APPENDIX 13

Boffa Miskell

Ruakākā Solar Park Development

Ecological Effects Assessment
Prepared for Meridian Energy Limited

28 August 2023

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Executive Summary

Meridian Energy Limited are proposing to construct and operate a 170 ha solar energy park across three sites between Ruakākā township and Marsden Point. This report provides an ecological assessment to inform Meridian Energy's engineering design of the proposed Solar Energy Park and to support their subsequent resource consent application.

The three Sites are mostly grazed exotic grassland, with some areas of shrubland, the occasional mature native and exotic tree, exotic hedgerows and wetlands. The ~ 5 ha of kānuka forest and shrubland, on the southern edge of Site 1A is ecologically significant indigenous vegetation of high ecological value. The proposed development avoids this kānuka forest and shrubland. As the other terrestrial vegetation being removed is generally of low ecological value, the majority of the Sites will be returned to the main current vegetation type (exotic grassland) and planted buffers will be established, the ecological effects on terrestrial vegetation values (excluding the kānuka forest and shrubland) will be **Low to Very Low.**

A total of 19.11 ha of natural inland wetlands were identified across the three Sites, mostly in Site 1 and mostly dominated by exotic vegetation and highly degraded. Of the identified wetlands, the 4.7 ha of open water habitat has high ecological value and are ecologically significant habitat for indigenous fauna. The proposed development includes retention of ~ 2 ha of this open water habitat on Site 1. The levelling of the remainder of the Sites to enable safe piling will result in removal of ~ 17 ha of wetland. This loss of wetland extent will be offset by enlarging and enhancing the retained 2 ha open water wetland on Site 1 and constructing a large indigenous wetland on Site 3, in an area that was historically wetland prior to land clearance and drainage. As the loss of wetland habitat will be short term (~ 3 years), and the offset wetlands will have a larger total extent (~ 19 ha in total) and higher ecological value, the ecological effect of this temporary wetland habitat loss is Low. Effective implementation of a comprehensive Wetland Restoration and Management Plan, including control of animal and plant pests, is expected to increase the breeding success of birds that inhabit the site and therefore, have a **positive** effect on wetland and avifauna ecological values in the short to medium term.

All watercourses within the three sites are farm drainage channels, which have low ecological value. The exception is the Unnamed Drain on the edge of Site 3, which has Moderate to High ecological value. The main concern of the proposed development on freshwater values is through sedimentation and stormwater runoff, impacting water quality. These potential impacts will be managed through appropriate sediment and erosion control measures and potential positive impacts are predicted due to the change of land use from cattle grazing to sheep grazing. With effective implementation of the Erosion and Sediment Control Plan, the ecological effects on freshwater values will be **Very Low**.

The proposed Sites have Very High to High avifauna value, moderate to High herpetofauna value and High bat habitat value. As there will be removal of potential native bird, lizard, fish and bat habitat, that could lead to injury or mortality, and there are other potential effects during construction and operational stages, several mitigation measures have been proposed. These measures include, for example, targeted lizard salvage, staged clearance, avoiding important seasons, application of bat roost protocols, pest control of main mammalian predators and best practice for drain maintenance. Effective implementation of these mitigation measures will minimise the overall level of effect on bird, lizard, fish and bat ecological values to be **Very Low to Low**, with the potential for positive effects in the short to medium term, particularly for lizards and birds.

Overall, by effectively implementing the outlined avoidance and mitigation strategies the level of ecological effects of the proposed Ruakākā solar park development on terrestrial values is expected to be **Low** to **Very Low**, on wetland values is likely to be **Low** and on freshwater values is likely to be **Very Low**, with an expected **Net Gain** in terrestrial vegetation, wetland, avifauna and herpetofauna values in the short to medium term (~ 3 - 5 years).

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1.0 Introduction

1.1 Background

Meridian Energy Limited are proposing to construct and operate a large-scale solar energy park across three sites between Ruakākā township and Marsden Point, approximately 15 km south-east of Whangārei. The proposed development involves the construction, operation, and maintenance of the solar farm consisting of approximately 200,000 photovoltaic solar panels set across 170 hectares, which will have an installed capacity of approximately 130 MW. This report provides an ecological assessment to inform Meridian Energy's engineering design of the proposed Solar Energy Park and to support their subsequent resource consent application.

1.2 Report scope

The scope of this assessment is:

- Desktop survey and compilation of available information on the site and local environment.
- Site walkover and vegetation, avifauna, and herpetofauna surveys including vegetation plots and delineation of wetland features.
- Evaluation of ecological values, including significance.
- Evaluation of the magnitude and level of effects on ecological values as a result of proposed activities.
- Identification of opportunities to address ecological effects, having regard to the “effects management hierarchy”.

A particular focus of this evaluation is the provisions of the National Environmental Standards for Freshwater (NES-F), which regulate activities within, and in the vicinity of, natural inland wetlands. We understand that the proposed Solar Park is “Specified Infrastructure”, meaning that there is a consenting pathway for the project notwithstanding the presence of natural inland wetlands within the site. Nevertheless, where wetlands are identified in the vicinity of proposed works, the National Policy Statement for Freshwater management (NPS-FM) requires an “effects management hierarchy” approach to addressing potential adverse effects, i.e., avoid adverse effects where practicable, then minimise, offset or compensate.

1.3 Site Description

The proposed solar park will be constructed across three sites located between Ruakākā and Marsden Point, with a total area of 202 ha (Figure 2). The flat to undulating sites are in a low-lying coastal area, surrounded by land predominately used for agricultural and industrial activities.

Prior to human colonisation and associated vegetation clearance, the sites and surrounding land would have been dominated by wetlands, dunelands and kauri/taraire-kohekohe-tawa forest (Appendix 1). Site 1 would’ve likely been about two thirds dune forest (totara, kānuka, broadleaved forest) and one third bog/fen mosaic, Site 2 was likely mostly gumland (mānuka,

gumland grass/tree, scrub/sedgeland) and Site 3 mostly bog/fen mosaic with some dune forest (Singers & Lawrence, 2018).

The largest of the sites (hereafter referred to as Site 1) is 105 ha, located to the southwest of the Marsden Point Oil Refinery and is adjacent to the Carter Holt Harvey LVL Plant. Site 1 is bordered by State Highway 15A to the west, Rama Road to the north, Bream Bay to the east and Alice Bloy Place to the south and is zoned Heavy Industry in the Whangarei District Plan.

The topography of Site 1 has formed from consolidated dunes and is gently undulating, with remnant dune crests and slacks aligned parallel to the coast. The site is intersected by a large drain (Bercich Drain) that runs northeast – southwest, with numerous minor drains running parallel and perpendicular.

Site 1 is a mix of exotic grassland, shrubland and wetland with the occasional shelter belt or tree. The western two-thirds is pastoral farmland used for cattle grazing (Sites 1B and 1C, Figure 1). While the eastern third has been retired from grazing for some years receiving minimal management or maintenance and is a mosaic of opened water wetlands, rank grassland and exotic and native scrub (Site 1A, Figure 1). The disposal field for the treated wastewater for Ruakākā township is in the shrubland to the south-east of site 1B and 1C. Construction of the Battery Energy Storage System (BESS) is underway on the north-eastern corner of Site 1A (Figure 1).

Site 2 is 41 ha of pastoral farmland used for cattle grazing, located adjacent to Port Marsden Highway (State Highway 15) and McCathie Road. Site 3 is 55 ha of pastoral farmland also used for cattle grazing located adjacent to Marsden Point Road and McCathie Road. Sites 2 and 3 are zoned as Light Industrial and Rural Production respectively, in the Whangarei District Plan.

Sites 2 and 3 have flat topography with some large drainage channels and numerous minor channels. The vegetation is mainly exotic pastoral grasses with some exotic shelterbelt trees and the occasional native tree. Two large stormwater retention ponds, both with open water and dense rushes, are located between sites 2 and 3.

1.4 Ecological context

Ecological Region and District

All three sites are located in the Waipu Ecological District, in the Eastern Northland Ecological Region. Marsden Point Beach on the eastern side of Site 1, is part of an area of “High Natural Character” in the Regional Policy Statement for Northland (Figure 2). The eastern most 200 m of Site 1A is identified as being within the 'Coastal Environment' in the Regional Policy Statement for Northland.

Several Significant Natural Areas (SNAs), identified through the Department of Conservation Protected Natural Areas Programme survey of Waipa Ecological District, are located near the Project Sites (Lux et al., 2007). The closest is the 725 ha Ruakaka Dunelands, which extends into Site 1A (Figure 2). There are also two small wetlands adjacent to the Sites that have been identified as SNAs; McEwan Road Wetland and Sime Road Wetland, which are both included in the top 150 wetlands in Northland, ranked 55th and 57th respectively (Wildland Consultants Ltd, 2011). The closest indigenous forest habitats identified as SNAs are Takahiwai Forest, about 1.5 km to the west of the Sites and Ruakākā Forest, about 4 km southwest of the Sites.

Threatened Environments

The Threatened Environment Classification 2012 identifies 'Threatened Environments' in New Zealand, which are areas where very little of the original indigenous vegetation remains and/or a low proportion of what remains is legally protected (Walker et al., 2015).

While Sites 2 and 3 are located in threat category 1; <10% indigenous cover left (Appendix 1), there is no indigenous ecosystems remaining on these sites. Likewise, while Site 1 is a mix of threat category 1 and threat category 2 (10-20% indigenous cover left), there is very little indigenous vegetation remaining.

It is also important to note that this classification was developed at a national scale, so should be used cautiously at a local scale and where available, regional/local information should also be used to determine significance. Lux et al. (2007) identified that 20% of dune systems remain in the Waipu Ecological District, the majority of which is highly modified, eg, dominated by introduced plant species, damaged by vehicle access and impacts of land use.

Naturally Uncommon Ecosystems

A national classification that identifies terrestrial ecosystems that were rare before humans arrived in New Zealand has identified 72 naturally uncommon ecosystems nationally (Holdaway et al., 2012; Williams et al., 2007; Wiser et al., 2013).

While the Sites, particularly Site 1, do contain coastal and wetland ecosystems that have been identified as naturally uncommon, including active sand dunes, stable sand dunes and dune slacks, the systems remaining in the Sites today are highly modified, and the original biological components of these rare systems are largely gone or degraded. The majority of the value in these features now, due to their degraded, highly modified state, is in their potential to be restored, not their current state.

1.5 Proposed Development

The proposed solar farm will be approximately 200,000 photovoltaic solar panels set across 170 ha, over the three Sites. The solar farm is anticipated to produce 130 MW of electricity and will be constructed of bifacial monocrystalline panels mounted on a fixed tilt (10 - 25˚) system aligned in rows running east-west or a Single Axis Tracking (SAT) system running north-south on all three sites.

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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

Projection: NZGD 2000 New Zealand Transverse Mercator

LEGEND
Site Boundary
Consented BESS area

RUAKĀKĀ ENERGY PARK
Site Overview
Date: 15 August 2023 | Revision: 0
Plan prepared by Boffa Miskell Limited
Project Manager: Tanya.Cook@boffamiskell.co.nz | Drawn: HCo | Checked: TCo

Map 1

Figure 1: Proposed Sites for the Ruakākā Energy Park Development, near Marsden Point.

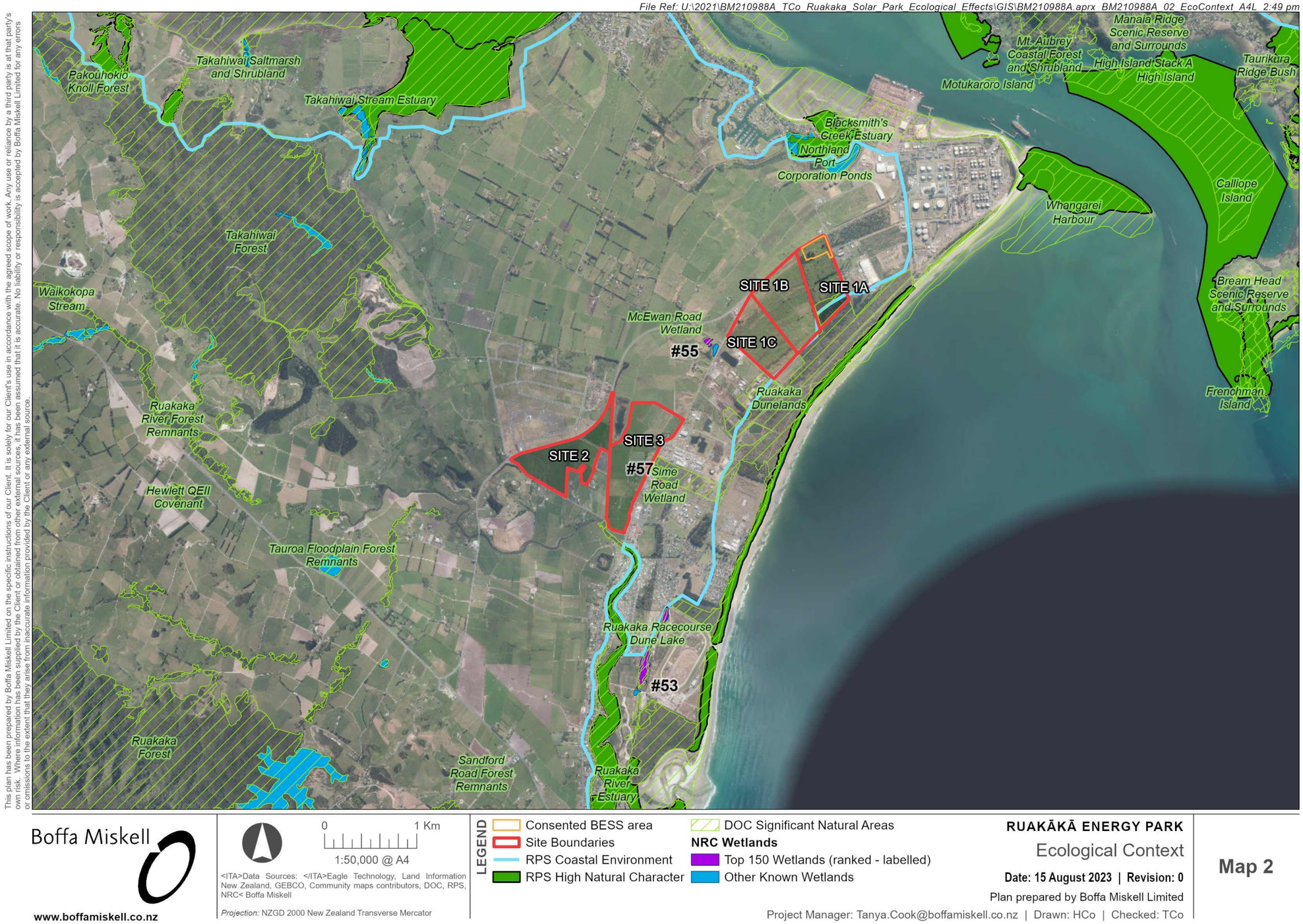

Figure 2: Ecological features of significance within the vicinity of the Proposed Sites

2.0 Relevant Policies and Plans

2.1 Overview

The key statutory definitions and criteria in both National and Local Government policies and plans relevant to this Assessment of Ecological Effects are outlined below.

This section is not intended as a statutory assessment; rather the purpose is to inform our ecological assessment. Refer to the Assessment of Environmental Effects for a detailed statutory assessment.

2.2 New Zealand Coastal Policy Statement (NZCPS)

The purpose of the NZCPS is to state policies in order to achieve sustainable management of natural and physical resources in the coastal environment of New Zealand.

Policy 11 of the NZCPS aims to protect indigenous biological diversity in the coastal environment. As covered above, the eastern most 200 m of Site 1A falls within the "coastal environment".

2.3 National Policy Statement for Indigenous Biodiversity (NPS-IB)

The NPS-IB released on the 7 July 2023, provides national direction to help protect, maintain and restore New Zealand's terrestrial indigenous biodiversity. However, under section 1.3(3) it does not apply to the "*development, operation, maintenance or upgrade of renewable electricity generation assets and activities and electricity transmission network assets and activities."*

2.4 National Policy Statement for Freshwater Management (NPS-FM)

The objective of the NPS-FM is to ensure that natural and physical resources are managed in a way that prioritises:

- first, the health and well-being of water bodies and freshwater ecosystems;
- second, the health needs of people (such as drinking water); and
- third, the ability of people and communities to provide for their social, economic, and cultural well-being, now and in the future.

The NPS-FM provides regional councils with updated direction on how they should manage freshwater under the Resource Management Act 1991 (RMA), including introducing a variety of policies or modifications to policies, as well as setting out specific tasks to be undertaken. The NPS-FM also directs that councils be satisfied that the 'effects management hierarchy'

approach (as set out in the NPS-FM) is applied to existing and potential values of existing waterbodies and wetlands (except where exemptions provide for it).

The NPS-FM sets out 15 policies for the management of freshwater in New Zealand. While all of the policies are relevant, we draw particular attention to the following:

Policy 1: Freshwater is managed in a way that gives effect to Te Mana o te Wai.

Policy 2: Tangata whenua are actively involved in freshwater management (including decision-making processes), and Māori freshwater values are identified and provided for.

Policy 3: Freshwater is managed in an integrated way that considers the effects of the use and development of land on a whole-of-catchment basis, including the effects on receiving environments.

Policy 5: Freshwater is managed through a National Objectives Framework to ensure that the health and well-being of degraded water bodies and freshwater ecosystems is improved, and the health and well-being of all other water bodies and freshwater ecosystems is maintained and (if communities choose) improved.

Policy 6: There is no further loss of extent of natural inland wetlands, their values are protected, and their restoration is promoted.

Policy 9: The habitats of indigenous freshwater species are protected.

The consistency of the proposal with these policies is assessed in the Statutory Assessment contained in the AEE.

The NPS-FM also provides the policy framework for the National Environmental Standard for Freshwater (NES-F), including a definition for "natural inland wetlands" (refer to 3.2), which are subject to regulatory controls under NES-F provisions.

2.5 National Environment Standards for Freshwater

The NES-F places controls on certain activities that pose risks to freshwater and freshwater ecosystems. The controls mainly relate to farming activities, and the protection of natural inland wetlands and fish passage through waterways. These provisions have been considered in the ecological assessment of wetlands and watercourses on the Proposed Sites.

2.6 Regional Policy Statement for Northland

2.6.1 Overview

The Regional Policy Statement for Northland (RPSN) provides the broad direction and framework for managing the region's natural and physical resources. It identifies significant resource management issues for the region and sets out how resources such as land, water, soil, minerals, plants, animals and structures will be managed.

The objectives and policies relevant to the potential ecological effects of the proposed activities are contained in Part 3 (Objectives) and Part 4 (Policies – Water, land and common resources). The consistency of the proposal with these objectives and policies is assessed in the Statutory Assessment contained in the AEE. The following objectives and policies have informed our approach for our Assessment of Ecological Effects.

2.6.2 Identification and Management Ecological Values

Objective 3.4 of the RPSN seeks to protect the ecological integrity of Northland's indigenous ecosystems and biodiversity by:

a) Protecting areas of significant indigenous vegetation and significant habitats of indigenous fauna;

b) Maintaining the extent and diversity of indigenous ecosystems and habitats in the region; and

c) Where practicable, enhancing indigenous ecosystems and habitats, particularly where this contributes to the reduction in the overall threat status of regionally and nationally threatened species.

Policy 4.4.1 of the RPSN requires that subdivision, use and development avoids, remedies or mitigates adverse effects on significant ecological areas and habitats so they are no more than minor, including:

- *Indigenous taxa that are listed as threatened or at risk in the New Zealand Threat Classification System lists;*
- *Areas of indigenous vegetation and habitats of indigenous fauna, that are significant using the assessment criteria in Appendix 5 (of the RPSN);*
- *Areas set aside for full or partial protection of indigenous biodiversity under other legislation*
- *Areas of predominantly indigenous vegetation;*
- *Habitats of indigenous species that are important for recreational, commercial, traditional or cultural purposes;*
- *Indigenous ecosystems and habitats that are particularly vulnerable to modification, including wetlands, dunelands, northern wet heathlands, headwater streams, floodplains and margins of freshwater bodies, spawning and nursery areas.*

Policy 4.4.1 notes that if adverse effects cannot be reasonably avoided, remedied or mitigated then it may be appropriate to consider biodiversity offsetting followed by environmental biodiversity compensation.

Appendix 5 of the RPSN specifies that an area of indigenous vegetation or habitat(s) of indigenous fauna is significant if it meets one or more criteria for:

1. Representativeness,
2. Rarity and distinctiveness,
3. Diversity and pattern,
4. Ecological context.

2.6.3 Significant Wetlands

The RPSN identifies freshwater wetlands as a particularly modified and vulnerable ecosystem type, noting less than 5% of Northland's wetlands remain as a result of drainage, water diversion, disconnection and disturbance, including as a result of stock access.

