations and streams that the SEV outcome of Mangaroa tributary will be around 4.5, that the offset enhancements will raise any other nearby tributary by no more than 0.2 SEV score points. This means a ratio of around 3:1 (ignoring the option 0.5 multiplier for default and lag). Meridian, under this scenario will likely need to investigate the undertaking of the enhancement of around 720 m of the Mangaroa tributary or similar perennial nearby tributary. Enhancement would be in the form of excluding stock and planting of riparian indigenous vegetation (minimum width of revegetation of 10 m either side from the tributary bank edge). That the revegetation be indigenous and appropriate for the site; however, we note that if this enhancement is to occur on the Mt Munro site, then consideration would need to be given to the planting of species that do not attract birds (and thereby putting them at risk of collision with turbines). That management of that revegetation will require at least 5 years to ensure successful establishment and security. In addition, a survey of the tributary to identify instream enhancements including removal of any fish barriers, inclusion of woody debris elements and improvements to substrate and flow heterogeneity, will be required. Lastly where such offset occurs it should be considered in conjunction with the potential wetland offset that may be required.

9.3.1.2 Sediment and contaminant release

In terms of contaminant discharge risk, it is assumed that any active concreting work will have bunded areas and protection measures to ensure stored materials cannot be discharged from the site and into the aquatic systems.

We assume that the sediment management related to on site works will be managed such that effects downstream to intermittent and perennial stream systems will not occur. If and where such an effect does occur there will be a disruption for a time and the systems present will recolonise and reset as they have done since forest clearance. There is no mitigation requirement other than best practice erosion and sediment control.

9.3.1.3 Fish passage

We recommend that in terms of fish passage any culverts that are required to pass fish are designed following the guidance of the *New Zealand fish passage guidelines for structures up to 4 metres* (Franklin et al., 2018) and in line with NES-FW (2020). Prior to installation the proposed designs should be checked by the project aquatic ecologist and then validated in the field at the time of installation. If this occurs, fish passage issues and associated affects can be avoided.

[19] SEV ECR = Stream Ecological Valuation Environmental Compensation Ratio

9.3.1.4 Freshwater recommendations

- Monitor and report any significant sediment release events to freshwater systems. A freshwater ecologist should determine the level and frequency of monitoring required and what assessments are required when a considerable discharge event should occur.
- Ensure concrete work areas are protected against leachate or spills.
- Install culverts as per the NES FM (2020) and as further guidance *New Zealand fish passage guidelines for structures up to 4 metres* (Franklin et al., 2018) and get input from a freshwater ecologist prior to, and during, instalment.
- Establish an offset plan (after the design has been finalised and the length of affected stream verified) to cause the protection and betterment of a nearby perennial tributary which is at least 720m long and includes a 10 m either side revegetation undertaking and fixes any existing fish barrier issues.

9.4 Herpetofauna

The level of effect of the proposal on potential lizard populations does not warrant mitigation. However, it should be noted that if clearance is to occur in areas identified as lizard habitat, a Wildlife Act Authority ("permit") from the Department of conservation will likely be required. It is expected that a condition of the permit will be some form of management of effects to lizards, e.g. through pre-clearance salvage or sensitive vegetation clearance techniques.

9.5 Avifauna

The levels of effect of the proposal on bird species, does not warrant mitigation, however the following actions should be implemented to monitor (and verify) effects post-construction.

Post-construction bird strike monitoring of the wind farm and transmission line should be conducted for one year immediately after the wind farm becomes operational. If any mortalities of At Risk or Threatened species are detected, a review will be undertaken to determine if further monitoring is required, and any remedial, mitigation or offsetting actions need to be implemented.

9.6 Overarching Effects and Offset note

Currently the adverse effects identified which relate to wetlands and freshwater have been assessed based on the currently proposed infrastructure. The detailed design of the actual infrastructure in the Turbine Envelope and Turbine Exclusion Zones may (and it is promoted in this assessment) actually avoid direct impacts or the impact may be of lesser quantum than predicted here. This report, in addressing the offset requirement, recommends suitable offset ratios and good locations for the offsets, these can be use in a condition of consent to manage the appropriate offset amounts in relation to the final design and position of the various infrastructure rather than stipulating a hard and fast quantum now.

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Appendix 1: Avifauna survey dates and start times

SEASON	DATE	PC-1	PC-2	PC-3	PC-4	PC-5	PC-6	PC-7	PC-8
WINTER	10/08/2021	1152	1503	1543	1428	1341	1225	1309	1123
	11/09/2021	1541	1500	1536	1425	1354	1248	1324	1306
	12/08/2021	1100	0927	1130	0957	1026	Not recorded	0849	0811
SPRING	10/11/2021	0910	1114	0939	1050	1012	1210	1131	1205
	10/11/2021	1353	1417	1325	1420	1309	1619	1542	1616
	26/11/2021	0810	1252	0844	1200	1127	1022	1057	0946
SUMMER	4/02/2022	1354	1256	1327	1229	1157	1029	1131	1102
	15/02/2022	1229	1434	1315	1504	1632	1439	1558	1527
	21/02/2022	1247	1140	1317	1212	1105	0934	1036	1007
AUTUMN	11/03/2022	1257	1433	1330	1603	1506	1635	1543	1632
	03/04/2022	1253	1159	1332	1131	1104	0938	1036	1008
	05/05/2022	1038	1227	1115	1148	1456	1321	1425	1356

Appendix 2: EIANZ criteria for assigning ecological value to terrestrial and freshwater communities

FRESHWATER SYSTEMS:

MATTER	ATTRIBUTES TO BE ASSESSED
Representativeness	• Extent to which site/catchment is typical or characteristic • Stream order • Permanent, intermittent or ephemeral waterway • Catchment size • Standing water characteristics
Rarity / distinctiveness	• Supporting nationally or locally (i.e. ecological district) Threatened, At Risk or uncommon species • National distribution limits • Endemism • Distinctive ecological features • Type of lake/pond/wetland/spring
Diversity & pattern	• Level of natural diversity • Diversity metrics • Complexity of community • Biogeographical considerations - pattern, complexity, size, shape
Ecological context	• Stream order • Instream habitat • Riparian habitat • Local environmental conditions and influences, site history and development • Intactness, health and resilience of populations and communities • Contribution to ecological networks, linkages, pathways • Role in ecosystem functioning – high level, proxies

TERRESTRIAL:

MATTER	ATTRIBUTES TO BE CONSIDERED
Representativeness	Criteria for representative vegetation and aquatic habitats: • Typical structure and composition • Indigenous species dominate • Expected species and tiers are present • Thresholds may need to be lowered where all examples of a type are strongly modified Criteria for representative species and species assemblages: • Species assemblages that are typical of the habitat • Indigenous species that occur in most of the guilds expected for the habitat type
Rarity / distinctiveness	Criteria for rare/distinctive vegetation and habitats: • Naturally uncommon, or induced scarcity • Amount of habitat or vegetation remaining • Distinctive ecological features • National priority for protection Criteria for rare/distinctive species or species assemblages: • Habitat supporting nationally Threatened or At Risk species, or locally[20] uncommon species • Regional or national distribution limits of species or communities • Unusual species or assemblages • Endemism
Diversity & pattern	• Level of natural diversity, abundance and distribution • Biodiversity reflecting underlying diversity • Biogeographical considerations - pattern, complexity • Temporal considerations, considerations of lifecycles, daily or seasonal cycles of habitat availability and utilisation
Ecological context	• Site history, and local environmental conditions which have influenced the development of habitats and communities • The essential characteristics that determine an ecosystem's integrity, form, functioning, and resilience (from "intrinsic value" as defined in the RMA) • Size, shape and buffering • Condition and sensitivity to change • Contribution of the site to ecological networks, linkages, pathways and the protection and exchange of genetic material • Species role in ecosystem functioning – high level, key species identification, habitat as proxy

[20] Locally – defined as within Ecological District

Appendix 3: Mt Munro Wetland Plots

				Gully/feature no.	4	4	5	5	9	10	10	10	11	11	11	1	20	20	21	21	2	23	23b	2	2	26	26
Pastur	**Ratin**	**Common name**	**Species**	**Plot no.**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**1**	**13**	**14**	**15**	**16**	**1**	**18**	**19**	**2**	**2**	**22**	**23**
	FAC	kiokio	*Blechnum novae-zelandiae*																								
	FAC		*Euchiton delicatus*																								
Yes	FAC	yorkshire fog	*Holcus lanatus*			1	1	1		1				2			8				2		60		1	2	4
	FAC	hairy pennywort	*Hydrocotyle moschata*		1		1		1								1		1	1			3	1			
Yes	FAC	lotus	*Lotus pedunculatus*											1			2	1			1	1					
	FAC	creeping buttercup	*Ranunculus repens*		2	1	1	4	2	1	1	1	3	1		1	1	2			1	1	2	2	1		
Yes	FACU	yarrow	*Achillea millefolium*														15									5	4
Yes	FACU	sweet vernal	*Anthoxanthum odoratum*		2		1	4	2										90	80			10	2			85
	FACU	english daisy	*Bellis perennis*		1				1															1			
Yes	FACU	chickweed	*Cerastium semidecandrum*		1		2	1	1		2	2	4	3		1	2	1			3	1	2	1		1	3
Yes	FACU	Californian thistle	*Cirsium arvense*					1							1		1	1	1	1							
Yes	FACU	cocksfoot	*Dactylis glomerata*																								
	FACU	willow herb	*epilobium alsinoides*			1	1			1															1		
	FACU	hedge bed straw	*Galium mollugo*																								
Yes	FACU	cats ear	*Hypochaeris radicata*																								
Yes	FACU	hawkbit	*Leontodon taraxacoides*														1										
	FACU	pratria	*Lobelia angulata*		1	1			1	1							1	1						1	1		
Yes	FACU	rye grass	*Lolium perenne*																								
	FACU	bead plant	*Nertera depressa*																								
Yes	FACU	narrow leaved	*Plantago lanceolata*																								
	FACU	Prunella	*Prunella vulgaris*																								
Yes	FACU	hairy buttercup	*Ranunculus reflexus*																								
	FACU	Dandy lion	*Taraxacum officinale*																1								
Yes	FACU	Clover	*Trifolium repens*		2	1		1	2	1				1			2		2	9	1		3	2	1		
Yes	FAC	creeping bent	*Agrostis stolonifera*		2			2	2															2			
	FAC	rautahi	*Carex geminata*																	3							3
	FAC	centella	*Centella uniflora*																								
	FAC	marsh bed straw	*Galium palustre*																								
Yes	FAC	blue sweet grass	*Glyceria declinata*		6	3	6	1	6	30	40	40	30	60	40	2		35			6	60	5	6	3	3	4
	FAC	jointed rush	*Juncus articulatus*								1	1			1		2									1	
	FAC	toad rush	*Juncus bufonius*																								
	FAC		*Juncus conglomeratus*																								
	FAC	Wiwi	*Juncus edgariae*																								
	FAC	soft rush	*Juncus effusus*			1				1							10								1		
	FAC	Flat-leaved rush	*Juncus planifolius*					1																			
	FAC	broom rush	*Juncus sarophorus*		5	5	2	2	5	5	1	1							5	6		10		5	5		
	FAC	moss	*Shagnum perichaetiale*					1									53	20				5	10			83	
	OBL	Purei	*Carex secta*																								
	OBL	kuta	*Eleocharis acuta*														1									10	
	OBL	monkeymusk	*Erythranthe guttata*																								
Yes	OBL	sweet grass	*Glyceria fluitans*																								