Wetlands are deemed to meet significance criteria for Rarity and Distinctiveness if they comprise indigenous ecosystems or indigenous vegetation types, *and* are examples of the wetland classes that trigger Appendix 5 criteria, *or* exceed any of the following area thresholds:

a) *Saltmarsh greater than 0.5 hectare in area; or*

b) *Shallow water (lake margins and rivers) greater than 0.5 hectare in area; or*

c) *Swamp greater than 0.4 hectare in area; or*

d) *Bog greater than 0.2 hectare in area; or*

e) *Wet Heathlands greater than 0.2 hectare in area; or*

f) *Marsh; Fen; Ephemeral wetlands or Seepage / flush greater than 0.05 hectares in area.*

2.7 Proposed Regional Plan for Northland

Section C.2 of the Proposed Regional Plan for Northland Appeals Version – June 2023 (PRPN) sets out the rules relating to activities in the beds of lakes and rivers and in wetlands.

The PRPN includes definitions that relate to wetlands. In addition to the NPS-FM definition for a natural inland wetland, the PRPN defines a Natural Wetland as:

"Any wetland including an induced wetland and a reverted wetland, regardless of whether it is dominated by indigenous vegetation, but does not include: a constructed wetland, or wet pasture, damp gully heads, or areas where water temporarily ponds after rain, or pasture containing patches of rushes".

The PRPN further differentiates “significant wetlands” from other wetlands (as defined in the RMA), based on the significance criteria set out in Appendix 5 of the RPSN. More stringent rules apply in significant wetlands than in other natural wetlands.

Other rules of the PRPN relevant to the proposed sites are section C.6.4, which covers stormwater discharges to land and water, and section C.8.2, C.8.3 and C.8.4, which cover land use and disturbance activities, including land preparation, earthworks and vegetation clearance.

Finally, Section D.2.18 of the PRPN sets out the rules relating to managing the adverse effects of activities on indigenous biodiversity in the coastal environment and outside the coastal environment.

2.8 Whangarei District Plan

The Ecosystems and Indigenous Biodiversity chapter of the District Plan Operative in Part 2022 contains objectives and policies that seek to maintain and enhance ecosystems and biodiversity and provide protection for indigenous vegetation and habitats of indigenous fauna, including indigenous wetlands, which are of Moderate, Moderate-High, High or Outstanding value as determined by the criteria set out in ECO-SCHED1.

3.0 Methods

3.1 Terrestrial vegetation

Terrestrial vegetation was surveyed during site visits to undertake wetland assessments and lizard surveys (refer to Sections 3.2 and 3.5 below). This included a walk-over survey of each site, identifying and photographing the main areas of vegetation and mature trees, using ESRI fieldmaps and the in-built GPS in a tablet and/or mobile phone. The vegetation communities were then mapped using ArcGIS online.

3.2 Wetlands

3.2.1 Identification of wetlands

The RMA definition of a wetland is *"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*".

A desktop review was undertaken to identify potential areas that could meet this RMA definition of a wetland, using recent satellite and drone imagery (Appendix 2), historical aerial imagery (Appendix 3) and topography (contours).

Site visits were undertaken to identify and delineate wetland features, using the national wetland delineation protocols. The sites have been visited on various dates, due to unseasonal weather conditions and changes in vegetation, drainage and grazing pressure (Table 1).

Table 1: Site visits to identify and delineate wetlands on the Proposed Sites

Date	Sites covered	Rainfall (mm) 7 days prior[1]	Rainfall (mm) 1 month prior
27 Oct – 2 Nov 2021	1 (A, B & C)	152	255
31 May 2022	1A	29.5	67.5
20 June 2022	1B & 1C	27	177
7 & 8 March 2023	1A	0.5	344.5
22 March 2023	1B	12	104
4 March 2022	2 & 3	0	110
15 November 2022	2 & 3	195	270

3.2.2 Delineation of natural inland wetlands

The NPS-FM refers to a national wetland delineation protocol to assist in cases of uncertainty or dispute about the existence or extent of a wetland as defined in the RMA (Ministry for the

[1] NRC Rainfall Station: Whangārei Harbour at Marsden Point Oil Refinery

Environment, 2022b). This protocol uses vegetation, soil and hydrology indicators and references a schedule of hydrophytic plants. "Hydrophytes" (hydrophytic vegetation) are defined in the Wetland Delineation Protocols as **"***plant species capable of growing in soils that are often or constantly saturated with water during the growing season*". The NPS-FM protocol uses a standard vegetation plot[2] to identify and delineate natural wetlands, and no minimum wetland size is specified. Therefore, the broad scope of the definition encompasses localised areas of wet-tolerant rushes and herbs within low-lying areas and overland flow paths.

The hydrophyte categories (wetland indicator status ratings: Clarkson (2021)[3] and subsequent updates) are:

- Obligate (OBL): occurs almost always in wetlands (estimated probability >99% in wetlands)
- Facultative Wetland (FACW): occurs usually in wetlands (67–99%)
- Facultative (FAC): equally likely to occur in wetlands or non-wetlands (34–66%)
- Facultative Upland (FACU): occurs occasionally in wetlands (1–33%)
- Upland (UPL): rarely occurs in wetlands (<1%), almost always in 'uplands' (non-wetlands).

Hydrophytic species include a number and variety of wet tolerant herbaceous exotic plants, including common constituents of pasture (both intentional and accidental).

The vegetation, soil and hydrology tools are applied following a hierarchical sequence of tests, each requiring an increasing level of detail shown by the wetland delineation flow chart from the Ministry for the Environment (2022b) provided in Appendix 4. In summary, these tests comprise:

- Rapid Test: if all dominant species[4] have a wetland indicator status of OBL or FACW, the feature is a wetland.
- If the Rapid Test failed to identify the area as a wetland than the Dominance and Test and Prevalence Index were applied:
  - Dominance Test (DT): If >50% of the dominant species are OBL, FACW or FAC
  - Prevalence Index (PI): a plot-based algorithm derived from the species composition and cover abundance of plants is calculated. The vegetation is considered to be hydrophytic (wetland) if PI ≤ 3.0.
  - If the area passes both the DT and PI, the feature is a wetland.
- If there is uncertainty with the area or if the area passes one but not both the DT and PI, or if all/most (ie, > 50%) dominant species are FAC (or FACU or UPL), then the Hydric soils and Wetland hydrology tools were applied:
  - If the area passes both tools, it is a wetland.

[2] As per protocols, a 2 x 2 m plot was used for the herbaceous stratum and 10 x 10 m for the shrub stratum

[3] New Zealand wetland plant indicator status ratings 2021 - Appendix 1 - New Zealand wetland plant indicator status ratings 2021 - Manaaki Whenua - Landcare Research DataStore

[4] *Dominant species = The most abundant plant species (when ranked in descending order of abundance, eg, in a plot, and cumulatively totalled) that immediately exceed 50 per cent of the total cover for the stratum, plus any additional species comprising 20 per cent or more of the total cover for the stratum. This is known as the 50/20 rule, and is calculated for each stratum (tree, sapling/shrub and herb).*

- If the area passes the Wetland hydrology tool but fails the Hydric soils tool, it is a wetland.
- If the area fails both, it is not a wetland.

The NPS-FM (December 2022) defines a "natural inland wetland" as a wetland (defined in the RMA) that is not:

(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.

Clause (e) is the only exclusion that pertains to any of the wetlands identified on the proposed sites. The percentage cover of pasture species[5] was assessed for each vegetation plot, following the national Pasture Exclusion Methodology (Ministry for the Environment, 2022a).

3.2.3 Wetland mapping

The majority of the wetlands were identified using the Rapid test as they were dominated by FACW or OBL species. Vegetation plots, hydric soil and wetland hydrology indicators were assessed in areas of uncertainty following the methods outlined in the Wetland Delineation Protocols (Ministry for the Environment, 2022b). Maps showing the location of vegetation plots and observation points across the three sites and the results of the delineations are provided in Appendix 5.

A representative selection of identified wetland features were delineated on-site by walking their boundary using ESRI fieldmaps and the inbuilt GPS on an ipad or cellphone. These field delineated wetlands were then used to guide the mapping of all other wetland features within the Sites based on the hydrology and vegetation data from recent satellite and drone imagery, and topography data. Where the vegetation and/or hydrology has changed over the last two years, the results of the most recent site visit were used.

[5] The Pasture Species list provided in Appendix 1 of the Pasture Exclusion Methodology was used. Pasture-exclusion-assessment-methodology.pdf (environment.govt.nz)

3.3 Freshwater

3.3.1 Field Assessments

No formal surveys of freshwater fauna were undertaken in the wetlands or watercourses present on the proposed Sites. However, the main watercourses were walked during site visits and general observations of habitat availability and quality were assessed. Any biota observed were noted.

3.3.2 Watercourse classification

The PRPN does not have a definition for River, so we have used the RMA definition for **River**:

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

Based on this definition artificial watercourses, such as farm drainage channels, would not be classified as a river. However, the PRPN includes the following definition for an **Artificial watercourse**:

"A man-made channel constructed in or over land for carrying water and includes an irrigation canal, roadside drains and water tables, water supply race, canal for the supply of water for electricity power generation and farm drainage canals. It does not include a channel constructed in or along the path of any historical or existing river, stream or natural wetland."

Therefore, where we have identified that a watercourse within the sites is in or along the path of a historical or existing river, or natural wetland, we have considered it is not an Artificial Watercourse. For these watercourses to determine whether they meet the RMA definition of a river, we have used the PRPN definition for an **Intermittently flowing river or stream**:

"A river that is naturally dry at certain times of the year and has two or more of the following characteristics:

1) it has natural pools, and

2) it has a well-defined channel, such that the bed and banks can be distinguished, and

3) it contains surface water more than 48 hours after a rain event which results in river flow, and

4) rooted terrestrial vegetation is not established across the entire cross-sectional width of the channel, and

5) it appears as a blue line on topographical maps at 1:50,000 scale."

Based on this definition, Bercich Drain on Site 1 and Unnamed Drain on Site 3 are classified as rivers (refer to Section 4.3).

3.3.3 Habitat quality

Stream habitat quality and abundance was assessed for watercourses that were identified as being an intermittently or continually flowing river or stream, using the Rapid Habitat Assessment method (Clapcott, 2015). This involves scoring 10 different stream habitat criteria

and summing the scores, with a higher overall score indicative of better stream habitat quality and abundance. A total Habitat Quality Score of 0-25 indicates poor habitat condition, 26-50 fair, 51-75 good and 76-100 excellent (Clapcott et al., 2020).

3.3.4 Freshwater fish

A review of New Zealand Freshwater Fish Database records within 5 km of the sites was undertaken and the results of a fish survey on Site 1, undertaken in August 2020 (Wildland Consultants Ltd, 2022) was also reviewed. The focus of the 2020 fish survey was to determine whether mudfish were present on site and therefore it involved 50 gee minnow traps deployed in wetland and drain habitats for three trap nights.

The NIWA Fish Passage Assessment Tool was also reviewed to check for potential barriers to fish passage[6].

3.4 Avifauna

3.4.1 Desktop review

A list of bird sighting records was compiled of all relevant species recorded in a 20 km radius of the sites, using ebird and inaturalist. Species that did not have an association with the habitats found within the site were excluded.

3.4.2 Field surveys

No formal bird counts were undertaken during surveys in 2021 and 2022, however, incidental observations were recorded.

Avifauna surveys were undertaken throughout March 2023, with a focus on cryptic wetland species. Preliminary site visits and a desktop review of aerial imagery identified Site 1 to have more habitat and higher quality habitat for cryptic wetland birds compared to Sites 2 and 3, so this site received greater survey effort.

Point counts along transects throughout all sites were undertaken. Observations were undertaken with 10x42 binoculars covering all diurnal and tidal periods, peak tidal periods were targeted multiple times to determine the Sites' value for coastal and wader species.

Playback surveys were undertaken to target cryptic wetland species. Playback was used for Pūweto / spotless crake (*Zapornia tabuensis*), Kotoreke / marsh crake (*Porzana pusilla affinus*), Mohu-perurū / banded rail (*Gallirallus phillippensis assimilis*), and Mātātā / fernbird (*Bowdleria punctata* vealeae).

Playback surveys involve playing the call of the target species through a speaker or other suitable device in an attempt to elicit a response call from cryptic wetland bird species that may be otherwise difficult to detect.

Recordings (<1 minute) of the calls of the target cryptic wetland birds were played through handheld bluetooth speakers followed by a 2-minute period of listening for any response calls,

[6] NIWA fish Passage Assessment Tool; Fish Passage Assessment Tool (niwa.co.nz), accessed on 12 May 2023.

before repeating the call. The relative distance and location of each bird call heard was estimated, to assess whether multiple individuals of the same species were present.

The surveys began 1 ½ hours before first light, from the same locations within the higher value habitat found across Sites 1, 2 and 3. The two stormwater ponds between Sites 2 and 3 were also surveyed four times during March 2023. During each site visit a list of bird species seen and/or heard was assembled.

3.4.3 Data constraints

The following data constraints have been identified and taken into consideration for this assessment:

- eBird: An open-source application for people to upload avifauna observations. Anyone can upload records, so this includes a wide range of species identification skills, and this is not a standardised survey method with ranging survey effort which adds to the variability of the records.
- Site observations: The site visits for avifauna surveys are a brief snapshot in time of the avifauna assemblage present during that particular tide, time of day and season.

3.5 Herpetofauna

3.5.1 Desktop review

A desktop assessment of the three Sites was undertaken by viewing the Sites on Google Earth to determine the location of each of the Sites with respect to contiguous habitats and representative vegetation types. A search of the Department of Conservation's herpetofauna database was undertaken to determine what lizard species are known to be present within 10 km of the site within the contiguous landscape (i.e. excluding records from Whangarei Heads which are < 5 km away but separated by Whangarei Harbour).

3.5.2 Field surveys

Site 1A

A formal lizard survey commenced in November 2022, with two passive lizard detection tools deployed across vegetation and habitats (mainly comprising rank grassland and gorse shrubland) throughout Site 1A (Appendix 6). However, within weeks of deployment, transects 1 and 2 were removed due to the northern section of the property being subject to regular mowing.

The survey tools selected were tracking tunnels with inked tracking cards and ground-based artificial cover objects (ACOs) made from onduline. These tools were selected due to being passive tools that do not require the entrapment, capture, or handling of lizards to detect their presence.[7]

[7] An approved Wildlife Act Authority (WAA) permit is required for the capture, trapping, handling, relocation and killing of indigenous lizards. These activities cannot be undertaken without a WAA being issued by the Department of Conservation.

Survey equipment was left undisturbed for eight weeks before being inspected on five separate occasions between December 2022 and February 2023. Tracking cards were inspected and changed on four occasions.

An evening spotlighting survey was undertaken by one herpetologist and one ecologist in March 2023 during fine weather conditions (>10° with little to no wind or rain). Spotlighting was undertaken for three-person search hours within the area of kānuka forest and shrubland, which offers potentially favourable habitat for elegant gecko and possibly Pacific gecko.

Sites 1B, 1C, 2 and 3

These sites were surveyed during the latter half of the 2022-2023 field season, with survey equipment being deployed in February 2023 and surveys were undertaken in April and May. A combination of ACOs (n= 22) and tracking tunnels (n=21) were installed throughout areas of rank grassland, scrub and areas surrounding woody debris (Appendix 6). The equipment was left undisturbed in-situ for eight weeks before being inspected on three occasions. Tracking tunnels were inspected and refreshed on three occasions across six weeks. Survey equipment was removed in May 2023.

3.6 Bats

No formal field surveys for bats or roost tree assessments were undertaken. Records in the DOC bat database[8] within 25 km of the Proposed Sites were reviewed. A desktop assessment was undertaken using GIS to determine the location of each of the Sites with respect to nearby forests and other potential bat habitat and known bat populations and records. The vegetation within the Sites and surrounding landscape was assessed using a combination of site visits and GIS to identify potential habitats and ecological features of relevance to bats.

3.7 Ecological Effects Evaluation

3.7.1 Overview

The ecological significance of vegetation and fauna habitats was evaluated using criteria set out in the RPSN.

The method for assessing the magnitude and level of ecological effects on ecological features associated with the proposal (in accordance with Policy 4.4.1 of the RPSN) was based on the Environment Institute of Australia and New Zealand's (EIANZ) Ecological Impact Assessment Guidelines (Roper-Lindsay et al. 2018).

In summary, this method required an assessment of:

- Ecosystem/habitat and species values, as described in Section 3.7.2 ;
- Magnitude of effect using the criteria listed in Section 3.7.3; and
- Level of ecological effect using the decision matrix presented in Section 3.7.4, which determines the level of effect based on the ecological value of the ecosystems or species assessed and the magnitude of effect.

[8] Based on most recent data available, which was extracted from database and supplied by DOC on 10 March 2022.

3.7.2 Assessment of ecological values

Ecological value has aspects of both quantity (rarity or extent) and quality (integrity, functionality, or condition), and incorporates an array of attributes across multiple levels of ecological organisation (species, communities, habitats, and ecosystems). EIANZ guidelines (Roper-Lindsay et al., 2018) provide a summary scale whereby a site's value is assessed as the extent to which an area or site exemplifies qualities of representativeness, rarity/distinctiveness, diversity and pattern, and ecological context characteristic of its ecosystem type. The criteria for freshwater ecological values, also includes as assessment of ecological integrity, which considers the structural and functional components of the freshwater feature. We have assessed terrestrial, wetland, and freshwater components (communities, habitats, and species) of the ecosystem against these criteria to determine the key values of the ecological features present.

Terrestrial and freshwater ecological features were ranked on a scale from "Negligible" to "Very High" value, based on the attributes outlined in Roper-Lindsay et al. (2018), as provided in Appendix 7.

3.7.3 Assessment of magnitude of effects

Once the values of ecosystem components have been identified and determined, the magnitude of the impact, if an impact is likely/expected, is assessed. Magnitude of effect is a measure of the extent or scale of the impact, its duration, and the degree of change that it will cause. A typical scale of magnitude ranges from "Negligible" to "Very High" (severe), as outlined in Table 25 in Appendix 7.

These criteria were considered firstly with the known proposed activities outlined in Section 6 and then with the recommended effects management in Section 8.

3.7.4 Assessment of level of ecological effect

The overall level of the effect, where there is a likely or predicted negative impact, was determined by applying the matrix in Table 26 in Appendix 7, which combines the ecological value and magnitude of effect to determine the level of ecological effect.

4.0 Ecological Values

4.1 Terrestrial vegetation

All three Sites are mostly grazed exotic grassland, with some areas of shrubland, the occasional mature native tree and exotic hedgerows. We identified seven terrestrial vegetation types across the proposed sites (Figure 5 and Figure 6).

Exotic grassland

Exotic grassland dominates all three Sites, including a mix of pasture species, such as rye grass, kikuyu and clover, as well as pastoral weeds, such as dock. Sites 1B, 1C, 2 and 3 are

grazed pastoral farmland used for cattle grazing, while Site 1A has been retired from grazing for some years receiving minimal management or maintenance and is a mosaic of rank grassland, wetlands and exotic and native scrub (Figure 3). The grassland tends to dominate the flat and slightly elevated areas, with wetland vegetation present in the low-lying slacks between historical dune crests, particularly in Site 1 (refer to section 4.2).

Figure 3: Grazed exotic pasture in Site 3, typical of all grazed grassland areas, and kikuyu dominated grass sward in Site 1A in May 2022

Exotic scrub

Small patches of exotic scrub are found throughout the sites, mostly dominated by gorse (*Ulex europeaus*) and boxthorn (*Lycium ferocissimum*) (Figure 4). Within Site 3, scrub borders drainage channels to the south of the site, and around a constructed farm pond to the east of the site. Kanuka (*Kunzea ericoides*), manuka *(Leptospermum scoparium)*, harakeke (*Phormium tenax)* and gorse are the main species present, with kikuyu (*Cenchrus clandestinum*) as the dominant ground cover. A stand of large (>20m) pines and patch of sparse gorse scrub is present at the northern end of site 2. Invasive species found within scrub patches, predominantly within Site 1A but also ungrazed areas of Site 1B, 1C and 2, include arum lily, madeira vine, Sydney golden wattle and black wattle.

Exotic shelterbelts and hedgerows

Exotic hedgerows are found throughout site 2 and site 3 between field borders and along property boundaries. Hedgerows are dominated by exotic species such as gorse, hawthorn, boxthorn and conifers, interspersed with occasional native trees such as puriri (*Vitex lucens*).

A large conifer shelterbelt is found around the southern border of Site 2. A row of fallen dead exotic trees extends northwards from the shelterbelt, and eastwards after 50-100m. Site 3 has a few hedgerows around the house and farm buildings, and between farm races on the east of the site.

A mature pine shelterbelt is found between Site 1A and 1B and on the northern corner on Site 2 (Figure 4).

Figure 4: Patch of boxthorn on Site 1B (left) and pine shelterbelt found at Northern corner of site 2 (right).

Residential gardens

There are ornamental trees and gardens, including some large native and exotic trees, around the house on Site 3. While the residential buildings have been removed, there are the remains of residential gardens on both Sites 1C and 2.

Specimen trees

Occasional mature native and exotic trees ranging in height from about 5 to 20 m, are scattered throughout the sites, including puriri (*Vitex lucens)*, totara (*Podocarpus totara*), kahikatea (*Dacrycarpus dacrydioides*), kānuka *(Kunzea ericoides*), poplar and pine.

Riparian vegetation on Bercich Drain

A mix of exotic and native riparian vegetation, ranging from 2-10 m wide, extends along the majority of the northern side of the Bercich Drain in Site 1A (Figure 5). The main species present include cabbage trees (*Cordyline australis*), karo (*Pittosporum crassifolium*), taupata (*Coprosma repens*), pōhuehue (*Muehlenbeckia complexa*) and giant umbrella sedge (*Cyperus ustulatus*) and exotic pine tree, gorse, pampas and woolly nightshade (Figure 7).

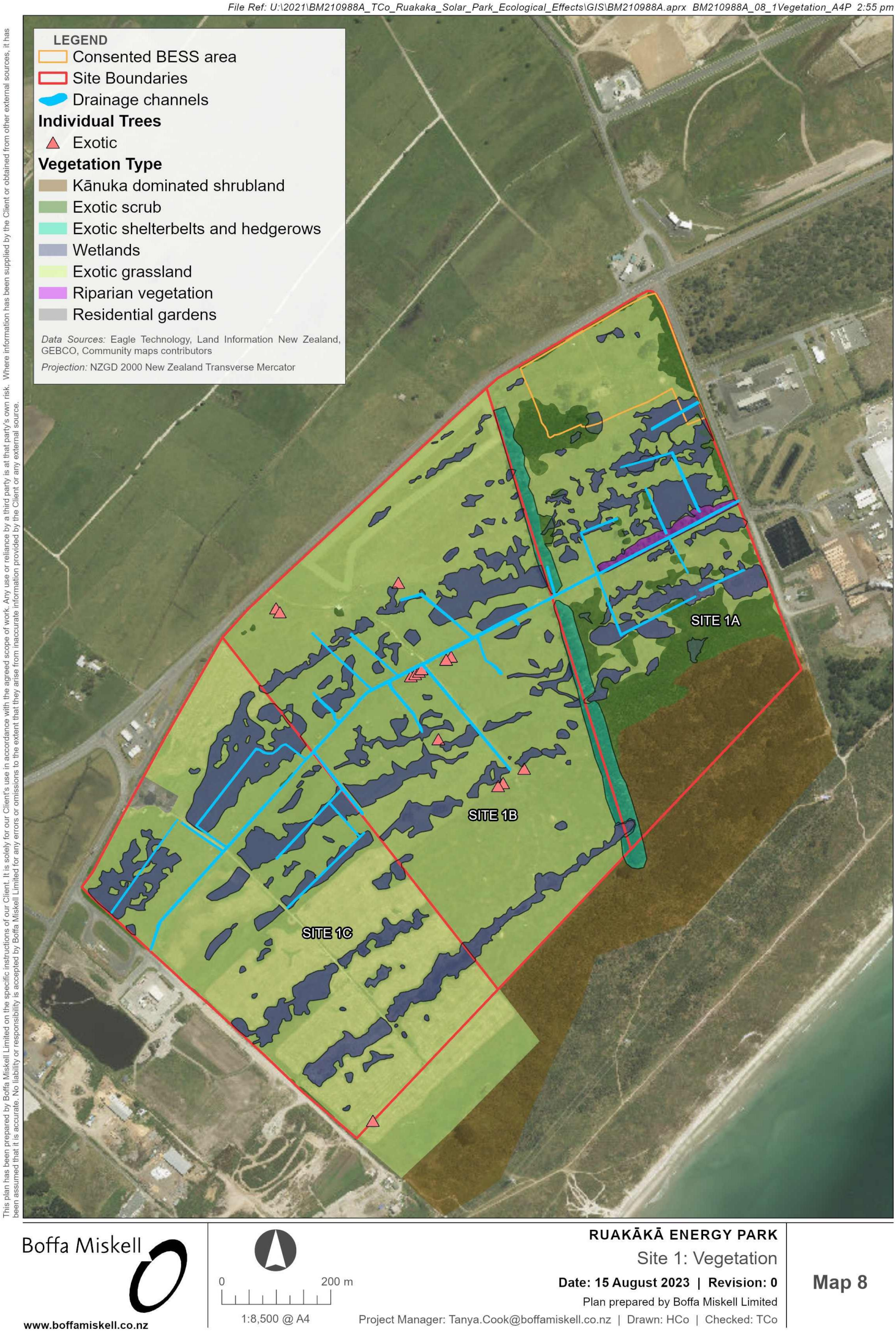

Figure 5: Vegetation in Site 1 of the Ruakākā Energy Park

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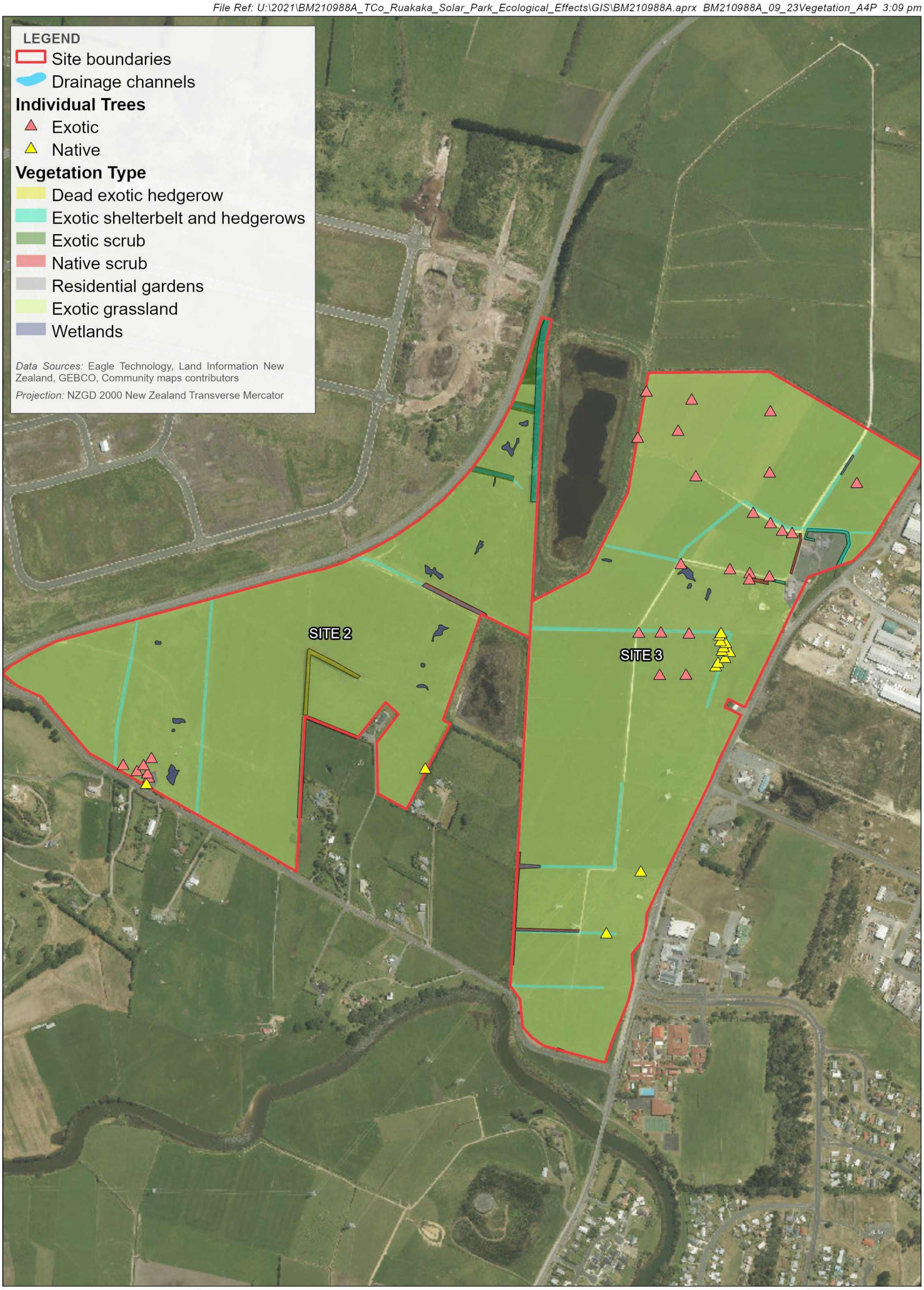

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RUAKĀKĀ ENERGY PARK
Sites 2 and 3: Vegetation
Date: 15 August 2023 | Revision: 0
Plan prepared by Boffa Miskell Limited
Project Manager: Tanya.Cook@boffamiskell.co.nz | Drawn: HCo | Checked: TCo

Map 9

Figure 6: Vegetation in Sites 2 and 3 of the Ruakākā Energy Park

Figure 7: Mix of native and exotic riparian vegetation on northern side of Bercich Drain in Site 1A.

Kānuka dominated forest and shrubland

Approximately 5 ha of forest and shrubland, dominated by kānuka, is located on the southern edge of Site 1A (Figure 5). This is part of a larger kanuka remnant (~15 ha in total), which sits within the protected natural area of the Ruakākā Dunelands. As of March 2023, all 10 species of *Kunzea* that were taxonomically recognised in 2014 have been regrouped into one species; *K. ericoides* (Heenan et al., 2023). From 2014 to 2023 this kanuka was taxonomically identified as *K. linearis*.

K. ericoides (5 – 8m tall) forms an open canopy with minimal understorey (Figure 8), and a ground cover of meadow rice grass *(Microlaena stipoides)* and bracken (*Pteridium esculentum*). The bush margin is fairly well-defined, with an abrupt transition to gorse-woolly nightshade scrub on the landward side.

Figure 8: Kanuka (Kunzea ericoides) dominated shrubland on Site 1A, showing sparse understorey (left) and transition from kanuka to gorse shrubland (right).

4.2 Wetlands

4.2.1 Overview

There are several wet areas throughout the sites with wetland vegetation present, especially in Site 1. The wetlands present within the proposed Site are palustrine marsh and/or swamp (i.e., rain and groundwater-fed, with mineral and peat substrates). We have classified these wetland features into three categories based on their vegetation composition and hydrology:

- exotic dominated wetlands;
- indigenous dominated wetland; and
- open water pond habitats.

4.2.2 Topography

Historically, Site 1 was an area of coastal duneland that reached at least as far inland as the current day State Highway 15. While the landform has been modified by farming over the last century, much of the original dune landform remains, with low dune crests and higher dune slacks still present on Site 1 running almost parallel to the coast. These relic dunes systems are evident in historical aerial imagery from 1942 and 1950 (Appendix 3) and recent drone imagery (Appendix 4). The wetlands identified on Site 1 have predominately formed in the low-lying dune slacks of this relic dune system.

Sites 2 and 3 have predominately flat topography with the occasional small depression.

4.2.3 Soils and Hydrology

The soils across site 1 are recent sands and mesic organic, which is moderately decomposed peat, Site 3 soils are mostly mesic organic, with a band of sandy ultic along the eastern boundary and Site 2 is mostly pan podzols[9].

Ground conditions on site 1 consisted of topsoil (from 0.05 m to 0.4 m), peaty sand (from 0.1 m to 0.4 m) (Figure 9) and sand (from 0.1 m to 1.5 m). While the soils on Sites 2 and 3 were characterised by approximately 20-30 cm of topsoil over 10 -15 cm of peaty sands, with saturated peaty soils present to the surface in low-lying depressions in November 2022 (Figure 10).

A high groundwater table was frequently observed during site visits (Spring 2021, November 2022, March 2023) across the sites. Large areas of standing water were present across Site 1 and wider property during the spring 2021 survey, while the subsequent surveys in May and June 2022 found wet areas were generally confined to drainage channels and well-defined areas of low relief. Several areas of standing water were identified within the proposed site during the June 2022 survey, mostly on the south-eastern side of the site closest to the coast.

A high groundwater table was present across Sites 2 and 3 in November 2022, with water pooling observed in small depressions scattered across the Sites, particularly in Site 2. No

[9] Manaaki Whenua Landcare Research (2023) New Zealand Soil Classification. Retrieved on 4/5/23 from: //soils-maps.landcareresearch.co.nz/?layername=fsl_nzsc&idcolumn=&idvalue=&mapfile=fsl&srs=EPSG:2193&mode=normal

surface water was observed in these depressions in March 2022, however, pugging from stock was present.

The extent and water depth of the wetlands in the three Sites are highly influenced by groundwater levels, especially in Site 1.

Figure 9: Soil core samples taken on Site 1 in October 2021, showing peat and sand composition

Figure 10: Soil profile on Site 2 (left) and soil core from low-lying depression in site 2, showing peat composition (right).

4.2.4 Vegetation

Pasture and hydrophyte mosaic

During site visits, areas were identified that had water pooling and/or hydrophytic vegetation present, especially in Site 1, but the areas were dominated by pasture species and/or FACU

species, such as rye grass, kikuyu and clover (Figure 11). These areas failed the Dominance Test and Prevalence Index (refer to the plot data in Appendix 5), and therefore are not wetlands These areas are shown as exotic grassland in Figures 6 and 7.

Figure 11: Pasture dominated areas; in Site 1C in June 2022 (left) and in Site 1B in March 2023 (right).

Exotic vegetation dominated wetlands

The majority of the wetland features present across the sites are dominated by exotic vegetation (Figures 12 and 13), including soft rush (*Juncus effusus*), mercer grass (*Paspalum distichum*), creeping buttercup (*Ranunculus repens*), water pepper (*Persicaria decipiens*), broom sedge (*Carex scoparia*) and marsh bedstraw (*Galium palustre*). The total area of these exotic wetlands is 13.65 ha, the majority of which is in Site 1 (Table 2). This includes the wetlands within the already consented BESS footprint.

These features mostly passed the Rapid Test, or if not, both the Dominance Test and Prevalence Index, and therefore, meet the RMA wetland definition (refer to the plot data in Appendix 5). There were a few areas with marginal Prevalence Index scores (ie, near 3) and/or the majority of dominant species were FAC or FACU, but they passed the Wetland Hydrology tool, so are also wetlands. No features had more than 50% cover of pasture species, so all mapped exotic wetlands meet the NPS-FM definition of a Natural Inland Wetland.

While these exotic wetlands do vary throughout the sites in terms of their dominant species, we have grouped these wetlands as they are all dominated by exotic vegetation, have similar hydrological function, and provide similar habitat values for indigenous fauna. These wetlands are characterised by low-growing dense vegetation (typically < 50 cm high) and periodic shallow water pooling. Stock have access to these wetland features in all sites, except site 1A, resulting in moderate to severe pugging and grazing of palatable species.

These wetland features have a patchy distribution as a result of the landform and farming land use. Furthermore, most of these features are dynamic, changing throughout the year and over time, with seasonal changes in hydrology, the presence of perennial species and farming practices, making them challenging to delineate. Therefore, the extent of these features has been determined, based on the most recent site visit and imagery (see section 3.2 for more detail on the wetland delineation and mapping methods used).

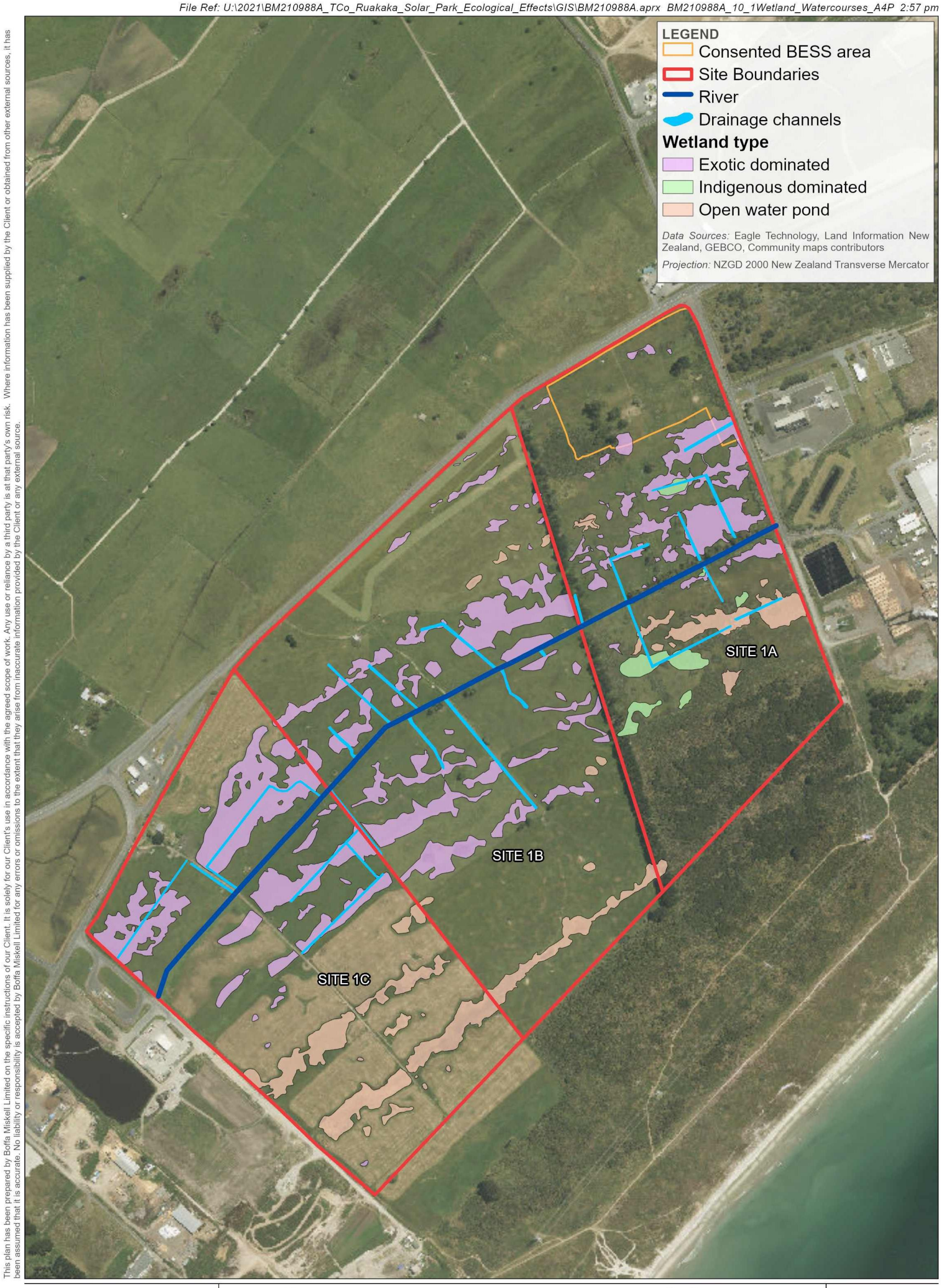

Figure 12: NPS Natural Inland Wetlands and watercourses in Site 1 of the Ruakākā Energy Park

Figure 13: NPS Natural Inland Wetlands and watercourses in Sites 2 and 3 of the Ruakākā Energy Park

Table 2: Area (ha) of each wetland type within the three proposed sites

Wetland type	Site 1	Site 2	Site 3	Total
Exotic dominated	13.32	0.26	0.07	13.65
Indigenous dominated	0.75	0	0	0.75
Open Pond Habitats	4.71	0	0	4.71
Total	18.78	0.26	0.07	19.11

In Site 1A these exotic wetlands were mostly dominated by a dense sward of broom sedge, creeping buttercup, water pepper and/or marsh bedstraw, with soft rush, mercer grass, and Yorkshire fog (*Holcus lanatus*) also common throughout. While less common the following exotic hydrophytic species were also scattered throughout these wetlands; umbrella sedge (*Cyperus eragrotis*) and sharp-fruited rush (*Juncus acuminatus*).

The occasional sparse clump or small patch of indigenous wetland vegetation was also present in these exotic dominated wetlands, including native willow weed (*P. decipiens*), wīwī (*Juncus edgariae*), sharp spike sedge (*Eleocharis acuta*), baumea (*Machaerina rubiginosa),* giant umbrella sedge *(Cyperus ustulatus)*, kuawa (*Schoenoplectus tabernaemontani*) and giant rush *(Juncus pallidus).*

Figure 14: Broom sedge dominated area in Site 1A in March 2023 (left) and creeping buttercup and marsh bedstraw dominated area in March 2023 (right).

The exotic wetlands in Site 1B were typically dominated by water pepper and/or mercer grass, whereas in Site 1C they were mostly dominated by soft rush and mercer grass with localised patches of water pepper (Figure 15). The water table was at or above ground surface in June 2022 and March 2023, with water pooling and severe pugging throughout low relief areas.

Figure 15. Water pepper dominated wetland in Site 1B in March 2023 (left) and soft rush, mercer grass and creeping buttercup wetland in Site 1C in June 2022 (right)

There were very few wetland features in Sites 2 and 3 (Figure 13). Found in low-lying depressions, they were all small, ranging in size from 30 to 570 m^2 and had either shallow water (< 30 cm deep) or saturated soil (Figure 16). They were mostly dominated by water pepper, with a mix of other exotic hydrophytic species present, such as Yorkshire fog, creeping buttercup, mercer grass, alligator weed *(Alternanthera philoxeroides)*, water starwort (*Callitriche stagnalis)* and umbrella sedge.

Figure 16: Small water pepper dominated wetlands typical of wetland features present on Sites 2 and 3.

Indigenous vegetation dominated wetlands

Wetlands that were dominated by indigenous wetland vegetation, have been classified as indigenous wetlands. They all located within site 1A and range in size from 100 to 4,000 m^2, with a total area of 0.75 ha (Figure 12). These features are characterised by tall-growing dense rushes and reeds and deeper water, typically > 50 cm (Figure 17).