				Gully/feature no.	4	4	5	5	9	10	10	10	11	11	11	1	20	20	21	21	2	23	23b	2	2	26	26
Pastur	**Ratin**	**Common name**	**Species**	**Plot no.**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**1**	**13**	**14**	**15**	**16**	**1**	**18**	**19**	**2**	**2**	**22**	**23**
	OBL	Scripus	*Isolepis caligenis*													1		10									1
	OBL	Isolepis	*Isolepis prolifera*								1	1		1							1	1					
	OBL	duck weed	*Lemna disperma*		3	1	1		3	1	1	1	10		1			1						3	1		
	OBL		*Luzula leptophylla*																								
	OBL	water forget me not	*Myosotis laxa caespitosa*		2	1	5		2	10	3	3	3		5			1						2	1		
	OBL	water cress	*Nasturtium microphyyllum*								10	10		1	25	3		20			1						
	OBL	dwarf montia	*Montia fontana subsp.*			5	1	2		50	40	40	50	30	27	7	15	7			3	21	5		5		

				Gully/feature no.	2	2	2	3	3	4	44	44	4	4	4	4	4	5	52	52	52	52	5	55	55	55	56
Pastur	**Ratin**	**Common name**	**Species**	**Plot no.**	**2**	**2**	**2**	**2**	**2**	**2**	**30**	**31**	**3**	**3**	**3**	**3**	**3**	**3**	**38**	**39**	**40**	**41**	**4**	**43**	**44**	**45**	**46**
	FAC	kiokio	*Blechnum novae-zelandiae*																								
	FAC		*Euchiton delicatus*																								
Yes	FAC	yorkshire fog	*Holcus lanatus*		4	4	1		1	1	15	1	1		1	1	1		1	1	15		4	45		35	
	FAC	hairy pennywort	*Hydrocotyle moschata*				2	1						1								1					
Yes	FAC	lotus	*Lotus pedunculatus*				1														2		2	25		1	
	FAC	creeping buttercup	*Ranunculus repens*				1	2	1	1	3	1	1	2		1	5	3	1	1	15	2	2	2	3	15	3
Yes	FACU	yarrow	*Achillea millefolium*		4	4																					
Yes	FACU	sweet vernal	*Anthoxanthum odoratum*		8	8	7	2			40		1	2	3		4				5	20	1	10		35	
	FACU	english daisy	*Bellis perennis*				1	1						1													
Yes	FACU	chickweed	*Cerastium semidecandrum*		3	3	1	1			1			1	1		1	1			4	2	2	2	4	1	4
Yes	FACU	Californian thistle	*Cirsium arvense*								1	1											2	2		1	
Yes	FACU	cocksfoot	*Dactylis glomerata*																								
	FACU	willow herb	*epilobium alsinoides*						1	1			1			1			1								
	FACU	hedge bed straw	*Galium mollugo*																								
Yes	FACU	cats ear	*Hypochaeris radicata*																								
Yes	FACU	hawkbit	*Leontodon taraxacoides*												1												
	FACU	pratria	*Lobelia angulata*					1	1	1		1	1	1		1			1	1		1					
Yes	FACU	rye grass	*Lolium perenne*																								
	FACU	bead plant	*Nertera depressa*																								
Yes	FACU	narrow leaved	*Plantago lanceolata*																								
	FACU	Prunella	*Prunella vulgaris*																								
Yes	FACU	hairy buttercup	*Ranunculus reflexus*																								
	FACU	Dandy lion	*Taraxacum officinale*																								
Yes	FACU	Clover	*Trifolium repens*				2	2	1	1	1	1	1	2	1	1	4	2	1	1		5	1	11			
Yes	FACW	creeping bent	*Agrostis stolonifera*					2			2			2							1						
	FACW	rautahi	*Carex geminata*		3	3																					
	FACW	centella	*Centella uniflora*												1												
	FACW	marsh bed straw	*Galium palustre*																								
Yes	FACW	blue sweet grass	*Glyceria declinata*		4	4	2	6	3	3	15	30	3	6	1	3	1	3	30	30	5	60	1	1	37	5	30
	FACW	jointed rush	*Juncus articulatus*																								
	FACW	toad rush	*Juncus bufonius*														4						1	1			
	FACW		*Juncus conglomeratus*																								
	FACW	Wiwi	*Juncus edgariae*																								
	FACW	soft rush	*Juncus effusus*						1	1		1	1			1			1			1	1	1		5	
	FACW	Flat-leaved rush	*Juncus planifolius*								1												1	1			
	FACW	broom rush	*Juncus sarophorus*				1	5	4	5	20	5	4	5	2	5			5	5	25	5					

				Gully/feature no.	2	2	2	3	3	4	44	44	4	4	4	4	4	5	52	52	52	52	5	55	55	55	56
Pastur	**Ratin**	**Common name**	**Species**	**Plot no.**	**2**	**2**	**2**	**2**	**2**	**2**	**30**	**31**	**3**	**3**	**3**	**3**	**3**	**3**	**38**	**39**	**40**	**41**	**4**	**43**	**44**	**45**	**46**
	FACW	moss	*Shagnum perichaetiale*				1				1															1	
	OBL	Purei	*Carex secta*																								
	OBL	kuta	*Eleocharis acuta*																								
	OBL	monkeymusk	*Erythranthe guttata*														5										
Yes	OBL	sweet grass	*Glyceria fluitans*																								
	OBL	Scripus	*Isolepis caligenis*	1	1																						
	OBL	Isolepis	*Isolepis prolifera*														3	2			1				2		
	OBL	duck weed	*Lemna disperma*				3	1	1		1	1	3		1	1	1	1	1			1			1		10
	OBL		*Luzula leptophylla*																								
	OBL	water forget me not	*Myosotis laxa caespitosa*				2	1	1		10	1	2		1		3	10	1			2			3		3
	OBL	water cress	*Nasturtium microphyyllum*			1										5			10								
	OBL	dwarf montia	*Montia fontana subsp.*					5	4	1	48	4		2	5		4	50	50					50	1	50	