The vegetation included large patches of rautahi (*Carex lessoniana*), jointed twig rush *(Machaerina articulata),* baumea and kuawa, ranging in size from ~50 to 400 m^2. None of these species is threatened (de Lange et al., 2018).

Figure 17: Kuawa patch near the BESS platform (left) and jointed twig rush patch near the kanuka stand (right).

Standing open water pond habitats

Several large, mostly long ponds are present in the dune slacks on Site 1, predominately on the south-eastern side. These were characterised by moderately deep (> 50 cm) open water areas. They had a mix of mostly exotic low-growing, emergent, and floating aquatic plants. During the June 2022 site visit, the littoral zone was dominated by emergent soft rush and native willow weed, interspersed with floating aquatic plants (*Azolla pinnata* and *Landoltia punctata),* and large areas of open water. There was a small patch of the native kuawa in the centre of one pond (Figure 18).

There were also several smaller ponds evident during the June 2022 and March 2023 site visits, which were dominated by *Persicaria*, and soft rushes, with margins of creeping buttercup and mercer grass.

A farm track runs through the centre of these ponds in Site 1C and stock have access to these ponds in both sites 1B and 1C. On the southern side of Site 1A, four-wheel drive tracks are present through some of the open water ponds and exotic wetlands.

The extent of these wetland features is shown in Figure 12, with a total area of 4.71 ha.

Figure 18. Area of open water pond habitat in Site 1C in June 2022 (left) and in Site 1B in March 2023 (right).

4.3 Freshwater

4.3.1 Overview

All watercourses within the three Sites are farm drainage channels, most of which were constructed by the 1950s.

The large main channel that runs the length of Site 1, in a northeast – southwest direction, is known as Bercich Drain. There is also a large unnamed drain running along the west boundary of Site 3 (referred to as Unnamed Drain from here on). We consider these two drainage channels are excluded from the definition of an Artificial Watercourse in the PRPN because both are in an area that was historically natural wetland (refer to Appendix 3).

As both of these watercourses have a well-defined channel, contain surface water more than 48 hours after a rain event and are shown on 1:50,000 scale topographical maps as blue lines, they meet three of the characteristics in the PRPN definition for an Intermittently Flowing Stream or River, and therefore they meet the definition of a River under the PRPN and RMA. It is likely that both of these are continually flowing. We note that the management of these watercourses as drains, is the likely reason that these characteristics are present.

Bercich Drain leaves Site 1 at the eastern side and flows for a further ~ 1. 7 km to the east before, discharging directly into the coastal environment to Ruakākā Beach. The last ~ 250 metres of this watercourse is piped and it is likely that fish passage to the sea is restricted at times by low flows and coastal sand impoundment.

The Unnamed Drain on the edge of Site 3, flows south, under McCathie Road before discharging into Ruakākā River. This drain is likely to be tidally influenced at times. Other minor drains from Site 2 also flow under McCathie Road and discharge into the Ruakākā River.

Some of the other smaller drains in Site 1 are currently within a natural wetland and therefore are excluded from the definition of an Artificial Watercourse. These drains only meet one of the characteristics for an Intermittently Flowing Stream or River (contain surface water more than 48 hours after a rain event), and therefore based on the PRPN definition these water courses are ephemeral and therefore, are not treated as a ‘River’ under the PRPN and RMA.

4.3.2 Habitat quality

Both Bercich Drain and the Unnamed Drain are soft-bottomed and macrophyte dominated, although they are likely to have vegetation cleared at times, to maintain drainage and prevent flooding. Both are straight narrow channels with reasonably shallow slow-flowing water (50 cm – 1 m deep). The width of Bercich Drain ranges from 4 - 5 m and the width of the Unamed Drain varies from 2 – 2.5 m. The water was observed to be peat stained and turbid in both drains on most site visits.

The Unnamed Drain is fenced along its entire length on both sides to exclude stock. There is a narrow riparian strip (~2-3 m wide) of long kikuyu grass in the fenced area on both banks with some native and exotic shrubs, mostly on the western side (right bank) which provide some shade. The most western section of Bercich Drain in Site 1C is fenced to exclude stock and there is no stock in Site 1A but stock have access in Site 1B and the remainder of Site 1C. The riparian vegetation of Bercich Drain is mostly heavily grazed pasture, except in site 1A (refer to section 4.1).

During the 2021 and 2022 site visits, Bercich Drain contained a range of native species in patches along its length, including jointed twig rush, kuawa, raupō (*Typha orientalis),* sharp spike sedge, rautahi *(Carex geminata*) and native willow weed (Figure 19). However, the north-eastern section of Bercich Drain in Site 1A was cleared in 2022 and as of March 2023 has limited macrophyte growth. The Unnamed Drain had about 60-70% macrophyte cover in the northern half, including alligator weed, water purslane (*Ludwigia palustris*) and water pepper but had very little macrophyte cover in the more tidally influenced southern end (Figure 20).

Bercich Drain had a habitat quality score of 41.5 in Site 1A and 29 in Sites 1B and 1C. The Unnamed Drain had habitat quality score of 37.5. This indicates that these two watercourses have fair (moderate) quality and availability of habitat for freshwater invertebrates and fish in their current state.

Figure 19: Kuawa patch in Bercich Drain in Site 1C (left) and water pepper and willow weed dominated reach through Site 1B and part of Site 1C (right).

Figure 20: Northern end of the Unnamed Drain, showing macrophyte cover (left) and southern end of Unnamed Drain as it leaves the property, and flows under McCathie Road (right)

All other watercourses within the three sites are small drainage channels, which are likely to be periodically dry. They are all soft-bottomed and dominated by a mix of soft rush, water pepper and willow weed. This includes several small drains in Site 3 running perpendicular and connecting to the Unnamed Drain and three small-vegetated drainage channels running north – south within Site 2, all of which are dominated by exotic soft rush and water pepper.

There is also a retired farm dairy effluent pond on the eastern side of Site 3 near the farm buildings.

Stormwater ponds

Two stormwater ponds are located between Sites 2 and 3. While outside of the proposed Sites, they have been considered in our assessment due to their close proximity and the wetland habitat they are providing for avifauna. The stormwater ponds contain a mix of open water, emergent rushes with significant areas of raupō, oioi (*Apodasmia similis*), sedges (*Carex sp.*) and riparian exotic and native tree species. The ponds are contained by high banks dominated by kikuyu and patches of gorse.

4.3.3 Freshwater fish

A total of 10 native fish species and two exotic species have been recorded in the NZ Freshwater Fish Database within 5 km of the sites (Table 3, Appendix 9), however, there were no fish records within the sites or within 1 km of the sites. Based on the available habitat, the invasive mosquito fish (*Gambusia affinis*) recorded in nearby drains and ponds, and the native shortfin eel (*Anguilla australis*) and īnanga (*Galaxias maculatus*) are the main species likely to be found within the Sites. Inanga have been recorded in Takahiwai Stream, which flows into coastal saltmarsh and mangroves on the western side of Marsden Point and the Ruakākā River. Rank, wet pasture, rushland and tidally influenced streams with dense grass swards on their banks have potential value as spawning habitats for īnanga. Inanga have a threat status of At-Risk – Declining (Dunn et al., 2018). We note that while shortfin eels are Not Threatened, they are an important taonga species for mana whenua.

The only native fish species observed during site visits was a shortfin eel (~ 50 cm long) in Bercich Drain in Site 1A in February 2023 and a school of ~10 īnanga (6- 8 cm in length) in the Unnamed Drain on the edge of Site 3 in March 2022. Mosquito fish were also observed in several of the smaller drains on Site 3.

The only fish caught during the 2020 survey within Site 1 were two shortfin eels (Wildland Consultants Ltd, 2022). Both were caught in the eastern end of Bercich Drain in Site 1A. One was 22 cm and the other was 29 cm. Two introduced bell frogs were also caught in the most eastern open water pond in Site 1B. No īnanga or mudfish were found. Based on the results of the survey, Wildland Consultants (2022) concluded that there is unlikely to be a population of black mudfish within Site 1.

There were no records of potential barriers to fish passage in the NIWA Fish Passage Assessment tool within the three sites or downstream of the sites. There are at least three culverts on Bercich Drain for track crossings, one located in each of Sites 1A, 1B and 1C. These are unlikely to be a barrier to fish passage.

Table 3: Fish recorded within 5 km of the proposed Sites (refer to Appendix 9 for location).

Fish species	Location(s)	Year of record(s)	Threat status	Likelihood of being present within Sites
Shortjaw kokopu (*Galaxias postvectis)*	Ruakākā River	1981	Threatened - Nationally Vulnerable	Very low
Tuna/longfin eel (*Anguilla dieffenbachii*)	Ruakākā River and unnamed stream	1981 - 2020	At Risk - Declining	Low
Inanga (*Galaxias maculatus*)	Takahiwai Stream and Ruakākā River	2000 - 2020	At Risk - Declining	Present in Site 3
Giant bully (*Gobiomorphus gobioides*)	Ruakākā River & Takahiwai Stream	1919 - 2003	At Risk – Naturally Uncommon	Low
Tuna/shortfin eel (*Anguilla australis*)	Ruakākā River and ponds	2003 - 2020	Not Threatened	Present in Site 1, likely present in Site 3 also.
Banded kokopu (*Galaxias fasciatus*)	Ruakākā River, Waiwarawara Stream & Tauroa Stream	1981 - 2020	Not threatened	Very low
Redfin bully (*Gobiomorphus huttoni*)	Ruakākā River & Takahiwai Stream	1981 - 2020	Not Threatened	Low
Common bully (*Gobiomorphus cotidianus*)	Ruakākā River & Takahiwai Stream	2003 - 2020	Not Threatened	Low
Common smelt (*Retropinna retropinna*)	Ruakākā River/2019	2019	Not Threatened	Low
Grey mullet (*Mugil cephalus*)	One Tree Point Pond/2017	2017	Not Threatened	Low – possibly in lower reaches of the Unnamed Drain
Mosquito fish (*Gambusia affinis*)	Takahiwai Stream, Ruakākā River & Unnamed stream	2000 - 2019	Introduced	Present in Site 3
Grass carp (*Ctenopharyngodon idella)*	One Tree Point Pond	2017	Introduced	Very low

4.4 Avifauna

4.4.1 Desktop review

Twenty-nine native species were found within a 20 km grid of all sites (Appendix 10) and all likely to use habitats provided by Sites 1, 2 & 3. Five of these species are threatened, including matuku-hūrepo / Australasian bittern (*Botaurus poiclioptilus*), matuku-moana / Pacific reef heron (*Egretta sacra),* pārera / grey duck (*Anas supercillosa),* pāteke / brown teal (*Ana chlotoyis)* and

weiwea / New Zealand dabchick (*Poilocephalus rufopectus)* (Robertson et al., 2021). A further five species have a threat status of At-Risk - Declining and four have a status of At-Risk – Recovering.

Matuku-hūrepo, have been recorded near the site on 10 separate occasions on ebird from 2015 until 2022 and likely use the Sites and surrounding habitats regularly. DOC (2007) states that matuku-hūrepo are recorded regularly in the vicinity of the Ruakākā Dunelands.

4.4.2 Field surveys

Over the nine surveys undertaken during February and March 2023 and observations made during site visits between 2021 - 2023, 18 resident native species were observed or heard within the Sites (Table 4), all in low numbers (e.g., often individual birds). Of these, 12 species use freshwater bodies/wetlands as their primary habitat.

Two of these recorded species are Threatened: matuku-hūrepo (Threatened – Nationally Critical) and weweia (Threatened – Nationally Increasing). A further two have a threat status of At Risk – Declining (mohu-pererū and pihoihoi), one At Risk – Recovering (kāruhiruhi / pied shag) and one At Risk – Relict (kawau / black shag).

Matuku-hūrepo were sighted in a patch of inundated rushland in the farmed portion of Site 1B during the spring 2021 survey and on seven occasions in February, March, and April 2023 (Appendix 11). Observations on 23 March 2023 suggest that two individuals are using the Sites as concurrent observations from Site 1B and the edge of Site 3 were made. In conjunction with anecdotal reports from the landowner of a pair of birds, we consider it is likely that the birds are resident within the Site.

A pair of weweia were seen within the large open pond wetland on the east side of Sites 1B and 1C during three of four surveys in March 2023. Three weweia (two adults and one juvenile) were also observed on the Northern stormwater pond, which are likely to be different individuals to the pair on Sites 1B and 1C.

A mohu-pererū was heard in Site 1A in the wetlands between Bercich Drain and the kānuka forest during the 2023 surveys and pihoihoi were seen on several occasions within the grassland areas of Sites 1B and 1C during site visits in 2023.

Numerous observations of kāhu / swamp harriers (Not Threatened) were made during the 2021, 2022 and 2023 surveys, with a nest observed in a patch of soft rush in Site 1 in 2021 and a juvenile observed in Site 1 in 2023. Nesting kakīōnau / black swan (Not threatened) were also recorded on Site 1 in 2023.

A further 10 native, one non-resident native (vagrant) and nine introduced species were recorded during the site visits and 2023 bird surveys (Table 4). Additionally, three native species that were not detected within the Sites, were seen on the stormwater ponds between Sites 2 and 3; pārera / grey duck (Threatened – Nationally Vulnerable), pūweto (At Risk – Declining) and grey duck x mallard hybrid (Not Threatened).

During targeted high tide surveys, only one coastal wading bird species was recorded, which was an individual poaka recorded in Site 1B.

Table 4: Avifauna recorded within the Sites and the two stormwater ponds (SPN & SPS) between Sites 2 and 3, during site visits (2021, 2022, and 2023) and the 2023 bird surveys. Species shown in bold use freshwater systems/wetlands as their primary habitat. Note three species marked with an asterisk were only observed on the stormwater ponds, not within the Sites. SPN = Stormwater Pond North. SPS = Stormwater Pond South.

Species	Scientific name	Threat classification	Location
Matuku hūrepo/Australasian bittern	***Botaurus poiciloptilus***	**Threatened - Nationally Critical**	**1A, 1B, 1C, edge of Site 3, SPS**
Pārera/grey duck*	***Anas superciliosa***	**Threatened - Nationally Vulnerable**	**SPN**
Weweia/dabchick	***Poliocephalus rufopectus***	**Threatened - Nationally Increasing**	**1C, SPN**
Mohu-pererū/banded rail	***Gallirallus philippensis assimilis***	**At Risk - Declining**	**1A, SPN**
Pīhoihoi/New Zealand pipit	*Anthus novaeseelandiae*	At Risk – Declining	1B, 1C
Pūweto/spotless crake*	***Porzana t. tabuensis***	**At Risk - Declining**	**SPN**
Kāruhiruhi/pied shag	***Phalacrocorax v. varius***	**At Risk - Recovering**	**1A, 1C, SPN**
Kawau/black shag	***Phalacrocorax carbo novaehollandiae***	**At Risk - Relict**	**3**
Kāhu/swamp harrier	*Circus approximans*	Not threatened	1A, 1C, SPN
Kōtare/sacred kingfisher	***Todiramphus sanctus vagans***	**Not threatened**	**1A**
Pūkeko/swamp hen	***Porphyrio m. melanotus***	**Not threatened**	**1A, 1B, 3, SPN**
Spur-winged plover	*Vanellus miles novaehollandiae*	Not threatened	All, SPN
Matuku moana/white-faced heron	***Egretta novaehollandiae***	**Not threatened**	**1A, 1B, 1C, 2, SPN**
Pūtangitangi/paradise shelduck	***Tadorna variegata***	**Not threatened**	**All, SPN**
Warou/welcome swallow	*Hirundo n. neoxena*	Not threatened	1B, 1C, 2, 3
Kakīānau/black Swan	***Cygnus atratus***	**Not threatened**	**1C, SPN**
Grey duck x mallard*	***Anas superciliosa x platyrhychos***	**Not threatened**	**SPN**
Tete/grey teal	***Anas gracilis***	**Not threatened**	**1C, SPN**
Poaka/pied stilt	***Himantopus h. leucocephalus***	**Not threatened**	**1B**
Tauhou/silvereye	*Zestrops lateralis*	Not threatened	1A
Riroriro/Grey warbler	*Prosthemadera novaeseelandiae*	Not threatened	1A
Kawaupaka/little pied shag	***Phalacrocorax melanocephalus melanocephalus***	**Vagrant**	**1A, SPN**
Rakiraki/mallard	***Anas platyrhynchos***	**Introduced and Naturalised**	**1A, 1C, SPN**
Magpie	*Gymnorhina tibicen*	Introduced and Naturalised	1
Yellowhammer	*Emberiza citrinella*	Introduced and Naturalised	1A
Tārangi/European starling	*Sturnus vulgaris*	Introduced and Naturalised	All
Tiu/house sparrow	*Passer domesticus*	Introduced and Naturalised	All
Manu pango/blackbird	*Turdus merula*	Introduced and Naturalised	All
Myna	*Acridotheres tristis*	Introduced and Naturalised	3
Kairaka/Eurasian skylark	*Alauda arvensis*	Introduced and Naturalised	2, 3
Manu kai-hua-rakau/song thrush	*Turdus philomelos*	Introduced and Naturalised	1B, 1C

4.5 Herpetofauna

4.5.1 Database review

The herpetofauna database holds numerous records of shore skink (*Oligosoma smithi*) throughout the Bream Bay dunelands, and this is one of the two indigenous species that are considered most likely to be present within vegetation and habitats in Site 1A. The other species identified as most likely to be present within the sites is copper skink (*O. aeneum*), which has some potential to be distributed across each of the sites where suitable terrestrial habitats are present. Copper skink and shore skink both have a threat status of At Risk – Declining (Hitchmough et al., 2021).

There are no records in the herpetofauna database for indigenous geckos in the contiguous landscapes within 10km of the sites; however, it is noted that elegant gecko was seen in the Ruakākā Dunelands in 1992 (Lux et al., 2007).

4.5.2 Habitat descriptions

In general, the pasture and wetland habitats that dominate most of the sites are considered unsuitable for copper skink and shore skink.

Site 1

Vegetation and habitats varies within Site 1. Site 1A contains a mixture of retired kikuyu grassland, wetland, exotic scrub, gorse shrubland and kānuka scrub and forest. Except for the wetland areas (which dominate the southern two thirds of this site), most of the vegetation provides some habitat value to indigenous lizards. Where grassland has become rank, habitat values increase accordingly, particularly beneath gorse shrubland and around the edges of the kānuka scrub. The indigenous riparian vegetation on the edge of Bercich Drain that runs through the centre of this site includes discrete patches of *Muehlenbeckia* sp. together with scattered tussocks of wetland vegetation beneath. These areas provide dense cover for resident indigenous skinks (if they are present), together with abundant food resources by way of invertebrate fauna and seasonal fruit.

If present, elegant gecko could potentially occupy habitats within the kānuka forest and the adjacent gorse shrubland that buffers it. No recent or nearby records exist for either Pacific gecko (*Dactylocnemis pacificus*) or Raukawa gecko *(Woodworthia aculate*), however, there is also some (low) potential for both species to occupy habitats within the kānuka forest.

Sites 1B and 1C are dominated by grazed pasture and wetlands, neither of which provide suitable habitat for indigenous lizards. Some patches of gorse, boxthorn and exotic trees in the location of the residential gardens and old wooden debris around farm sheds provide habitat of some value for indigenous lizards, however, this is patchy and surrounded by grazed pasture.

Site 2

Site 2 is dominated by grazed pasture but also comprises areas of rank grassland, shelterbelts, occasional individual native trees, and some wetlands. A large patch of gorse scrubland is present in the northern end of the site, as well as around site boundaries. Woody debris from previously felled pine trees is present in the southern section of the site adjacent to McCathie Road, and an old-disestablished shed with rank weeds and broken, rotting timbers also provide potential complex habitat for skinks if present (Figure 21).

Figure 21: Felled pine debris left in-situ in Site 2, to break down provides good quality habitat to skinks if present (left) and old farm structure with rank weeds and rotting panels of wood that may offer habitat to copper skinks if present (right)

Site 3

As with Sites 1 and 2, Site 3 is dominated by grazed pasture with paddocks separated by exotic hedgerows, shelterbelts, scattered patches of gorse and vegetated drainage channels. A retired farm dairy effluent pond is situated to the east of the site with riparian vegetation comprising kanuka, manuka, flax and rank kikuyu, which may offer some habitat value to skinks if they are present. Further, a house, sheds and residential gardens are also present, and these may also offer some potential value to indigenous skinks, if they are present.

4.5.3 Field surveys

No indigenous lizards were detected during the field surveys in all three sites; however, plague skinks (*Lampropholis delicata*) were detected throughout the Sites and observed on site in very high densities.

It is noted that summertime in Northland is typically hot and dry, and the areas fringing the wetland edges that lizard survey equipment was installed in were expected to remain dry. However, the summer of 2022-2023 was unseasonably wet, with regular heavy rainfall and several flooding events. Consequently, some of the equipment was lost, some of it was inundated with fluctuating water levels, and much of it became densely colonised by ants seeking refuge from saturated soils. These unexpected conditions have resulted in low confidence in the survey results, and it is still considered possible that indigenous lizards may be present, especially in Site 1A, albeit in low numbers.

No geckos were observed during the spotlighting survey in Site 1A. Survey conditions were suitable with no rain or wind. The temperature was a little cool at 13°C and very few invertebrates were observed.

4.6 Bats

There are two species of bats in New Zealand: the long-tailed bat (*Chalinolobus tuberculatus*) and the lesser short-tailed bat, which is separated into three subspecies (*Mystacina tuberculata* spp.). Short-tailed bats typically live within areas of mature native forest where they use hollow trees for roosting and ground hunting for foraging. No suitable habitat for short-tailed bats is available within the sites, therefore this species is not considered further in this assessment.

Long-tailed bats, which are Threatened - Nationally Critical (O'Donnell et al., 2023), preferentially roost in small cavities of old, large trees, but have also been observed to utilise other features such as loose bark, hollow limbs, or epiphyte growth for roosting. A study undertaken on a long-tailed bat population in rural Canterbury found they utilise a wide range of roost types in response to the limited availability of preferential roost characteristics (Sedgeley & O'Donnell, 2004). Bats can fly long distances at night when they are commuting between roosts and / or foraging, for which they use echolocation to hunt for flying insects. Long-tailed bats are known to use linear habitat features (for example, shelterbelts or edges of vegetation margins) to commute and forage (O'Donnell, 2000; Borkin & Parsons, 2009) and cross agricultural landscapes.

Monitoring has been undertaken for long-tailed bats at various locations within 25 km of the Proposed Sites (Appendix 12)[10]. The nearest locations where long tailed bats have been recorded are Brynderwyn Hills Forest, Otaika Valley Bush and Pukenui Forest, with the nearest records for each of these being approximately 20, 18 and 20 km respectively from the Proposed Sites. These records were all from monitoring undertaken in the last 5 years. The land use between these known long-tailed bat populations and the proposed sites is predominately farmland. Negative results (surveys which did not detect bats) are recorded on Te Whara (Bream Head) on the other side of Whangarei Harbour. The nearest mature native forests to the sites are Takahiwai and Ruakākā, which are 1.5 and 4 km away respectively. Both provide high quality habitat for bats in close proximity to the Sites. It is unknown whether bats are present in these forests, as neither have been surveyed.

Long-tailed bats can travel distances greater than 20 km (Bat Recovery Group - Department of Conservation, 2021), and will often use tree lines and waterways to forage around, or as navigational aids to reach preferred foraging areas.

The majority of the vegetation on the Sites is grazed pasture, wetlands and shrubland, which is unlikely to provide suitable habitat for bat roosting. However, the sites are within a mosaic of wetland foraging areas, connecting hedgerows and tree lines, and patches of forest in the surrounding landscape, and bats have been detected within the range that bats can travel in one night. There are some mature large trees present within the Sites, including two hedgerows of large pines; one next to the northern stormwater pond between Sites 2 and 3 and the other between Site 1A and 1B, and the occasional individual mature native and exotic tree scattered throughout the Sites. These larger trees are potentially roost trees, particularly as solitary roosts, given the scarcity of roost trees in the modified environments of the Sites and surrounding landscape. Long-tailed bats have also been recorded roosting in cabbage trees, and this species is present in the riparian vegetation on Site.

[10] Based on most recent DOC Bat Database download, supplied by DOC on 10 March 2022.

5.0 Assessment of Ecological Values

5.1 Overview

This section describes the values of terrestrial, wetland and freshwater ecological features within the Proposed Sites, their ecological significance and the ecological value we have assigned each of these features on a scale from Negligible to Very High, based on the attributes outlined in Roper-Lindsay et al. (2018), as provided in Appendix 7.

5.2 Terrestrial vegetation

5.2.1 Context

The only vegetation of note within the three sites, is an approximately ~5 ha stand of kānuka (*K. ericoides*, previously *K. linearis*) dominated shrubland on the southern edge of Site 1A. As covered in Section 1.4, the kānuka forest and shrubland on Site 1A is part of the Ruakaka Dunelands Significant Natural Area identified through the Protected Natural Areas Programme (PNAP) (Lux et al., 2007). The Ruakaka Dunelands, including the kānuka forest and shrubland on Site 1A is included as a SNA in the draft SNA online map provided by Whangarei District Council[11]. There are no other Significant Natural Areas identified within the three sites, in the PNAP report (Lux et al., 2007), or on the draft online map.

5.2.2 Kānuka dominated forest and shrubland

In the most recent threat classification for vascular plants, kanuka is split into 10 species. *K. linearis* and *K. ericoides* are both listed as Threatened – Nationally Vulnerable (de Lange et al., 2018). It is worth noting that *K. linearis* and *K. ericoides* have been assigned this threat status as a precautionary measure because of uncertainty with the threat posed by myrtle rust (*Austropuccinia psidii*), as opposed to being threatened by other factors (de Lange et al., 2018; Overdyke, 2020).

As noted in Section 1.4, according to the Threatened Environment Classification (2012) the kānuka forest within Site 1 is located in an area with less than 10% of indigenous vegetation remaining)., and located within dunes, which have been classified as a naturally uncommon ecosystem prior to human arrival and is listed as endangered (Holdaway et al., 2012; Williams et al., 2007; Wiser et al., 2013).

While the previously recognised 10 species of kānuka, have been taxonomically revised into one species (ie, *K. ericoides*), Heenan et al. (2023) state that the considerable phenotypic and ecotypic variation seen within regional populations of *Kunzea* is likely to be of ecological and conservation importance. Accordingly, the kanuka vegetation type within Site 1 is likely to be a distinct ecotype of Kunzea, which is adapted to coastal sandy soils of northern North Island (Lux et al. 2007).

[11] Draft Significant Natural Area Maps (arcgis.com) accessed on 16 May 2023.

We note that about 70% of the Ruakaka Dunelands SNA is exotic scrub and forest, including gorse, pampas, brush wattle, Chinese privet, tree privet, ginger and pines. Kānuka dominated forest on dunes is only 2% (approx. 15 ha) of the Ruakaka Dunelands SNA (Lux et al., 2007).

Based on this, the kānuka shrubland on site 1A is of **High** ecological value (Table 5).

Table 5: Ecological value of kanuka dominated shrubland on Site 1A proposed Ruakākā Solar Park, based on EIANZ criteria.

Matter	Description	Ecological value
Representativeness	While modified (includes some exotic vegetation) and smaller, mostly indigenous and representative of pre-human kanuka coastal dune forest.	Moderate - High
Rarity/distinctiveness	*K. ericoides/linearis* both classified as Threatened – Nationally Vulnerable. Nationally important – the habitat sits within aThreatened Environment (LENZ) and is an endangered ecosystem. Only 2% of Ruakaka Dunelands is kānuka forest.	Very High
Diversity & Pattern	Low level of plant diversity within the stand. Lacking natural structure (i.e. lacking understorey, and exotic vegetation is present throughout).	Low
Ecological Context	Contiguous with larger kanuka shrubland within the Ruakaka Dunelands Protected Natural Area. Rest of surrounding land highly modified. May play a role in stabilising the dunes and buffering inland areas. Likely to be an important habitat for native bird and lizard species.	Moderate
Ecological value		**High**

5.2.3 Other terrestrial vegetation

With the exception of the kānuka shrubland (discussed above), the vegetation composition in the remainder of the sites is typical of the rural farming landscape that surrounds the Sites. The habitats identified are fragmented, and generally dominated by exotic species and vegetation communities. All native species recorded are not threatened and are relatively common in the surrounding landscape. With the exception of the kanuka shrubland, the ecological value of all other vegetation within Sites 1, 2 and 3 is assessed as **Low** (Table 6).

Table 6: Ecological value of all other terrestrial vegetation on all three sites (excluding kanuka dominated shrubland on Site 1A) proposed Ruakākā Solar Park, based on EIANZ criteria

Matter	Description	Ecological value
Representativeness	Highly modified and mostly dominated by exotic species. Not representative of pre-human vegetation or communities.	Very Low
Rarity/distinctiveness	Habitat types and vegetation present are all common in the ecological district and region and are not threatened. One At-risk species (Pīhoihoi) recorded in vegetation outside of the wetlands.	Moderate - High
Diversity & Pattern	Low level of diversity, reflective of the modified rural landscape within the stand. Mostly exotic dominated, degraded and lacking vegetation structure.	Very Low - Low
Ecological Context	Isolated and small exotic dominated shrubland and hedgerows and isolated mature native tree. Lacks connection to larger habitats and unlikely to provide habitat for threatened fauna or act as an ecological corridor, with the exception of the Bercich Drain riparian vegetation on Site 1A.	Very Low - Low
Overall Ecological value		**Low**

5.3 Wetlands

5.3.1 Overview

While, in general, wetlands are now rare nationally and regionally, and dune slack wetlands are classified as endangered nationally (Holdaway et al., 2012), the wetlands within the proposed Sites are highly modified and degraded systems. This has been considered in the assessment of values for all three main categories of wetlands we have identified: open water habitats, indigenous wetlands and exotic wetlands.

Mapped wetland areas at the Sites are predominantly exotic, though there are some small patches dominated by indigenous vegetation. None of the mapped wetlands contain indigenous vegetation features of sufficient size to meet the ecological significance criteria in the RPSN.

The value of the identified exotic and indigenous wetland features as habitats for indigenous fauna is uncertain, but due to their degraded condition and small size, they are unlikely to contain resident populations of any threatened or at-risk species. However, the open water habitats are known to be frequented by matuku-hūrepo and have resident weweia (both Threatened species), which means these wetland features meet criteria 2b in Appendix 5 and are a significant habitat for indigenous fauna. Therefore, the open water wetlands are a significant ecological area under the RPSN. However, the other wetland features in the proposed Sites do not meet the RPSN criteria as significant ecological areas.

The wetlands mapped in Figures 12 and 13 are consistent with the PRPN definition of a Natural Wetland and as covered above, the mapped open water habitats are Significant Wetlands under the PRPN.

5.3.2 Open water habitats

While these open pond habitats are highly modified and not representative of pre-human dune slack wetlands in their current condition, the original landform of the dune slack is intact and they are of sufficient size and quality to provide likely permanent habitat for a pair of threatened weweia, and foraging habitat and possibly breeding habitat for the threatened matuku-hūrepo. This means that these wetlands are significant ecological areas under the RPSN and also significant wetlands under the PRPN (refer to Section 3.7). Therefore, based on this criterion and noting that dune slack wetlands are endangered ecosystems, the ecological value of the open water pond habitats in Site 1 is assessed as **High** (Table 7).

Table 7: Ecological value of open water habitats proposed Ruakākā Solar Park, based on EIANZ criteria.

Matter	Description	Ecological value
Representativeness	Highly modified, eg, dominated by exotic wetland vegetation, mostly surrounded by grazed pasture and grazed by stock (exception is Site 1A). Damaged by four-wheel drive vehicles in Site 1A. Not representative of pre-human dune slack wetlands in current state.	Low - Moderate
Rarity/distinctiveness	Dune slack wetlands are nationally endangered and are rare within in the Waipu Ecological District. Dominated by introduced plants species, with no Threatened or At-Risk plants present. Several Threatened or At-Risk bird species, recorded as inhabiting and/or using these pond habitats. No native fish species detected.	Very High
Diversity & Pattern	Moderate plant diversity but lacking natural structure, eg, very little tall reeds or rushes present, due to stock access, and dominated by exotic vegetation.	Moderate
Ecological Context	Still mostly has original shape, extent and hydrology of dune slack wetland, several are of reasonable size but surrounded by heavily grazed pasture and stock have access. Very little surface hydrological connection with surrounding watercourses (typical of dune slack wetlands) but likely influenced by groundwater connections and receives water from the Ruakākā wastewater disposal field. Provides moderate quality habitat for matuku hūrepo and high-quality habitat for weweia.	Moderate - High
Overall Ecological value		**High**

5.3.3 Indigenous wetlands

While these wetland features are dominated by indigenous vegetation, there is low diversity and no Threatened, At-Risk or Naturally Uncommon species present. They are unlikely to be of sufficient size to support resident populations of threatened fauna, and therefore, do not meet significance criteria in the RPSN. However, given the rarity of dune slack wetlands and natural wetlands dominated by indigenous vegetation, we have assessed the ecological value of these remnant indigenous wetlands in Site 1A as **High** (Table 8).

Table 8: Ecological value of indigenous vegetation dominated wetlands proposed Ruakākā Solar Park, based on EIANZ criteria.

Matter	Description	Ecological value
Representativeness	Small remnants of what would've been a larger indigenous wetland prior to human arrival in New Zealand. Now restricted to very small fragments, as a result of historical and recent drainage, previous stock access, invasive exotic species and potentially damage from four-wheel drive vehicles.	Moderate
Rarity/distinctiveness	Dune slack wetlands are rare nationally and wetlands with intact indigenous vegetation are particularly rare in the Waipu Ecological District. No Threatened or At-Risk plants recorded. Likely used by Threatened/At-Risk bird species occasionally, such as matuku-hūrepo and mohu-pererū, due to their presence within Site 1 but unlikely to have resident individuals, due to their small size.	High - Very High
Diversity & Pattern	Dominated by indigenous vegetation but low diversity and surrounded by exotic vegetation.	High
Ecological Context	Small, isolated fragments, surrounded by exotic vegetation, hydrologically and physically connected to larger exotic wetlands. Some potential to provide nesting habitat for some threatened cryptic wetland bird species, eg, matuku-hūrepo, mātātā/fernbird.	Moderate
Overall Ecological value		**High**

5.3.4 Exotic wetlands

Highly modified and degraded shallow wetlands, dominated by a dense low diversity growth of exotic vegetation. No threatened fauna likely to be resident but providing low-quality foraging habitat for the threatened matuku-hūrepo and given the rarity of dune slack wetlands, we have assessed the ecological value of these degraded exotic wetlands in the proposed Sites as **Moderate** (Table 9).

Table 9: Ecological value of exotic wetlands at the proposed Ruakākā Solar Park, based on EIANZ criteria.

Matter	Description	Ecological value
Representativeness	Highly modified, eg, dominated by exotic wetland vegetation, mostly surrounded by grazed pasture, grazed by stock (exception is Site 1A) and impacted by historical and recent drainage activities, therefore not representative of pre-human dune slack wetlands in current state.	Low
Rarity/distinctiveness	Dune slack wetlands are rare nationally and in the Waipu Ecological District. Features with slightly deeper water provide foraging habitat for matuku-hūrepo (one observation of this in Site 1B in March 2023).	Very High
Diversity & Pattern	While there is variation throughout the sites for these wetlands in terms of the dominant species, individually each of these wetlands is dominated by one or two invasive exotic species, typically forming a dense homogenous growth with low diversity.	Low
Ecological Context	Highly modified and degraded systems with severe pugging from stock and poor water quality in all Sites (except Site 1A) but likely providing some nutrient and sediment treatment for diffuse surface run-off and low-quality foraging habitat for matuku-hūrepo. Some of these features are shallow and small, so likely to be ephemeral features.	Low - Moderate
Overall Ecological value		**Moderate**

5.4 Freshwater

5.4.1 Overview

In general, aquatic habitat values are poor due to historic drainage and diversion of natural flow paths and the site's history of pastoral land use.

5.4.2 Rivers: Bercich and Unnamed Drains

Both drains are highly modified systems with no hydrological heterogeneity and limited instream habitat and riparian buffer (Table 10).

The ecological value of the habitat for native fish communities present in Bercich Drain is **Low**. This is based on the poor-quality aquatic habitat, poor water quality and poor connection with the sea, resulting in only the most tolerant native species inhabiting the watercourse in very low abundances. The overall ecological value of Bercich Drain is assessed as **Low**.

The overall ecological value of the Unnamed Drain is assessed as **Moderate to High**, due to presence of the At Risk īnanga, good hydrological connection with the Ruakākā River and the potential of providing spawning habitat for īnanga.

Table 10: Ecological value of Bercich Drain and the Unnamed Drain at the proposed Ruakākā Solar Park, based on EIANZ criteria.

Matter	Bercich Drain ecological value	Unnamed Drain ecological value
Representativeness	Drainage channel constructed in historical wetland. Aquatic vegetation is cleared periodically to retain drainage. Straight, narrow and shallow channel with homogenous slow flow, small industrialised upstream catchment. Very highly modified habitat - not representative of low order stream prior to human arrival in NZ. **Very low**	Drainage channel constructed in historical wetland. Straight, narrow and shallow channel with homogenous slow flow, fed from two large stormwater ponds, so likely to be permanent. Highly modified habitat – not representative of low order stream prior to human arrival in NZ. **Low**
Rarity/distinctiveness	Habitat common throughout region and Ecological District. No records or observations of threatened fish species and none likely to be present, due to poor connectivity to coast and disturbance regime of vegetation clearance. **Low**	Habitat common throughout region and Ecological District. Mostly exotic macrophytes present. One At Risk fish species present (īnanga). **High**
Diversity & Pattern	Some diversity in macrophyte community along Drain, with some tall native rushes and reeds in Site 1C but periodically cleared. Only 1 native fish present (shortfin eel). **Low**	Mostly exotic macrophytes present. At least two native fish species likely to be present (īnanga and shortfin eels). **Moderate**
Ecological Context	Fair habitat condition with an average HQS of 35. Some riparian vegetation in Site 1A, otherwise heavily grazed pasture to bank edge. Stock have access for at least 1/3 of its length. Possibly provides foraging habitat for matuku-hūrepo in places. **Moderate**	Fair habitat condition with an HQS of 37.5. Fenced to exclude stock. Has narrow riparian strip of dense grass sward, which will filter some sediment and nutrients and potentially provide vegetation for īnanga spawning habitat. Some shrubs providing shade. Good connection to Ruakākā River and sea. Tidally influenced, so may provide spawning habitat for īnanga. **Moderate - High**
Ecological Integrity	Very low nativeness, pristineness (poor water quality), diversity and resilience. **Very Low**	Low nativeness, pristineness (poor water quality) and diversity and moderate resilience. **Low**
Ecological Value	**Low**	**Moderate - High**

5.4.3 Other drainage channels

The ecological value of the other farm drainage channels on Site 1 is considered **Negligible,** due to the surrounding land use and stock access and/or no riparian buffer, intermittent/ ephemeral nature of water flow, artificial nature of drains, poor water quality, lack of habitat features and absence of permanent connectivity to the wider catchment (Table 11). The ecological value of the other farm drainage channels on Sites 2 and 3 is considered **Low**, due to the same reasons, except that these drains have better connection with the Ruakākā River and could possibly be inhabited by native freshwater fish at times.

Table 11: Ecological value of all other drainage channels at the proposed Ruakākā Solar Park, based on EIANZ criteria.

Matter	Description	Ecological value
Representativeness	Artificial farm drainage channels. Most have stock access and severe pugging, and very low stream habitat quality. Small, constructed drains with either intermittent or ephemeral flows. Some are fenced but with limited riparian buffer. Not representative of pre-human ephemeral stream.	Very Low
Rarity/distinctiveness	Habitat very common throughout region and Ecological District. Unlikely to support Threatened, At-Risk or Uncommon freshwater fauna or flora. Dominated by exotic vegetation.	Very Low
Diversity & Pattern	The only instream habitat are mostly exotic macrophytes. Unstable system for freshwater biota, due to periodic drying, warm water temperatures and low DO with low or no flows periods. Native fish (eg, short fin eels) may periodically be present in some of the larger drains on Sites 2 and 3.	Very Low - Low
Ecological Context	Short reaches and small catchment areas. Would provide some (low) sediment and nutrient treatment of water run-off and flow attenuation but limited connection with downstream catchments and sea at times due to periodic drying.	Low
Ecological integrity	Very low in all aspects of ecological integrity (nativeness, pristineness, diversity and resilience).	Very Low
Ecological Value		**Negligible - Low**

5.5 Avifauna

5.5.1 Site 1

Open water habitat within Site 1C, and the south-eastern portion of Site 1B are ranked as **Very High** value for avifauna. These features are frequented by a pair of matuku-hūrepo and a pair of weweia. Shrubland and wetland habitat in the eastern half of Site 1A is also of **Very High** value, as the habitat is complex and includes patches of open water, native rushes and sedges, and dense vegetation.

Site 1 as a whole (including pasture grassland, stands of trees, and wetlands) is utilised by a varied assemblage of native bird fauna (including two Threatened species, and three At-Risk species). Matuku-hūrepo have also been previously observed foraging in drains, wetlands (both indigenous and exotic), kanuka shrubland and rank grassland. Therefore, the northern portions of Site 1A and 1B are ranked as of **High** value for avifauna. However, we note these habitats are degraded, and most species recorded within the site are highly mobile and common in the surrounding landscape, and were in low abundance.

5.5.2 Sites 2 and 3

The habitat features within Sites 2 and 3 are similar and as such can be valued together. The avifauna community present on Sites 2 and 3 is dominated by native and exotic species that are

Not Threatened. While there is limited habitat for cryptic wetland bird species within these Sites, an individual matuku-hūrepo was recorded on the edge of Site 3, and in the southern stormwater pond between the Sites in March 2023, while ebird data shows that matuku-hūrepo are frequently seen in farmland surrounding the Sites. Therefore, while the avifauna community in Sites 2 and 3 is dominated by common species, the area is ranked as of **High** value due to incidental use of the sites by matuku-hūrepo.