				Gully/featur	56	56	5	5	59	59	6	61	61	6	6	67	67	67	6	6	70	70	71	7	7	7	7
Pastur	**Ratin**	**Common name**	**Species**	**Plot no.**	**47**	**48**	**4**	**5**	**51**	**52**	**5**	**54**	**55**	**5**	**5**	**58**	**59**	**60**	**6**	**6**	**63**	**64**	**65**	**6**	**6**	**6**	**6**
	FAC	kiokio	*Blechnum novae-zelandiae*																								
	FAC		*Euchiton delicatus*																								
Yes	FAC	yorkshire fog	*Holcus lanatus*		40					10			10							1		10	10				
	FAC	hairy pennywort	*Hydrocotyle moschata*				1								1									1	1	1	1
Yes	FAC	lotus	*Lotus pedunculatus*		2																						
	FAC	creeping	*Ranunculus repens*		2	1	2	3	3		3	3		3	2	3	3	3	3	3	3			2	2	2	2
Yes	FACU	yarrow	*Achillea millefolium*																								
Yes	FACU	sweet vernal	*Anthoxanthum odoratum*				2			35			35		2							30	35	2	2	2	2
	FACU	english daisy	*Bellis perennis*				1								1									1	1	1	1
Yes	FACU	chickweed	*Cerastium semidecandrum*		1	2	1	4	4	1	4	4	1	4	1	1	1	1	1	1	4	1	1	1	1	1	1
Yes	FACU	Californian thistle	*Cirsium arvense*																								
Yes	FACU	cocksfoot	*Dactylis glomerata*																								
	FACU	willow herb	*epilobium alsinoides*																								
	FACU	hedge bed straw	*Galium mollugo*																								
Yes	FACU	cats ear	*Hypochaeris radicata*																								
Yes	FACU	hawkbit	*Leontodon taraxacoides*							1			1									1					
	FACU	pratria	*Lobelia angulata*				1								1									1	1	1	1
Yes	FACU	rye grass	*Lolium perenne*																								
	FACU	bead plant	*Nertera depressa*																								
Yes	FACU	narrow leaved	*Plantago lanceolata*																								
	FACU	Prunella	*Prunella vulgaris*																								
Yes	FACU	hairy buttercup	*Ranunculus reflexus*																								
	FACU	Dandy lion	*Taraxacum officinale*																								
Yes	FACU	Clover	*Trifolium repens*		1		2			15			15		2	1	1	1	1			15		2	2	2	2
Yes	FACW	creeping bent	*Agrostis stolonifera*				2								2									2	2	2	2
	FACW	rautahi	*Carex geminata*																								
	FACW	centella	*Centella uniflora*							1			1									1	1				
	FACW	marsh bed straw	*Galium palustre*																								
Yes	FACW	blue sweet grass	*Glyceria declinata*		40	40	6	3	30	15	3	30	15	3	6	35	40	40	3	5	30	15	15	6	6	6	6
	FACW	jointed rush	*Juncus articulatus*			1																					
	FACW	toad rush	*Juncus bufonius*		1																						

				Gully/featur	56	56	5	5	59	59	6	61	61	6	6	67	67	67	6	6	70	70	71	7	7	7	7
Pastur	**Ratin**	**Common name**	**Species**	**Plot no.**	**47**	**48**	**4**	**5**	**51**	**52**	**5**	**54**	**55**	**5**	**5**	**58**	**59**	**60**	**6**	**6**	**63**	**64**	**65**	**6**	**6**	**6**	**6**
	FACW		*Juncus conglomeratus*																								
	FACW	Wiwi	*Juncus edgariae*																								
	FACW	soft rush	*Juncus effusus*																								
	FACW	Flat-leaved rush	*Juncus planifolius*																								
	FACW	broom rush	*Juncus sarophorus*		1	5			20			20		5								20	20	5	5	5	5
	FACW	moss	*Shagnum perichaetiale*	1																							
	OBL	Purei	*Carex secta*																								
	OBL	kuta	*Eleocharis acuta*																								
	OBL	monkeymusk	*Erythranthe guttata*							2										2		5					
Yes	OBL	sweet grass	*Glyceria fluitans*																								
	OBL	Scripus	*Isolepis caligenis*																								
	OBL	Isolepis	*Isolepis prolifera*	1	1					3																	
	OBL	duck weed	*Lemna disperma*	1	1	3	1	10		2	10		1	3	1	2	1	2	1	10			3	3	3	3	
	OBL		*Luzula leptophylla*																								
	OBL	water forget me	*Myosotis laxa caespitosa*		3	2	3	3		3	3		3	2	3	3	4	3	5	3			2	2	2	2	
	OBL	water cress	*Nasturtium microphyyllum*		10					2					1				1								
	OBL	dwarf montia	*Montia fontana subsp.*	10	40		5	50	2	5	50	2	5		55	50	50	6		50	2						