5.6 Herpetofauna

As there is minimal suitable habitat for indigenous lizards in the majority of the Sites and no lizards were detected during our surveys, it is considered unlikely that abundant or significant populations of indigenous lizards are present. There is some potential for low numbers of skinks to be distributed across rank grassland habitats throughout each of the three Sites. Copper skinks and/or shore skinks (both At Risk – Declining) are potentially present at very low densities (likely below detectable limits, due to predation by mammalian predators and the site's long history of disturbance). Old structures, densely vegetated riparian margins, and rank grassland of Site 1A are those most likely to offer protective refuge to skinks.

There are no records for native geckos near the Sites (other than an anecdotal observation of Auckland green gecko in adjacent kanuka forest). For these reasons, the ecological value for indigenous lizard habitats on Sites 1B, 1C, 2 and 3 has been assessed as **Moderate** and on Site 1A as **High**.

5.7 Long-tailed bats

As native forest with suitable bat habitat is present in close proximity to the Sites, and potential roost trees and foraging opportunities are present within the Sites, our evaluation assumes that bats are both roosting and foraging on site. Long-tailed bats are a Threatened - Nationally Critical species, hence the habitat is potentially of **High** value.

Field surveys may establish that bats are not routinely using the trees on the subject sites, which would likely reduce the value assigned to these features. However, given recent observations of bats within 20 km of the site, appropriate management measures to minimise mortality risk during site clearance would nonetheless be required (Section 8.6), as bats can forage over a wide area and use roost features opportunistically.

5.8 Ecological significance

The ecological significance of the features present across the three Proposed Sites are summarised in Table 12 below, including whether the features meet Regional Policy Statement for Northland (RPSN) ecological significance criteria and their ranking under the Whangarei District Plan (WDP) criteria.

*Table 12: Ecological features present within the proposed Sites, including whether the features meet ecological significance criteria in the RPSN and their ranking value under the WDP. * = potential but not confirmed.*

Ecological feature	Ecological Significance under RPSN	Ranking value under WDP	Explanation
Kānuka dominated forest and shrubland	Yes	Moderate-High	Meets RPSN criteria 1(a) for Representativeness and 2(a) and 2(b) for Rarity/distinctiveness Habitat or sequence which is rare in Waipu Ecological District
Grazed pasture	No	Potential	Potential foraging and resting habitat for avifauna
Gorse shrubland, rank grassland and debris	Yes*	Moderate*	If copper or shore skinks are present, meets RPSN criteria 2(b) for Rarity/distinctiveness and 4(c) for Ecological Context Viable habitat of indigenous fauna
Open water habitats	Yes	Outstanding	Meets RPSN criteria 2(b) for Rarity/distinctiveness and 4(c) for Ecological Context Contains two species listed in ECO-SCHED2 of WDP as Outstanding Value
Indigenous wetlands	No	Potential	Small indigenous vegetation remnants that are largely constrained by invasive exotic wetland vegetation Potential foraging and resting habitat for avifauna
Exotic wetlands	No	Potential	Potential foraging and resting habitat for avifauna
Bercich Drain	No	Potential	Potential foraging habitat for avifauna and habitat for freshwater fauna
Unnamed Drain on edge of Site 3	Yes	Moderate	Meet RPSN criteria 2(b) for Rarity/distinctiveness and 4(c) for Ecological Context Viable habitat of indigenous fauna
Other drainage channels on all sites	No	Potential	Potential foraging habitat for avifauna and habitat for freshwater fauna
Mature native and exotic trees (prospective bat roosts)	Yes*	Moderate (High if bats confirmed as present)*	If bats are present, meets RPSN criteria 2(b) for Rarity/distinctiveness and 4(c) for Ecological Context Viable habitat of indigenous fauna – bats are listed in ECO-SCHED2 of WDP as High Value.

6.0 Proposed activities

As outlined above, the proposed solar farm is expected to consist of approximately 200,000 photovoltaic solar panels set across 170 ha, over the three sites (Figures 22-24). The panels are expected to be bifacial monocrystalline panels aligned in rows running east-west or north-south on all three sites. The panels will be mounted on either a fixed tilt system of 10 to 25 degrees or a Single Axis Tracking (SAT) system.

While detailed design is ongoing, it is currently anticipated that:

- The panel distance above ground level will be about 1.5 m at the lowest point on Site 1 and between 1.7 - 2.9 m for Sites 2 and 3, reaching a maximum height of ~ 3.9 m on Site 1, 4.3 m on Site 2 and 5.5 m on Site 3.
- The row spacing will be dependent on detailed design and could be between 7 and 8.5 m apart (centre to centre) with an approximate 2.5 - 4 m or ~ 4 – 7 m horizontal gap between adjacent rows of panels in a fixed tilt and SAT system respectively.
- There will be approximately 25 to 35 inverters needed across the three sites. Cabinets housing the inverters, transformer, and associated equipment to convert DC energy produced by the solar panels into AC energy required by the national grid will be placed around the site and connected by buried cabling.
- The development will also include ancillary buildings (mostly within the already consented BESS development and by the existing buildings on Site 3), structures, access and perimeter roads, cabling and infrastructure.
- The site perimeter is anticipated to be made secure by the construction of 2 m high security fence, and CCTV cameras mounted on 2.5 m high poles will be placed at points around the Sites.

The construction and operation of the Ruakākā Solar Park will require the following components, subject to detailed design:

- Ground contouring will be required across 190 ha to level and prepare the sites for safe piling, internal access routes and platforms for inverter stations, especially on Site 1 and excavations related to trenching for cable installation.
- The kānuka forest and shrubland in the western corner of Site 1 will remain and no earthworks will be undertaken within this area. There will be a 5 m planted buffer, perimeter road and security fence between the kānuka forest and solar panels. Other terrestrial vegetation within the Sites will be cleared during the construction stage.
- Both Bercich Drain on Site 1 and the Unnamed Drain on the edge of Site 3 that flows from the stormwater ponds into Ruakākā River, will be retained. Bercich Drain and the Unnamed Drain will be fenced with a 2 m setback, to exclude sheep. No panels will be located within the easement for Bercich Drain in Site 1.
- Temporary culverts for the construction stage and permanent culverts will be installed for road crossings on Bercich Drain, the unnamed Drain and other minor drains, as per the indicative site layout plans (Figures 22-24). This will require temporary instream works.

- Open water drains with existing easements on the Sites will remain and internal roading will align with these drains to allow ease of maintenance. Post-construction stormwater from Site 1 will be directed to Bercich Drain, from Site 2 will be directed to the stormwater ponds to the east and Site 3 to the either the constructed wetland, or the Unnamed Drain on the western side. Minor farm drainage channels (without easements), will either remain in place or be removed, redirected and/or consolidated, where it is possible to do so without impacting the flow pattern and capacity.
- In operational stage, maintenance activities (eg, vegetation and sediment removed) will be undertaken on Bercich Drain, Unnamed Drain and other drains, if required, to maintain the free flow of water and prevent flooding.
- Cable trenches for 33 kV cables will be ~ 1.2 m deep and approximately 60 – 70 cm wide and trenches for DC cables will be ~ 0.6 m deep and ~1 m wide. These will be installed progressively across the sites. Cables that need to cross rivers (Bercich Drain and Unnamed Drain) will likely be directionally drilled under the river. This will be confirmed as part of detailed design.
- The photo-voltaic panels will sit on mounting structures that are supported by piles. These will be screwed or driven into the ground.
- The Battery Energy Storage System (BESS) is already consented and construction is underway in the northern corner of Site 1A. The 0.15 Ha wetland offset as part of the BESS consent will be wrapped into the larger wetland offset plan as part of this consent.
- Site access locations are proposed from McCathie Road for Site 2 and from Marsden Point Road for Sites 1 and 3, including the current access from Rama Road for Site 1. Laydown areas will be created adjacent to these access locations.
- New roads will be constructed through all three Sites. The proposed access roads and service roads within the Sites range from 4 to 8 m wide. The surface of service roads will be gravel.
- Located across the Sites, amongst the solar panel arrays, will be approximately 25 to 35 structures housing electrical equipment including inverters, transformer and switchgear. The footprint of each structure will be approximately 12 by 2.5 m and ~2.5 m high. Each structure will be installed on piles or concrete surfaces.
- Buffer planting to achieve screening is planned for some of the boundary edges of Sites 2 and 3 (Littoralis 2023). Species planted are proposed to be a mix of native species and fast-growing exotic species in a buffer strip about 2 metres wide. Planting buffer locations are detailed in Littoralis 2023.
- A total area of 2.05 ha of open water habitat in the south-east side of Site 1B and 1C, including a large pond and adjacent smaller wetlands, will be retained, enlarged and enhanced to partly mitigate the wetland extent lost as a result of the earthworks during solar park construction. The proposed area of this wetland when enlarged and enhanced will be 9.1 ha.
- There will be a perimeter road, security fence and 5 m average width vegetated buffer between the retained and enhanced wetland on Sites 1B and 1C and the solar panels.
- A wetland will be constructed at the southern end of Site 3, to offset the wetland extent lost as a result of the earthworks during solar park construction. Within the constructed wetland there will be a 12 m radius setback from the edge of the Transpower tower

foundations, a 12 m radius setback from Northpower electric pole risers, and access roads to these structures will be provided. There will be a perimeter road and security fence between the constructed wetland and solar panels. Work and wetland development around the Transpower lines and towers will follow Transpower's Development Guide[12].

- The remaining land beneath and surrounding solar arrays will be sown in exotic pasture grassland post-construction. Light sheep grazing is proposed for all three Sites after solar farm establishment, which will replace the current use, which is mostly cattle grazing.
- Groundwater takes for construction will be up to 600 m^3/day, split between Site 1 (300 m^3/day) and Sites 2 and 3 (300 m^3/day).
- During the operational stage, cleaning of solar panels will be undertaken using water only, with no chemicals used during the cleaning process. Water sourced for the cleaning of the solar panels will be taken from a consented groundwater take of up to 75 m^3/day, which will be needed up to twice per year.
- No artificial lights will be installed onsite, except for emergency, site entrance and maintenance lighting where needed.

[12] The Development Guide | Transpower

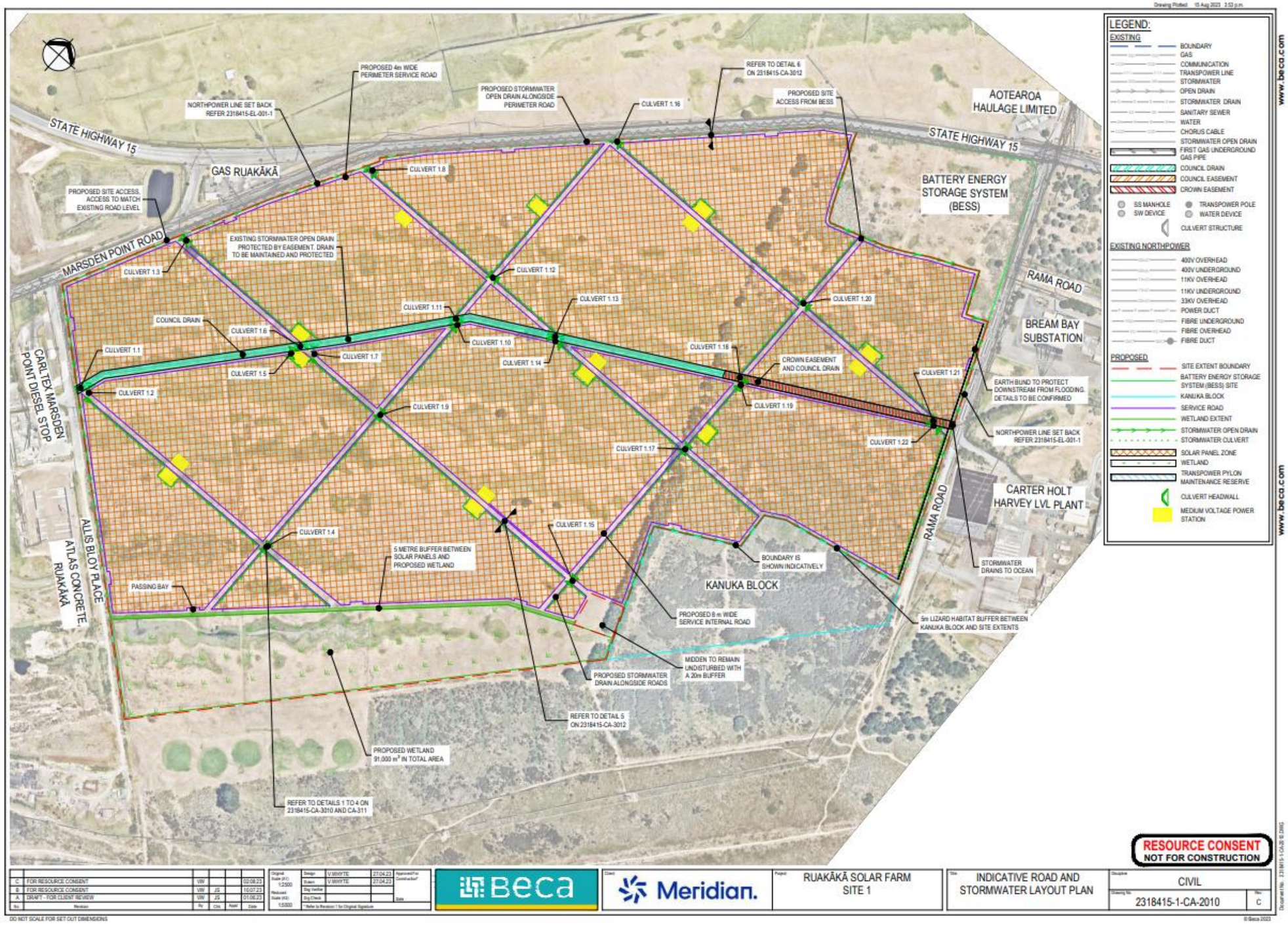

Figure 22: Indicative layout for Site 1 of the proposed solar park development at Ruakākā. Source: BECA.

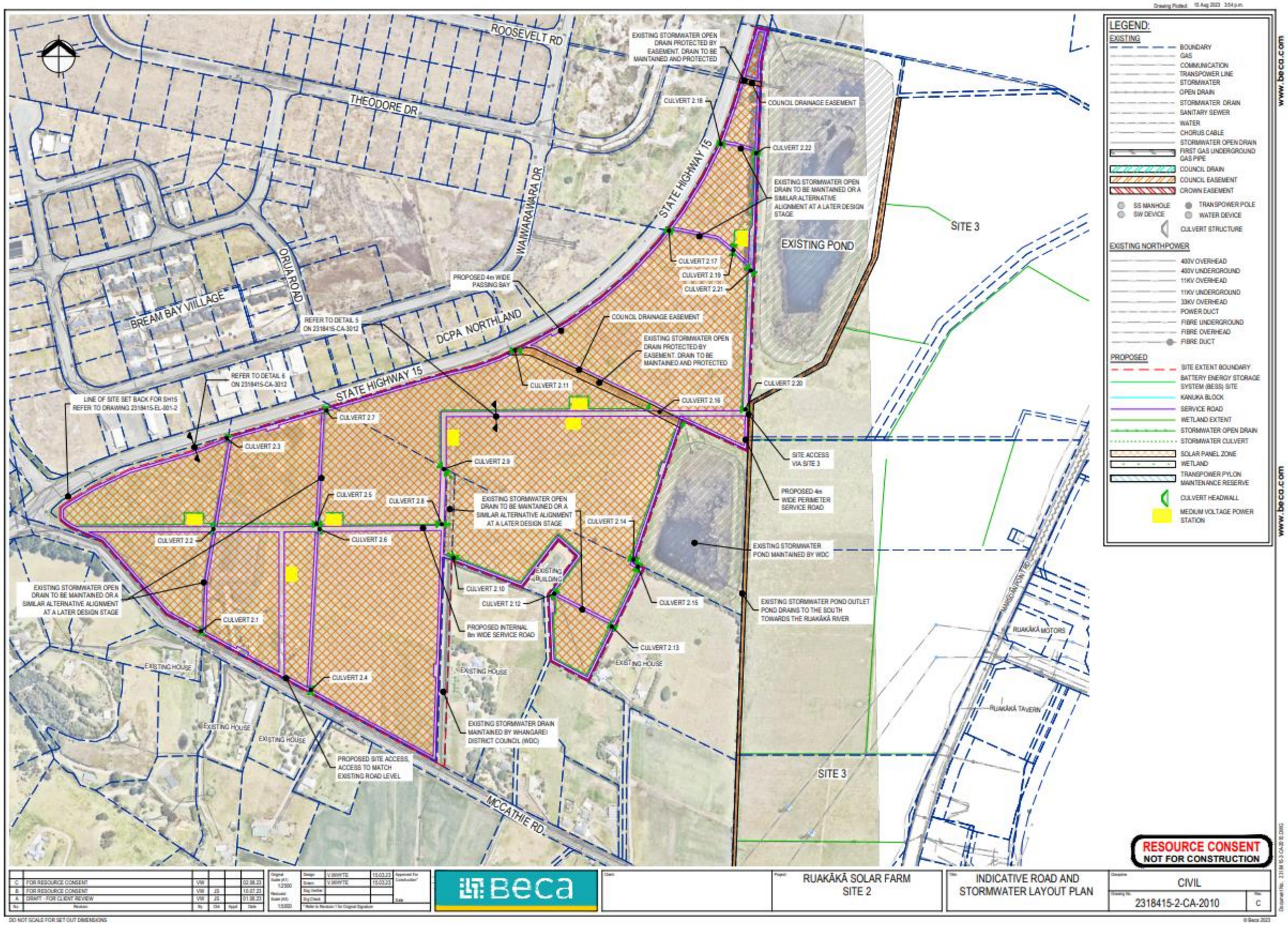

Figure 23: Indicative layout for Site 2 of the proposed solar park development at Ruakākā. Source: BECA

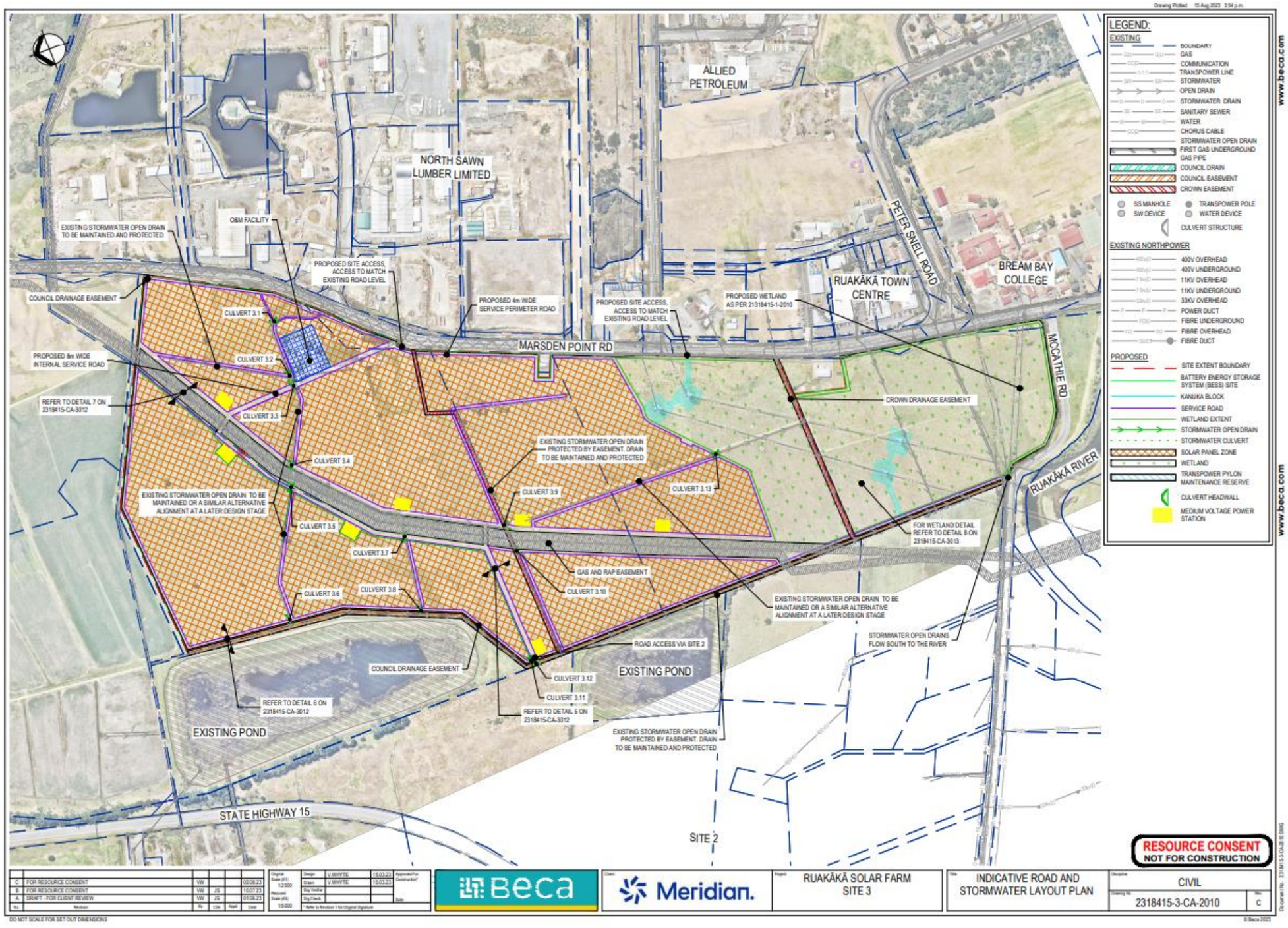

Figure 24: Indicative layout for Site 3 of the proposed solar park development at Ruakākā. Source: BECA

7.0 Ecological Effects

7.1 Overview

The following sections address the potential ecological effects arising from construction, operation and maintenance of the solar park. In summary, these include:

- Habitat loss and degradation through vegetation clearance and site levelling, with associated effects on native fauna (mortality, injury, loss of foraging opportunity, disturbance, or displacement of fauna);
- Sedimentation of aquatic systems during earthworks, and associated effects on water quality;
- Non-lethal effects on fauna due to noise, vibration, and artificial lighting during construction;
- Stormwater runoff from any impervious surfaces associated with infrastructure and associated increase in temperature and contaminants discharged to the receiving environment; and
- Uncertain potential or theoretical risks of the solar array once operational (eg, collision risk for avifauna, microclimate changes).