				Gully/feature	79	80a	80b	82a	82b	83	84	85	86	88	89	90	91	92a	92b	92c
Pasture	**Rating**	**Common name**	**Species**	**Plot no.**	**70**	**71**	**72**	**73**	**74**	**75**	**76**	**77**	**78**	**79**	**80**	**81**	**82**	**83**	**84**	**85**
	FAC	kiokio	Blechnum novae-																	
	FAC		*Euchiton delicatus*																	
Yes	FAC	yorkshire fog	*Holcus lanatus*							10		10		10		10	10	10		
	FAC	hairy pennywort	*Hydrocotyle moschata*	1		1														
Yes	FAC	lotus	*Lotus pedunculatus*				30													12
	FAC	creeping buttercup	*Ranunculus repens*	2	3	2		4		3		3		4				3		
Yes	FACU	yarrow	*Achillea millefolium*																	
Yes	FACU	sweet vernal	*Anthoxanthum*	20		20	1		35		35		35		35	60	35			
	FACU	english daisy	*Bellis perennis*	1		1														
Yes	FACU	chickweed	*Cerastium*	1	4	1	1	5	1	4	1	4	1	5	1	1	1	4	2	
Yes	FACU	Californian thistle	*Cirsium arvense*											1						
Yes	FACU	cocksfoot	*Dactylis glomerata*																	
	FACU	willow herb	*epilobium alsinoides*																	
	FACU	hedge bed straw	*Galium mollugo*																	
Yes	FACU	cats ear	*Hypochaeris radicata*																	
Yes	FACU	hawkbit	*Leontodon taraxacoides*						1		1		2		1	1	1			
	FACU	pratria	*Lobelia angulata*	1		1														
Yes	FACU	rye grass	*Lolium perenne*																	
	FACU	bead plant	*Nertera depressa*																	
Yes	FACU	narrow leaved plaintain	*Plantago lanceolata*																	
	FACU	Prunella	*Prunella vulgaris*																	
Yes	FACU	hairy buttercup	*Ranunculus reflexus*																	
	FACU	Dandy lion	*Taraxacum officinale*														1			
Yes	FACU	Clover	*Trifolium repens*	2		2	23		15		15		15	1	15	2	15			3
Yes	FACW	creeping bent	*Agrostis stolonifera*	2		2														
	FACW	rautahi	*Carex geminata*																	

	FACW	centella	*Centella uniflora*												1	1	1			
	FACW	marsh bed straw	*Galium palustre*																	
Yes	FACW	blue sweet grass	*Glyceria declinata*	60	30	60	40	35	15	34	5	39	15	35	15	1	15	40	40	
	FACW	jointed rush	*Juncus articulatus*																	
	FACW	toad rush	*Juncus bufonius*																	
	FACW		*Juncus conglomeratus*																	
	FACW	Wiwi	*Juncus edgariae*																	
	FACW	soft rush	*Juncus effusus*																	
	FACW	Flat-leaved rush	*Juncus planifolius*																	
	FACW	broom rush	*Juncus sarophorus*	5		5	1		20		30		20		20	22	20			
	FACW	moss	*Shagnum perichaetiale*				2												2	
	OBL	Purei	*Carex secta*																	
	OBL	kuta	*Eleocharis acuta*																	
	OBL	monkeymusk	*Erythranthe guttata*																	
Yes	OBL	sweet grass	*Glyceria fluitans*																	
	OBL	Scripus	*Isolepis caligenis*																	
	OBL	Isolepis	*Isolepis prolifera*				2												2	
	OBL	duck weed	*Lemna disperma*	3	10	3		1		1		1		1						
	OBL		*Luzula leptophylla*																	
	OBL	water forget me not	*Myosotis laxa*	2	3	2		5		3		3		3				3		
	OBL	water cress	*Nasturtium*																	
	OBL	dwarf montia	*Montia fontana subsp.*		50			50	3	55	3	50	2	50	2	1	2	50	30	

				Gully/feature no.	**1**	**2**	**3**	**4**	**5a**	**5b**	**5c**	**T**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**
Pasture	**Rating**	**Common name**	**Species**	**Plot no.**	**-**	**-**	**-**	**-**	**-**	**-**	**-**		**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
	FAC	kiokio	*Blechnum novae-zelandiae*									**R**										
	FAC		*Euchiton delicatus*			35	5	2	10	10	10											
Yes	FAC	yorkshire fog	*Holcus lanatus*									**A**	35		10		8	10	30	10	30	10
	FAC	hairy pennywort	*Hydrocotyle moschata*			2	7	4	10	10	10											2
Yes	FAC	lotus	*Lotus pedunculatus*			5			15	15	15	**N**	10	15	30	20	2	10	10	35	10	10
	FAC	creeping buttercup	*Ranunculus repens*										10		1		2	15	5	1	5	
Yes	FACU	yarrow	*Achillea millefolium*			1	2					**S**										
Yes	FACU	sweet vernal	*Anthoxanthum odoratum*										5	5	1				30	1	30	
	FACU	english daisy	*Bellis perennis*									**M**										
Yes	FACU	chickweed	*Cerastium semidecandrum*				2		1	1	1											
Yes	FACU	Californian thistle	*Cirsium arvense*									**I**						1				
Yes	FACU	cocksfoot	*Dactylis glomerata*											4								
	FACU	willow herb	*epilobium alsinoides*									**S**										
	FACU	hedge bed straw	*Galium mollugo*																			
Yes	FACU	cats ear	*Hypochaeris radicata*									**S**										
Yes	FACU	hawkbit	*Leontodon taraxacoides*			1	6		1	1	1											
	FACU	pratria	*Lobelia angulata*									**I**						1				2
Yes	FACU	rye grass	*Lolium perenne*																			
	FACU	bead plant	*Nertera depressa*									**O**										
Yes	FACU	narrow leaved plaintain	*Plantago lanceolata*																			
	FACU	Prunella	*Prunella vulgaris*																			
Yes	FACU	hairy buttercup	*Ranunculus reflexus*									**N**										
	FACU	Dandy lion	*Taraxacum officinale*					2	10	10	10											