7.2 Effects on Terrestrial Vegetation

Kānuka forest and shrubland on Site 1 is being retained and will be outside of the security fence, and sheep will not have access. Therefore, direct effects on this vegetation community are **Avoided**.

Most other vegetation on the Sites will be removed during construction. The majority of the vegetation being removed is exotic grassland. For most areas this is a temporary loss during construction, as the area below solar panels will be returned to exotic grassland post-construction.

Most other patches of exotic and native shrubs, hedgerows/ shelterbelts, and individual mature native and exotic trees scattered through the sites will also be removed during construction.

Note that mature trees have potential habitat value for bats, which is assessed separately in Section 8.6. Otherwise, while the magnitude of vegetation clearance is high, the ecological value of the grassland and woody vegetation is generally very low, and the loss is temporary. Therefore, the level of effect on terrestrial vegetation within the Sites is **Negligible**.

7.3 Effects on Wetlands

7.3.1 Loss of wetland extent

Levelling of the Sites will remove the majority of identified wetland features, with the exception of 2.05 ha of open water habitat in the south-east side of Site 1B and 1C. While an adaptive approach will be used in detailed design and during earthworks to avoid wetland features where practicable, we have assumed a 'worst-case' scenario in calculating the magnitude of loss. This equates to a total loss of 17.06 ha (including 0.1 ha from the BESS) of wetland extent across the three sites (mostly on Site 1), including open water pond habitats, indigenous wetlands and exotic wetlands.

It is our understanding that wetlands which are removed will not be reinstated, to ensure access between solar panel rows is retained for maintenance. This will result in loss of habitat for freshwater invertebrates, wetland bird species, including several Threatened and At-Risk species, introduced frogs (a food source for wetland birds), eels and potentially other native freshwater fish. In the absence of effects management measures, we have assessed the magnitude of effect on wetland values due to wetland loss as **Very High**.

7.3.2 Operational effects

The south-eastern open water wetland habitat that is being retained and enhanced (refer to Section 8.2) will be designed to maintain similar hydrological characteristics, including current water levels and natural seasonal changes, by retaining its connection with the groundwater table. The water depth and extent of this wetland is highly influenced by groundwater levels, and we do not expect this to vary as a result of the proposed development beyond the range of the natural seasonal changes this system currently experiences, given:

- The proposed design of the solar panels allows for water to flow and percolate below the panels (refer to section 2.1 of Beca's Civil Design report[13]).
- The soil will be predominately sand overlaid with organic topsoil and vegetation cover reinstated as pasture grasses used for sheep grazing, which are similar to the pre-development conditions, and compaction is not expected to substantially reduce the ability for rainwater to infiltrate the ground[13].
- A substantial portion of the water currently feeding this open water wetland is likely shallow groundwater from the Ruakākā treated wastewater disposal field to the east of this feature.
- The proposed groundwater take for panel cleaning is negligible (up to 75 m^3/day twice a year), relative to the estimated allocation available in the Ruakaka Aquifer of 1,736,025 m^3/year[14].

Therefore, operational effects on the remaining wetland habitat are assessed as **Negligible – Low**. As discussed below (Section 7.4.2), there are likely to be **Positive effects** on this wetland during the operational stage of the project, as stock will no longer have access to this wetland.

[13] Beca Limited. 2023. Ruakaka Energy Park Solar Farm Consent Design. Prepared for Meridian Energy Limited.

[14] Based on the indicative groundwater allocation map retrieved from the NRC website on 18 August 2023: Indicative water quantity allocation maps - Northland Regional Council (nrc.govt.nz)

7.4 Effects on Freshwater Values

7.4.1 Construction impacts

Farm Drain Removal

Most of the minor farm drainage channels (excluding Bercich and the Unnamed Drains) will be removed, redirected and/or consolidated when the Sites are levelled. These are all Artificial Watercourses. Due to the small size, ephemeral nature, lack of connection and poor water quality of these drains in Site 1, it is unlikely that they are providing habitat for native freshwater fish.

A few drains on Sites 2 and 3, which are slightly larger and have better hydrological connection with the Ruakākā River, may at times be inhabited by low numbers of native freshwater fish. Therefore, removal or re-alignment of these drains could result in injury and/or mortality of native freshwater fish, depending on timing of works. As drains similar to those being removed will be re-established on site to provide drainage, we consider the loss is temporary and therefore have assessed the magnitude of effects in the absence of mitigation and control measures to be **Negligible** for Site 1 and **Moderate** for Sites 2 and 3.

Installation and removal of culverts

There are several road crossings to be established across Bercich Drain and one across the Unnamed Drain, which will be created using temporary culverts during construction and permanent culverts to remain during the operational stage. The placement of poorly designed instream structures can create full or partial barriers to native freshwater fish.

As both native fish species (shortfin eels and inanga) recorded in low numbers within the Sites need to migrate to the sea to complete their lifecycle, it is important that instream structures, such as culverts are designed and installed to maintain fish passage that is similar to natural conditions. Under the National Policy Statement for Freshwater Management and in turn the Proposed Regional Plan for Northland (PRPN), the construction and installation of structures in rivers must not create a barrier to fish passage during normal flow conditions.

Given the size of the watercourses, the native fish present, and assuming the culvert design and installation follows the requirements of regulations 69 and 70 of the National Environment Standards for Freshwater, the recommendations in the New Zealand Fish Passage Guidelines (Franklin et al., 2018) and meets the permitted activity standards in the PRPN, the magnitude of this potential effect on native freshwater fish values is **Negligible**.

Removal of riparian vegetation

The removal of the riparian vegetation on the northern side of Bercich Drain in Site 1A (approximately the north-eastern third of the Bercich Drain), will have direct and indirect potential and actual effects on these aquatic ecosystems. The removal of trees and shrubs will result in:

- reduced shade, likely leading to increased water temperatures and greater diurnal temperature fluctuations,
- increased light availability, which in turn will potentially lead to an increase in primary productivity, mostly macrophyte growth,
- reduced habitat availability and food sources for freshwater fauna eg, overhanging vegetation and allochthonous sources of detritus.

Also, the loss of dense grass swards and other groundcover in the riparian zone of Bercich Drain (mostly only Site 1A) and the Unnamed Drain is predicted to reduce the filtering ability of the riparian zone to remove sediment and nutrients from diffuse surface run-off and will also remove potential spawning habitat for inanga on the Unnamed Drain. In the operational stage, the entire length of both Drains will be fenced with a 2 m setback to exclude sheep, so we expect there to be some filtering effect from groundcover in the riparian zone. Therefore, this effect is temporary (during the construction stage) and livestock exclusion in the operational stage is likely to have positive effects on water quality and stream habitat.

Based on these reasons, the magnitude of effects of removing riparian vegetation on the freshwater ecological values for Bercich Drain is assessed as **Moderate** and for the Unnamed Drain is assessed as **Negligible**.

Sedimentation

The main potential effect during construction for the two watercourses considered to be intermittently or continually flowing rivers or streams within the three Sites; Bercich Drain and the Unnamed Drain, is sediment inputs from earthworks. Earthworks activities increase the potential for erosion and destabilisation effects and have the potential to discharge sediment into waterways both during and after the works until the ground surface has stabilised. The risk is higher for Bercich Drain, due to its location in the middle of the earthworks area.

Sediment discharges to aquatic ecosystems can cause a range of adverse effects, including smothering aquatic life, damaging fish and invertebrate gills, destruction of spawning grounds, and the deposition of nutrients to waterbodies. Increased turbidity can interfere with aquatic fauna's ability to feed due to poor visibility, and reduced light penetration can reduce photosynthetic activity.

A detailed Erosion and Sediment Control Plan[15] has been developed to manage the risk of sediment entering waterbodies across all three sites. Perimeter bunds and/or silt fences will be established and maintained around all earthworks areas and sediment retention devices will be installed in stages on sites as needed and maintained during the construction phase to control and treat stormwater run-off. All devices will be constructed and maintained in accordance with Auckland Council's GD05 Guidelines, including the use of flocculants to improve sediment treatment (Leersnyder et al., 2016).

In addition, the installation/removal of culverts (as covered above) and wetland construction in the southern corner of Site 3 have the potential to cause localised sedimentation effects. We have assumed that detailed culvert design and installation, and wetland design and construction will be undertaken in accordance with Auckland Council's Erosion and Sediment Control Guide GD05 (Leersnyder et al., 2016), to minimise sediment inputs into nearby waterways and downstream systems.

As covered above, the risk of sedimentation of waterways will be minimised and mitigated through the use of erosion and sediment control measures, as outlined in the erosion and sediment control plan and during the detailed culvert and wetland design stage. Given this, we consider that the magnitude of this potential effect will be **Negligible – Low.**

[15] Beca Limited (2023) Erosion and Sediment Control Plan (ESCP): Ruakaka Energy Park Solar Farm. Prepared for Meridian Energy Limited.

7.4.2 Operational impacts

Drain maintenance

Ongoing drain maintenance will have effects on the ecological values of the watercourses in the Sites once the solar park is operational. The proposed maintenance (eg, vegetation clearance and sediment removal), if required, of Bercich Drain, the Unnamed Drain on the edge of Site 3 and any other minor drainage channels may cause injury and/or mortality of native freshwater fish species and will also result in temporary loss of habitat (eg, macrophytes) for instream biota. However, as these drains have historically and recently had similar maintenance undertaken, we consider that the effects will be similar to existing conditions, and therefore have assessed the magnitude of this effect on freshwater ecological values as **Negligible.**

Changes to water flows

There is no substantial change in land cover planned by the proposed solar park development, for example, permeable grassland (pasture/agricultural) to impermeable surfaces. The majority of all three Sites will be permeable substrates (eg, area under panels will be returned to grazed pasture and roads will be gravel). As water will flow off the panels and inverter stations and percolate into the ground, they will act as a "shield" as opposed to an impervious surface. Also, inverter stations may be raised above the ground. The roof rainwater run-off from a single building on Site 3, will discharge to a drainage channel, which flows into the Ruakākā River. Beca (2023) expects there to be no change in stormwater runoff rates as a result of the solar panel infrastructure compared to pre-development.

The stormwater design for Site 1 post-construction will be similar to the current drainage pattern, ie, the majority of the site will drain to Bercich Drain in the middle of the site, via drains on the uphill side of internal roads. The removal of most depressions within Site 1 as a result of site levelling, has the potential to increase the Site run-off during heavy rain, in turn impacting on downstream environments. This will be mitigated by the construction of an earthen bund along Rama Road to avoid adverse effects on downstream properties. The drainage networks for Sites 2 and 3 post construction, will maintain existing drainage channels where possible, including those that carry stormwater from neighbouring properties, with some consolidation of minor drains. The stormwater will leave the Sites in the same locations, flowing into the Ruakākā River.

Based on the above reasoning, we predict there will likely be no or very little change in water flow in Bercich Drain and the Unnamed Drain, as a result of the proposed activities, and therefore have assessed the magnitude of this effect on freshwater ecological values as **Negligible.**

Water quality impacts

The solar panels are sealed systems, so are not a risk to water quality, as long as they are regularly checked and maintained. Any damaged solar panels will be removed/replaced. Cleaning of solar panels will be done with water only, so there is no risk to water quality associated with this activity.

As covered above, Beca (2023) expects there to be no change in stormwater runoff rates as a result of the solar panel infrastructure compared to predevelopment. The drainage network will be designed with drains on the uphill side of roads to collect sheet run-off and given the nature of the activities to be undertaken on the Sites, eg, occasional vehicle access for maintenance checks and monitoring, contaminants in stormwater run-off are likely to be minimal. Therefore,

the magnitude of potential effects on freshwater ecological values from stormwater run-off is predicted to be **Negligible.**

We note that replacing cattle grazing with lower intensity sheep grazing will reduce the pressure on the land and impacts on downstream aquatic ecosystems and water quality through reduced losses of contaminants, such as sediment and nutrients (Brown et al., 2011; Parliamentary Commissioner for the Environment, 2013). Cattle currently graze most wetlands, therefore consolidating (refer to section 8.2) and fencing off wetlands to prevent stock entry will also improve freshwater values.

Sediment losses can be higher on a national average for sheep farms; however, this is often associated with farming marginal, steep land with higher erosion potential. The Sites will be flat topography once operational, and the sediment losses compared to current farming practices, especially as the main drains will be fenced to exclude sheep, are expected to be below average in this instance. Therefore, the overall magnitude of water quality impacts from the proposed activities on watercourses will be **Positive**.

7.5 Avifauna

7.5.1 Construction potential effects

Habitat loss and degradation

The primary impact on birds associated with the proposed development is avifauna habitat loss across all Sites (particularly in Site 1) as a result of enabling earthworks. Effects include disturbance and possible temporary or permanent displacement of resident birds (including a pair of matuku-hūrepo that are frequently observed within the site), and a reduction in the extent of wetland habitat for populations that forage widely in the landscape. Works could result in injury or mortality to birds or nests if undertaken without appropriate management protocols.

Notwithstanding its degraded condition, avifauna habitat within Site 1 is assessed as **High** or **Very High** value, while habitat in Sites 2 and 3 are assessed as **High** value. The magnitude of effect has been assessed as **High** during construction, reducing to **Moderate** during the operational phase (i.e., loss or alteration to one or more key elements or features of the baseline conditions, such that the post-development character, composition and/or attributes will be partially changed; EIANZ, 2018). In the absence of effects management measures, the level of effect on avifauna values is therefore **Very High** for all sites during construction, reducing to **High** at Sites 2 and 3 during the operational phase.

7.5.2 Operational effects

The majority of species recorded are highly mobile, and utilise pastoral and degraded wetland habitats common throughout the surrounding landscape. It is likely that these populations will continue to utilise the Sites for foraging and resting once the solar park development (including wetland enhancement and construction) is completed, as they will be returned to pasture and there will be minimal disturbance or human activity around the solar arrays. However, we note that the quality and extent of habitat will be altered by the proposed wetland enhancement and construction.

There are uncertainties around the effects of solar arrays on some bird species. These matters are addressed in Section 7.8.

7.6 Herpetofauna

7.6.1 Construction impacts

There is limited lizard habitat within the Sites. Most of this habitat (excluding the kanuka forest) within the three Sites will be removed during construction. There is potential for injury, or mortality of any native lizards present within the Sites, during structure and debris removal, and vegetation clearance/earthworks. As the solar park development will result in the loss of most lizard habitat (excluding the kanuka forest) in the short term and potential injury or mortalities of indigenous lizards, the overall magnitude of effect on herpetofauna values in the absence of mitigation and control measures is assessed as **Moderate.**

7.6.2 Operational impacts

The long-term impacts of the solar park development on herpetofauna habitat values are assessed as **Negligible,** as lizard habitat within the Sites will be largely removed, hence no populations are expected to persist within the Sites following development. Small populations may persist around the periphery (particularly in Site 1), and the proposed planted buffers within the Sites may return some suitable lizard habitat to the Sites in the medium to long term.

7.7 Long-tailed bats

During the clearance and construction phase all potential roost trees previously identified will be felled. There is potential for injury and/or mortality of bats during this vegetation clearance. If bats are assumed to be present in these roost trees, the magnitude of effect from felling them is potentially **Very High** without mitigation.

The felling of the shelterbelts, individual trees and hedgerows will remove connectivity and foraging opportunities as well as potential roost features. If bats are assumed to be using these vegetation lines and trees, the magnitude of impact from removing them is potentially **Moderate** within the wider landscape without mitigation.

Modification of the remaining habitats, such as connectivity to the kānuka forest, wetlands and ponds, will be permanent, resulting in a potentially **Moderate** ongoing magnitude of effect, i.e. loss or alteration to one or more key elements or features of the baseline conditions, such that the post-development character, composition and/or attributes will be partially changed (EIANZ, 2018).

7.8 Uncertain Environmental Effects of Solar Array

Large solar farms are a novel feature in the New Zealand environment, and the responses of native fauna to these features and the changes to the microclimate as a result of their installation are largely unknown. This section outlines potential or theoretical risks to native fauna (primarily avifauna populations known to utilise the Sites) associated with the solar panels, based on information from the international case studies of large-scale solar arrays.

Collision risks to avifauna

The reflective surfaces of panels can be perceived as water bodies (referred to as the 'lake effect'), potentially leading to collisions with the structures when fauna attempt to land, feed or drink (Bennun et al., 2021). Birds associated with water are thought to potentially be at greater risk of solar panel collision (Kagan et al., 2014; Kosciuch et al., 2020, 2021). In the context of this site, weweia are the key species of conservation interest present at the sites that use water bodies in this way, though other waterfowl may be similarly affected.

Birds that drink 'on the wing' (whilst flying) such as welcome swallow (*Hirundo neoxena*) may also be vulnerable to such impacts (Harrison et al., 2017). Solar farms near aquatic habitats or within flight paths that avifauna use to travel between aquatic habitats may be at increased risk of panel collision, resulting in injury or death (Kosciuch et al., 2021).

The risk of bird collision with solar arrays was the subject of a review in 2017 carried out by Natural England, the UK Government's adviser agency on the natural environment, which concluded that bird collision risk from solar panels is low (Harrison et al., 2017), and little evidence exists that shows this phenomenon is the cause of bird deaths near solar facilities (Harrison et al., 2017; Visser et al., 2019; Kosciuch et al., 2020, 2021). However, there is a lack of research on the lake effect (with no research found in New Zealand) (Chock et al., 2021). We note that the panels used on the Sites will be coated with anti-reflective coating to minimise light reflectance[16]. While there is no empirical evidence that suggests anti-reflecting coating reduces avifauna panel collision (principally due to lack of research), anti-reflective coating will increase absorption and reduce light reflectivity, which will minimise the potential of the lake effect.

There is some evidence in the literature that visual interruption of large solar farm arrays into smaller blocks or the inclusion of other breaks in the panels are a useful recommendation to mitigate against this impact (Bennun et al., 2021). The proposed development will have a solar panel ground cover ratio between 45 – 62% (M. Sherman, Pers. Comm, 2 May 2023) and other physical interruptions in the array from roads, drains and other infrastructure will be present.

While we agree with the review carried out by Natural England (Harrison et al., 2017) in that the scientific and grey literature suggests that bird collision risk from solar panels is Low, given the lack of research on potential lake effect, and its impact on avifauna, especially in New Zealand, we recommend monitoring measures in section 8.4 below, to confirm this assessment.

Aquatic invertebrate attraction to solar panels

Insects can also be attracted to and aggregate around solar panels due to mistaking the polarized light as a water surface, potentially causing population declines in aquatic invertebrates when located near natural wetlands and waterbodies (Delibes et al., 2001 and Donovan & Thompson III, 2001 in Horvath et al., 2010). Polarized light appears to be one of the most important sensory cues used by aquatic invertebrates when identifying water bodies, which may be used as egg-laying sites. Artificial sources of highly polarised light could potentially impact aquatic invertebrate populations by inducing egg-laying in locations, where survival and breeding success is unlikely (Schwind, 1991; Horváth & Varjú, 2004).

[16] While the exact module that will be used is not known at this stage, it is known that it will be a high performing tier 1 module, which all have an anti-reflective coating, which reduces reflection of incident light to about 2% (M. Sherman, Pers. Comm. 2 May 2023)

We note that the likely invertebrate communities of the freshwater environments remaining within the vicinity of the panels are likely to be dominated by taxa tolerant of disturbance and pollution, and/or taxa associated with slow-flowing or lentic systems, which includes many taxa that complete their lifecycle within the aquatic system (i.e., do not have a terrestrial adult life stage). The panels will be coated with anti-reflective coating to minimise light reflectance. Proposed buffer planting and roads between the solar panels and freshwater environments will also likely reduce the risk. Therefore, the magnitude of effect on freshwater macroinvertebrate populations is unlikely to fundamentally change the character or baseline values of the macroinvertebrate communities present.

Microclimate effects

Solar and rain-shade effects of solar panels cause changes in microclimate and soil conditions within the footprint of the array (Chock et al., 2021, Yavari et al., 2022), generally resulting in lower soil and air temperatures and reduced evapotranspiration rates beneath panels relative to adjacent areas of comparable vegetation cover, though these effects vary depending on overall climatic conditions (i.e., differences are likely to be accentuated in sites that are typically arid and sunny).