Yes	FACU	Clover	*Trifolium repens*					20	20	20		1	12				10				2
Yes	FACW	creeping bent	*Agrostis stolonifera*									10	5				20				
	FACW	rautahi	*Carex geminata*								**L**										
	FACW	centella	*Centella uniflora*																		
	FACW	marsh bed straw	*Galium palustre*		50	30	70	5	5	5	**I**										
Yes	FACW	blue sweet grass	*Glyceria declinata*			10						8	40		70		5				20
	FACW	jointed rush	*Juncus articulatus*								**N**					90					5
	FACW	toad rush	*Juncus bufonius*																		
	FACW		*Juncus conglomeratus*								**E**										
	FACW	Wiwi	*Juncus edgariae*		3																
	FACW	soft rush	*Juncus effusus*																10		
	FACW	Flat-leaved rush	*Juncus planifolius*				2	25	25	25											
	FACW	broom rush	*Juncus sarophorus*		2	1					**P**	20	12	12			25	20		20	35
	FACW	moss	*Shagnum perichaetiale*																		
	OBL	Purei	*Carex secta*								**L**										
	OBL	kuta	*Eleocharis acuta*																		
	OBL	monkeymusk	*Erythranthe guttata*								**O**										
Yes	OBL	sweet grass	*Glyceria fluitans*																		
	OBL	Scripus	*Isolepis caligenis*								**T**										
	OBL	Isolepis	*Isolepis prolifera*																		
	OBL	duck weed	*Lemna disperma*											40		2			40		5
	OBL		*Luzula leptophylla*			35					**S**										
	OBL	water forget me not	*Myosotis laxa caespitosa*																10		
	OBL	water cress	*Nasturtium microphyyllum*			1															
	OBL	dwarf montia	*Montia fontana subsp. chondros*		1	2	3	4	5a	5b				1							2

Appendix 4: 2011 Survey Sediment and Water Quality Results Tables

Results of Visual Inspection of Sediment

		Transect 1	Transect 2	Transect 3	Transect 4	Transect 5	**Average Cover (%)**
KOP1	Section 1	5%	7%	5%	5%	10%	6%
	Section 2	5%	5%	5%	10%	5%	
KOP2	Section 1	10%	10%	8%	10%	5%	10%
	Section 2	9%	15%	10%	10%	14%	
MAK1	Section 1	18%	10%	8%	10%	10%	13%
	Section 2	15%	15%	13%	21%	13%	
MAK2	Section 1	20%	30%	28%	10%	60%	32%
	Section 2	25%	10%	58%	50%	30%	
MAK3	Section 1	30%	20%	20%	10%	11%	14%
	Section 2	20%	10%	10%	8%	5%	

Measures of Water Quality at Mt Munro Stream Sites

PARAMETER	**KOP1**	**KOP2**	**MAK1**	**MAK2**	**MAK3**
TSS (mg/L)	0.00	0.00	0.00	0.00	0.00
NTU	1.40	15.13	1.93	10.37	11.70
pH	7.50	7.07	7.34	7.06	7.25
Temperature (°C)	15.00	14.10	14.10	16.87	15.20

Appendix 5: Compiled avifauna species list

Refined list of species that use, or may potentially use, the Mt Munro project site based on the desktop review (the OSNZ Atlas 1999-2004 and the Atlas Effort Map 2022, the 2010-2012 survey data (includes that collated during point counts, stream observations (Makakahi River), a nocturnal survey, the transmission line surveys and incidentally) as well as the current 2021-2022 survey data (point counts and incidental observations (during both the point count and transmission line surveys)). The dark green cells indicate primary habitat used by each species and the light green cells indicated secondary habitat used by each species.

SPECIES		CONSERVATION STATUS	HABITAT						DATA SOURCE					
			Native forest	Exotic Forest	Scrub / shrubland	Farmland / open country	Freshwater / wetlands	Coastal / Estuary	Urban/ Residential	OSNZ ATLAS 1999-2004	eBird atlas effort Map data 2022	2010-2012 surveys (Combined)	2021/22 point counts & incid. obs.	2021/22 Trans. line surveys & incid. obs.
Tui	*Prosthemadera n. novaeseelandiae*	Not Threatened								Y	Y			Y
North Island fantail	*Rhipidura fuliginosa placabilis*	Not Threatened								Y	Y	Y	Y	Y
Kereru	*Hemiphaga novaeseelandiae*	Not Threatened								Y	Y	Y	Y	Y
North Island kaka	*Nestor meridionalis septentrionalis*	At Risk - Recovering								Y	Y	Y		Y
Shining cuckoo	*Chrysococcyx l. lucidus*	Not Threatened								Y	Y	Y	Y	Y
Whitehead	*Mohoua albicilla*	Not Threatened								Y	Y			
North Island tomtit	*Petroica macrocephala toitoi*	Not Threatened									Y			
Bush falcon	*Falco novaeseelandiae* "bush"	Threatened - Nationally Increasing								Y	Y		Y	Y
North Island rifleman	*Acanthisitta chloris*	At Risk - Declining								Y	Y			
Kingfisher	*Todiramphus sanctus vagans*	Not Threatened								Y	Y	Y		Y
Bellbird	*Anthornis m. melanura*	Not Threatened								Y	Y			Y
Long-tailed cuckoo	*Eudynamys taitensis*	Threatened - Nationally Vulnerable								Y	Y	Y		
Morepork	*Ninox n. novaeseelandiae*	Not Threatened								Y	Y	Y		
North Island robin	*Petroica longipes*	At Risk -Declining									Y			
North Island kokako	*Callaeas wilsoni*	Threatened – Nationally Increasing									Y			
Silvereye	*Zosterops lateralis lateralis*	Not Threatened								Y	Y	Y	Y	Y
Eastern rosella	*Platycercus eximius*	Introduced									Y			Y
Blackbird	*Turdus merula*	Introduced								Y	Y	Y	Y	Y
California quail	*Callipepla californica*	Introduced									Y			
Pheasant	*Phasianus colchicus*	Introduced								Y				

SPECIES		CONSERVATION STATUS	HABITAT						DATA SOURCE					
			Native forest	Exotic Forest	Scrub / shrubland	Farmland / open country	Freshwater / wetlands	Coastal / Estuary	Urban/ Residential	OSNZ ATLAS 1999-2004	eBird atlas effort Map data 2022	2010-2012 surveys (Combined)	2021/22 point counts & incid. obs.	2021/22 Trans. line surveys & incid. obs.
Grey warbler	*Gerygone igata*	Not Threatened								Y	Y	Y	Y	Y
Redpoll	*Carduelis flammea*	Introduced								Y		Y		
Rook	*Corvus frugilegus*	Introduced										Y	Y	
Swamp harrier	*Circus approximans*	Not Threatened								Y	Y	Y	Y	Y
House sparrow	*Passer domesticus*	Introduced								Y	Y	Y	Y	
Goldfinch	*Carduelis carduelis*	Introduced								Y	Y	Y	Y	Y
Spur-winged plover	*Vanellus miles novaehollandiae*	Not Threatened								Y	Y	Y	Y	Y
Magpie	*Gymnorhina tibicen*	Introduced								Y	Y	Y	Y	Y
Welcome swallow	*Hirundo n. neoxena*	Not Threatened								Y	Y	Y	Y	Y
Dunnock	*Prunella modularis*	Introduced								Y	Y	Y		
Starling	*Sturnus vulgaris*	Introduced								Y	Y	Y	Y	Y
Chaffinch	*Fringilla coelebs*	Introduced								Y	Y	Y	Y	Y
Song thrush	*Turdus philomelos*	Introduced								Y	Y	Y	Y	Y
Yellowhammer	*Emberiza citrinella*	Introduced								Y	Y	Y	Y	Y
Skylark	*Alauda arvensis*	Introduced								Y	Y	Y	Y	Y
Greenfinch	*Carduelis chloris*	Introduced								Y	Y	Y	Y	Y
Wild turkey	*Meleagris gallopavo*	Introduced								Y	Y			
Canada goose	*Branta canadensis*	Introduced								Y	Y			
NZ pipit	*Anthus n. novaeseelandiae*	At Risk - Declining										Y	Y	
Grey duck	*Anas superciliosa*	Threatened – Nationally Vulnerable								Y				
Little shag	*Phalacrocorax melanoleucos brevirostris*	At Risk - Relict								Y				

SPECIES		CONSERVATION STATUS	HABITAT						DATA SOURCE					
			Native forest	Exotic Forest	Scrub / shrubland	Farmland / open country	Freshwater / wetlands	Coastal / Estuary	Urban/ Residential	OSNZ ATLAS 1999-2004	eBird atlas effort Map data 2022	2010-2012 surveys (Combined)	2021/22 point counts & incid. obs.	2021/22 Trans. line surveys & incid. obs.
Black shag	*Phalacrocorax carbo novaehollandiae*	At Risk - Relict								Y				
NZ dabchick	*Poliocephalus rufopectus*	Threatened – Nationally Increasing									Y			
NZ scaup	*Aythya novaeseelandiae*	Not Threatened									Y			
Australasian shoveler	*Spatula rhynchotis*	Not Threatened								Y	Y			
Black swan	*Cygnus atratus*	Not Threatened								Y	Y			
Grey teal	*Anas gracilis*	Not Threatened								Y				
Feral goose	*Anser anser*	Introduced								Y				
Paradise shelduck	*Tadorna variegata*	Not Threatened								Y	Y	Y	Y	Y
Pukeko	*Porphyrio m. melanotus*	Not Threatened								Y	Y	Y		Y
Pied stilt	*Himantopus h. leucocephalus*	Not Threatened								Y				
Mallard	*Anas platyrhynchos*	Introduced								Y	Y	Y		Y
White-faced heron	*Egretta novaehollandiae*	Not Threatened								Y	Y	Y		
Black-backed gull	*Larus d. dominicanus*	Not Threatened								Y	Y	Y	Y	Y
Rock pigeon	*Columba livia*	Introduced								Y	Y	Y	Y	Y

Appendix 6: Detailed assessment of freshwater criteria for assigning ecological values for Mt Munro

Makakahi catchment sites (excluding Bruce Stream)

CRITERIA[21]	ASSESSMENT	VALUE
Representativeness	The catchment's macroinvertebrate community varied between good and fair health with the most recent sampling results EPT taxa account for >50% of the overall taxa richness. This may, in part, be due to a low abundance of fish taxa and limited habitat opportunities. The geographic location (altitude, distance from sea, etc) means historically the tributaries within the site were unlikely to have had a high fish population. The fish present within the catchment are limited to four species, Longfin and shortfin eel, and common and upland bullies in low numbers (plus koura). The macroinvertebrate and fish communities are representative of what would be expected in this stream. The tributaries have appeared to retain some natural characteristics including meander but have been subjected to land use change and continuing nutrient input from farming practices. Relative to other small tributary streams the streams on site are representative of the catchment, given the widespread land use change to agricultural practices.	Moderate
Rarity and distinctiveness	The characteristic of the tributary streams (modified by land use practices – farming) within the catchment are not rare nor distinct within the catchment. Longfin eel are classified as At Risk – Declining (Dunn et al., 2018). We have not taken these threat statuses into account when determining rarity/distinctiveness for this catchment as the classification system used is applicable at a national scale. It is out experience that at the catchment scale, Longfin ell are not rare. The NZFFD records for the Manawatu catchment since 2000 show there have been 396 longfin individuals recorded, 36% of all native fish individuals recorded since 2000.	Low
Diversity and pattern	There is a reasonable amount of hydraulic complexity, including flows over a mixture of substrates within the tributaries across the catchment (though in most cases substrates are overlain or have a large component of fine sediment). There are reasonable habitat opportunities for macroinvertebrates and fish but limited nutrient inputs from riparian vegetation (where present).	Low
Ecological context	Historic land clearance in within the site area as well as much of the catchment to facilitate ongoing farming practices. Stock can access much of the stream within the site as it is predominantly unfenced. Sediment loading would naturally have been high in erodible landscape and as a result on ongoing farm practices.	Very Low
Ecological integrity	Nativeness – Fair-good macroinvertebrate community and low diversity and abundance of fish - Low Pristineness – heavily farmed though some riparian elements present bush - Low Diversity – good macroinvertebrates, limited fish. Mostly homogenous habitat with patches of heterogeneity (mostly run/riffle habitat) - Low Resilience – despite stock access and land clearance, the macroinvertebrate community is fair-good - Moderate	Low
OVERALL ECOLOGICAL VALUE		**Low**

[21] Refer to Appendix 2 for details of each criteria

Kopuaranga catchment sites (excluding Bruce Stream)

CRITERIA[21]	ASSESSMENT	VALUE
Representativeness	The sites macroinvertebrate community varied between fair and good health with the most recent sampling results EPT taxa account for <15% of the overall taxa richness. The fish present within the site are limited to 4 species, Longfin and shortfin eel, and common and upland bully in low numbers (plus koura). Common bully was recorded in 2011 and not in 2021. The macroinvertebrate and fish communities are representative of what would be expected in this stream, and match NZFFD records from stream within the catchment with similar characteristics. The streams have retained some natural characteristics including meander but has been subjected to extensive land use change and continuing nutrient input from farming practices throughout the site. The sites hold no real riparian cover which is relatively uncommon within the upper catchments of the Kopuaranga River. Relative to other sections of stream tributaries with the upper reaches of the Kopuaranga catchment the stream on site are fairly representative of the catchment.	Moderate
Rarity and distinctiveness	Longfin eel are classified as At Risk – Declining (Dunn et al., 2018). We have not taken these threat statuses into account when determining rarity/distinctiveness for this catchment as the classification system used is applicable at a national scale. It is out experience that at the catchment scale, Longfin eel are not rare. There are no distinct macroinvertebrate taxa nor do EPT taxa account for a high percentage of the community.	Low
Diversity and pattern	There is limited hydraulic complexity. There are limited habitat opportunities for macroinvertebrates and fish.	Low
Ecological context	There has been historic land clearance in within much of the catchment to facilitate ongoing farming practices. Stock can access much of the stream within the site as it is predominantly unfenced. Sediment loading would naturally have been high as a result on ongoing farm practices.	Very Low
Ecological integrity	Nativeness – Fair-good macroinvertebrate community and low diversity and abundance of fish - Low Pristineness – heavily farmed, stock access to much of streams – Very Low Diversity – good macroinvertebrates, limited fish. Mostly homogenous with patches of heterogeneity (mostly run/riffle habitat) - Low Resilience – despite stock access and land clearance, the macroinvertebrate community is fair-good - Moderate	Low
OVERALL ECOLOGICAL VALUE		**Low**

Bruce Stream sites

CRITERIA[21]	ASSESSMENT	VALUE
Representativeness	The sites macroinvertebrate community varied between fair and good health with the most recent sampling results EPT taxa account for <40% of the overall taxa richness. The fish present within the site are limited to 3 species, Longfin and shortfin eel, and common bully in low numbers (plus koura). Of all NZFFD records for Bruce Stream, the only additional species recorded is shortjaw kokopu. The macroinvertebrate and fish communities are representative of what would be expected in this stream. The stream has retained natural characteristics including meander but has been subjected to land use change and continuing nutrient input from farming practices throughout the upper reaches (exclusive of Pūkaha Reserve) and within the site. The sites hold a relatively degree of riparian cover which is relatively common within the upper catchments of Bruce Stream. Relative to other	Moderate

CRITERIA[21]	ASSESSMENT	VALUE
	section of Bruce Stream the reaches within the site are representative of the wider Bruce Stream catchment.	
Rarity and distinctiveness	Longfin eel are classified as At Risk – Declining (Dunn et al., 2018). We have not taken these threat statuses into account when determining rarity/distinctiveness for this catchment as the classification system used is applicable at a national scale. It is our experience that at the catchment scale, Longfin eel are not rare. The NZFFD records for the Manawatu catchment since 2000 show there have been 396 longfin individuals recorded, 36% of all native fish individuals recorded since 2000. The proportion of longfin recorded in the Bruce Stream relative to all identified native individuals is a substantial degree higher (90%).	Moderate
Diversity and pattern	Bruce Stream within the site has maintained its meandering paths and heterogentic flows and hydraulic complexity. Flows are over a multitude of substrate types though with high sediment loading within the site (>50% is places). Sediment filling interstitial spaces of substrate limits fish habitat.	Low
Ecological context	There has been historic land clearance in within much of the catchment to facilitate ongoing farming practices. Stock can access much of the stream within the site as it is predominantly unfenced. However within the Bruce Stream system there is a degree of riparian vegetation and some of the headwaters waterways are within Pūkaha Reserve which is a native forested area. Sediment loading would be naturally high as a result on ongoing farm practices.	Moderate
Ecological integrity	Nativeness – lower numbers of macroinvertebrate taxa but good macroinvertebrate community. Low abundances of limited fish species - Low Pristineness – farmed for most of the Bruce catchment though some native bush (Pūkaha) - Moderate Diversity – good macroinvertebrates, multiple fish species. Reasonable habitat and hydraulic complexity driven by sustained- natural flow - High Resilience – despite some stock access, limited riparian vegetation outside of forest areas, and extensive farming land use, the macroinvertebrate community is typically good - Moderate	Moderate
OVERALL ECOLOGICAL VALUE		**Moderate**

About Boffa Miskell

Boffa Miskell is a leading New Zealand professional services consultancy with offices in Auckland, Hamilton, Tauranga, Wellington, Christchurch, Dunedin and Queenstown. We work with a wide range of local and international private and public sector clients in the areas of planning, urban design, landscape architecture, landscape planning, ecology, biosecurity, cultural heritage, graphics and mapping. Over the past four decades we have built a reputation for professionalism, innovation and excellence. During this time we have been associated with a significant number of projects that have shaped New Zealand's environment.

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