The relevance of international studies to New Zealand and Northland is likely to be limited, as most are based on solar farms in desert locations. With respect to the proposed Ruakākā solar park development, the likelihood of large changes in microclimate and soil conditions occurring is assessed as low, because the solar park will be spread across three irregularly-shaped sites (as opposed to one large array), while Northland's wet, sub-tropical climate will enable maintenance of intact vegetation cover beneath panels at all times. The Sites will be maintained as grazed exotic grassland, therefore the microclimate and soil condition changes for the proposed solar park is likely to be Very Low.

7.9 Level of ecological effects

The level of ecological effects of the proposed solar park development, taking into account the ecological value of features from section 5 and the magnitude of effects from section 7, are summarised in Table 13 for terrestrial ecological features, Table 14 for wetland features and Table 15 for freshwater ecological features.

Table 13: Level of ecological effects from the proposed activities on terrestrial ecological values

Ecological feature	Ecological value of feature being impacted	Activity/Effect	Magnitude of effect	Level of ecological effect
Kanuka forest	High	Vegetation loss (construction)	Avoided – no impact	Avoided – no impact
Other terrestrial vegetation (excl. kanuka forest)	Low	Vegetation loss (construction)	Negligible	Very Low
Avifauna on Site 1	Very High	Habitat loss and degradation (construction)	High	Very High
		Habitat loss and degradation (operational)	Moderate	High
		Collision risk (operational)	Low	Moderate
Avifauna on Sites 2 and 3	High	Habitat loss and degradation (construction)	High	Very High
		Habitat loss and degradation (operational)	Moderate	High
		Collision risk (operational)	Low	Low
Herpetofauna in kanuka forest	High	Habitat loss (construction)	Avoided - no impact	Avoided - no impact
Herpetofauna on remainder of Site 1A	High	Habitat loss (construction)	Moderate	High
		Habitat loss (operational)	Negligible	Very Low
Herpetofauna – Sites 1B, 1C, 2 and 3	Moderate	Habitat loss (construction)	Moderate	Moderate
		Habitat loss (operational)	Negligible	Very Low
Bat habitat	High	Loss of roost trees (construction)	Very High	Very High
		Loss of foraging habitat (construction)	Moderate	High
		Loss of habitat (operational)	Moderate	High

Table 14: Level of ecological effects from the proposed activities on wetland ecological values

Ecological feature	Ecological value of feature being impacted	Activity/Effect	Magnitude of effect	Level of ecological effect
South-eastern open water pond wetland on Sites 1B and 1C	High	Loss of wetlands (construction)	Avoided – no impact	Avoided – no impact
		Changes to water level (operational)	Negligible - Low	Low - Very Low
Other open water pond wetlands	High	Loss of wetlands (construction)	Very High	Very High
Indigenous wetlands	High	Loss of wetlands (construction)	Very High	Very High
Exotic wetlands	Moderate	Loss of wetlands (construction)	Very High	High

Table 15: Level of ecological effects from the proposed activities on freshwater ecological values

Ecological feature	Ecological value of feature being impacted	Activity/Effect	Magnitude of effect	Level of ecological effect
Bercich Drain	Low	Removal of riparian vegetation in Site 1A (Construction)	Moderate	Low
		Sedimentation effects (construction)	Negligible - Low	Very Low
		Drain maintenance (operational)	Negligible	Very Low
		Culvert placement creating fish barrier (operational)	Negligible	Very Low
		Water quality effects (operational)	Negligible - Positive	Very Low - Net Gain
		Change in water flows (operational)	Negligible	Very Low
Unnamed Drain	Moderate - High	Removal of riparian vegetation (Construction)	Negligible	Very Low
		Sedimentation effects (construction)	Negligible - Low	Very Low
		Drain maintenance (operational)	Negligible	Very Low
		Culvert placement creating fish barrier (operational)	Negligible	Very Low
		Water quality effects (operational)	Negligible - Positive	Very Low - Net Gain
		Change in water flows (operational)	Negligible	Very Low
Other minor drainage channels on Site 1	Negligible	Redirection or removal (Construction)	Negligible	Very Low
Other minor drainage channels on Sites 2 and 3	Low	Redirection or removal (Construction)	Moderate	Low

8.0 Effects management

8.1 Terrestrial vegetation enhancement

Vegetation buffers (using a mix of native and exotic species) will be established as part of the development, in some places around the edge of the Sites and between the solar panels and wetlands on Sites 1 and 3, and kānuka forest on Site 1. The total area of these planted buffers will be similar to the area of vegetation being removed, will have improved diversity and abundance of native species (though trees will take 15 – 20 years to reach mature canopy heights) and have ongoing pest control (see Section 8.7 below).

8.2 Wetland Restoration and Enhancement

The loss of wetland extent anticipated as a result of the proposed construction is to be mitigated and offset through:

- Expansion and enhancement of open water habitat in the south-east portions of Site 1B and 1C and adjacent smaller wetlands, which will increase the total wetland extent in this area from 2.05 ha to ~9.1 ha (ie, 7.05 ha of new wetland habitat); and
- Recreation and restoration of wetland over 11.73 ha[17] of drained, low-lying land in the southern corner of Site 3.

In total, the proposed wetland mitigation offset will create up to 18.78 ha of new wetland habitat.

The objectives of the proposed restoration and enhancement are to replace the full extent of wetlands removed as a result of construction, and ensure the restored wetlands are of similar or better habitat and ecological function to those that are to be removed.

Works will include the creation a mosaic of habitats, including dense tall reed-rush vegetation, lower-growing rushes and sedges, and shallow open water, to provide foraging, roosting/resting, breeding, and nesting habitat for the species known to use the sites currently, with particular focus on matuku-hūrepo and weweia.

The final design of the wetland on Site 3 will consider the potential risk of birds perching or nesting on the power pylons or lines. The most likely species of large birds that may perch on power pylons and/or powerlines, and that are present in the area, include shags in low numbers and moderate densities of white-faced heron. For shag species, there is currently a large amount of suitable nesting and/or perching habitat within the surrounding localised area (eg, large trees overhanging Ruakākā River within 1 km of the Site) and for white-faced heron there are large areas of damp pasture and shallow water. Given the habitat currently available in the landscape surrounding the power pylons and lines, the avifauna species that may perch on these structures, and the relative abundance of these species, we consider that the net effect of creating a wetland on Site 3, on large birds nesting and/or perching on the towers is likely to be minimal compared to the current situation. To further reduce the risk of large birds perching on the towers, we recommend avoiding the creation of areas of open water directly adjacent to or under the power pylons and any areas of open water that are created are shallow in nature i.e. ≤ 1 m in depth. An indicative concept plan has been developed for this wetland in Site 3, to show the extent and indicative vegetation structure (Figure 25).

A detailed Wetland Restoration and Management Plan will be prepared in consultation with Patuharakeke Te Iwi, including:

- Detailed wetland design, including water depth, size, layout, catchment area and staging;
- Wetland and riparian plant species to be planted, including density, size and layout, including connections to adjacent habitat;
- Maintenance and monitoring, including ongoing pest plant and animal control.

As there is currently no pest control on these sites, and wetland bird species are highly susceptible to predation, effective implementation of this Wetland Restoration and Management

[17] Note that this extent will be reduced if additional wetland area can be avoided during earthworks.

Plan is expected to increase the breeding success of birds that inhabit the site and therefore, increase the number of individuals.

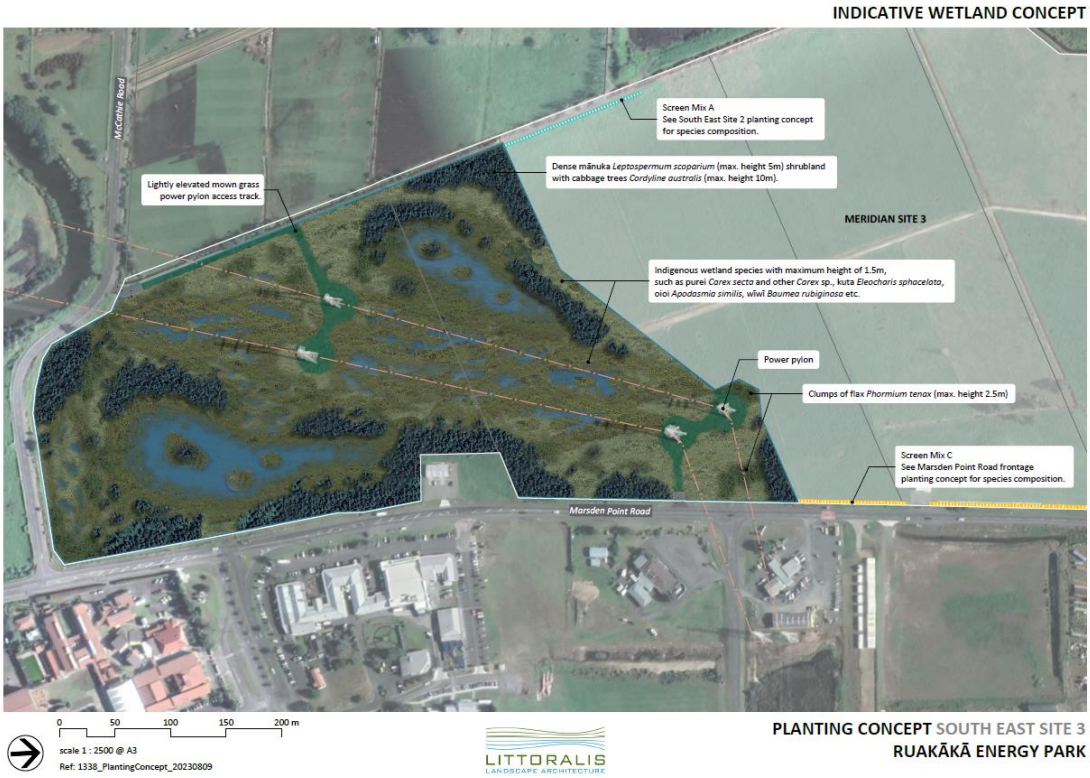

Figure 25: Indicative concept plan for proposed wetland on Site 3.

8.3 Management of Freshwater Habitats

We recommend the design and installation of culverts in Bercich Drain on Site 1 and the Unnamed Drain on the edge of Site 3, follow the recommendations in the New Zealand Fish Passage Guidelines (Franklin et al., 2018) and if possible, meet the permitted activity standards in the Proposed Regional Plan for Northland (PRPN), as well as regulations 69 and 70 of the NES-F, to ensure fish passage is maintained for the migratory native fish species present in these watercourses and therefore, effects will be **Negligible.**

Effects on freshwater ecological values will be further reduced by the development and implementation of a Native Fish Capture and Relocation Plan to manage effects associated with earthworks in wetlands, rivers and drains. In the construction stage, this Plan will:

- restrict earthworks in minor drains to dry periods when they have no or very little water, and therefore have very low habitat value for native freshwater fish and invertebrates, and/or,
- require removal of fish from any drains, wetlands or rivers that are likely to provide habitat for freshwater fish is undertaken by a suitably experienced ecologist, prior to earthworks.

The Plan will also set out best ecological practice for drain maintenance activities, if required, during the operational stage. Drain maintenance will be undertaken with best practice erosion and sediment control, following Auckland Council's GD05 Guidelines (Leersnyder et al., 2016), and should meet the relevant permitted activity rules in the PRPN, which includes:

- C.2.1.3 for the maintenance of the free flow of water in rivers, which applies to Bercich and the Unnamed Drains
- C.4.1.4 for the maintenance and clearance of drains, which applies to all other minor drains
- The general conditions in C.4.1.9.

In addition, the effects of drain maintenance can be further reduced by following the good practice outlined in Greater Wellington Regional Council's guide for the mechanical management of waterways (Greater Wellington Regional Council, 2020) and the national works in waterways guideline (Ministry for the Environment, 2021). As a minimum, this will include avoiding maintenance work in the īnanga spawning season in potential spawning areas, retaining at least 10 m of aquatic vegetation cover within each 200 m length of drain cleared, undertaking fauna salvage (eg, fish, freshwater mussels and keewai if present) and ensuring machinery used is free of invasive freshwater pests.

8.4 Avifauna Management

A Native Bird Management and Monitoring Plan, similar to the protocol already developed for the BESS site will be developed by a suitably qualified ecologist and implemented, to avoid and manage potential adverse effects on native bird species. This plan will require, as a minimum, that:

- Vegetation clearance of, and in the vicinity, of potential breeding and nesting habitat for cryptic wetland bird species be undertaken outside of the main breeding/nesting season for matuku-hūrepo and weweia, which is typically August to February inclusive.
- Clearance of other terrestrial vegetation be undertaken outside the main breeding/nesting seasons for native birds using the site, if possible. If not possible, nest checks will be done prior to vegetation clearance.
- No earthworks undertaken in the vicinity of prospective nesting sites that have not been cleared prior to breeding season.
- Monitoring and management throughout the earthworks stage to manage the risk of native waders species, such as Tūturiwhatu / NZ dotterel (*Charadrius obscurus*), establishing nests within or in the vicinity of the earthworks footprint.
- Management of mammalian predators across the three Sites, focusing on rodents and mustelids, to offset for the potential and actual effects on avifauna. This will help species re-establish within the Sites post-construction and improve survival rates.

Where possible, final project design and methodology should consider staging of works across the three sites, so not all sites are cleared simultaneously.

8.4.1 Monitoring

We have identified a potential risk of avifauna collisions with solar panels. We consider that while the existing available data suggests this is a low risk, the lack of research in New Zealand on this potential effect justifies monitoring during the operational phase. Avifauna Collision Risk Monitoring will be included in Native Bird Management and Monitoring Plan, which will require a minimum of two years of post-construction surveillance at the solar farm to detect and assess the impact (if any) on avifauna due to panel collision. In particular, monitoring will include

observations of bird behaviour in locations near to open water bodies over two summer seasons (post breeding).

If this monitoring is consistent with the literature identified above and confirms that the level of effect is **Low or less than Low**, then no further action will be required.

However, if the monitoring indicates that the operation of the solar farm has given rise to a more than **Low** level of ecological effect on avifauna species, an avifauna management plan should be developed to provide the methods and any ongoing monitoring required to ensure that the level of ecological effect on avifauna does not exceed a **Low** level of effect.

Potential management methods identified in the avifauna management plan to manage such effects will be required to be species-specific and responsive to observations made during the monitoring programme. This may include potential collision deterrent/prevention intervention methods, such as the use of deterrent devices or visual warning devices/markings (flags, streamers, or visually distinctive markings on panels) to deter attempted landing on panels or direct manipulation of habitat onsite if mortalities were linked to, or only recorded in the vicinity of particular habitat features. For example, at the terminus of a shelterbelt or vegetation edge, near open water present during heavy rain, or near artificial structures.

8.4.2 Incidental discovery protocol

Outside of the formalised monitoring any dead or injured birds incidentally encountered should be reported to DOC. Injured birds should be immediately transported to a veterinarian (approved by DOC) experienced in indigenous wildlife rehabilitation. The vet must euthanise birds whose injuries are causing suffering and are not likely to heal sufficiently to allow rehabilitation and return to the wild. The location, photographs (if possible), and cause of injury/death (if known) should be noted.

8.5 Herpetofauna

To mitigate the above potential adverse impacts to native lizards at the Sites, it is recommended that a combined approach of targeted lizard salvage, staged vegetation reduction and removal, habitat replacement and predator control are undertaken. It is only recommended that active mitigation management is undertaken in areas where the likelihood of native lizard presence is high. This would broadly involve the measures outlined in (Table 16) below. We believe effective implementation of these mitigation measures will minimise the overall level of effect of the proposed activities on lizard ecological values on the Sites to be **Very Low**, with potentially **Positive** effects in the medium term, as a result of pest management and proposed planted buffers across the Sites.

To further reduce effects, in areas where native lizards are more likely to be present, if possible, earthworks, debris removal and vegetation clearance in new areas should be avoided in colder months (June – September), because lizards are relatively inactive and therefore are less likely to move away from disturbance.

If further mitigation is required, in addition to the measures outlined in Table 16 below, off-site compensation can be used. Bream Bay has a known population of copper skink and shore skink in close proximity to the project area. Activities such as pest mammal control, habitat enhancement and or funded monitoring of the population may all be possible options to benefit local lizard communities.

Table 16: Proposed lizard management recommendations for different areas within Sites 1, 2 and 3.

Measure	Relevant Stage / Area	Details
Lizard salvage	Stage 1 - Areas of gorse that are located adjacent to kanuka forest and shrubland. Stage 2 – Shelterbelts, structures, and felled pine stumps Stage 3 – Residential gardens, riparian vegetation	Live trapping in targeted areas for five consecutive days.
Staged vegetation reduction	Pasture / grasslands (mostly Site 1A, but any other areas of dense grass sward)	Staged mowing over 3-4 sessions to be undertaken in thick grassland to reduce habitat suitability for any potential low numbers of indigenous skink. This should be done in a manner that directs lizards into adjacent habitats that will not be impacted by site development activities. An alternative to this is via grazing stock to slowly reduce habitat suitability of rank grasslands.
Habitat replacement	All sites	Wetland edges and buffer planting should be planted with lizard-friendly species that are known to provide food and refuge resource (mainly to copper skinks).
Pest management	All sites	A pest management plan should be developed and implemented, to help reduce the predation pressure on native lizards by mammalian predators.

8.5.1 Wildlife Act Authority

A Wildlife Act Authority (WAA) is required to capture, handle, relocate, translocate, or kill indigenous wildlife. Before lizard salvage may be undertaken, a WAA will need to be gained from the Department of Conservation. A dedicated Lizard Management Plan (LMP) should be prepared to describe the above briefly outlined strategy. The LMP shall include but not be limited to:

- A description of lizard habitats and values.
- Clear identification of the discrete areas being proposed for lizard salvage.
- Clear identification of the areas that are not being proposed for salvage.
- Identification and justification of a proposed lizard release site.
- Additional activities to offset or compensate the loss of individual lizards and/or their habitats. These may include pest animal control, habitat restoration, creation or enhancement, or funding to a local community initiative to improve lizard values in local areas where they are known to be present.

- Contingencies for discovering a threatened species or unexpectedly high lizard numbers.

The LMP should be prepared alongside a WAA application form and submitted to DOC for review and approval. This can be a time-consuming process and it is recommended that applications are submitted at least 6-9 months prior to commencing works.

8.5.2 Incidental discovery protocol

Any incidental encounters of dead or injured lizards should be reported to DOC. The location, photographs (if possible), and cause of injury/death (if known) should be noted. DOC should advise on any further action needed.

8.6 Long-tailed bats

As a precautionary approach has been taken, and bats are assumed to be present, a bat management plan will be required to detail the necessary management actions needed to avoid and mitigate the potential impacts. It will include the following actions in more detail:

- To minimise the likelihood of bats being harmed or killed during vegetation clearance and tree felling, the bat roost protocol (Bat Recovery Group - Department of Conservation, 2021) will be implemented to assess whether trees are current bat roosts. This will need to be overseen by an ecologist with the appropriate Department of Conservation competencies to carry out the work. Where potential roost features are present, acoustic detectors and/or endoscopes will be used to determine whether bats are present prior to felling.
- Replacement planting will be required to restore connectivity within the landscape. The location of replacement shelterbelts has yet to be determined.
- If existing potential roost trees cannot be retained, replacement roost features will need to be provided in the form of bat boxes to fill in the time lag until replacement trees reach sufficient maturity to naturally form roost features.
- Predator control will be required where retained or replacement roost features are present.

These recommendations are based on the precautionary approach that has been chosen. It is recommended that an acoustic survey is undertaken to refine the knowledge and assumptions relating to how bats use this site. If surveys determine that bats are not using the features within the site, replacement planting and roost features will not be required.

When the bat roost protocol is implemented correctly, the magnitude of effect resulting from death or injury during felling will be **Negligible**. Providing appropriate mitigation is applied to restore or retain roosting, foraging and connectivity features, the overall magnitude of effects of both construction and operation on the ecological value of the Sites for long-tailed bats is assessed as **Low**.

8.7 Pest control

An integrated Pest Management Plan, including pest plants and animals, will be developed and implemented across the three Sites to minimise and mitigate adverse effects on native birds, lizards, bats and vegetation. The Plan will include but not be limited to:

- Target pest species.
- Control methods and timing.
- Maintenance and monitoring requirements.

8.8 Level of ecological effect after management

The overall level of ecological effects of the proposed solar park development, if the above effects management recommendations are effectively implemented are outlined in Table 17. Note only activities/effects that resulted in a **level of ecological effect** that was higher than Low (ie, Moderate, High or Very high) in section 7.9 are included below.

Table 17: Level of ecological effects from the proposed activities with the additional recommended effects management in Section 8 considered.

Ecological feature	**Ecological value of feature being impacted**	**Activity/Effect**	**Magnitude of effect (from section 7.9)**	**Effects management**	**Level of ecological effect with recommended effects management**
Open water wetlands	High	Loss of wetland extent (construction)	Very High	Offset	Very Low
Indigenous wetlands	High	Loss of wetland extent (construction)	Very High	Offset	Very Low
Exotic wetlands	Moderate	Loss of wetland extent (construction)	High	Offset	Very Low
Avifauna on Site 1	Very High	Habitat loss and degradation (construction)	High	Mitigation and offset	Low
		Habitat loss and degradation (operational)	Moderate	Mitigation and offset	Low
		Collision risk (operational)	Uncertain*	Monitoring, and mitigation if required	Low*
Avifauna on Sites 2 and 3	High	Habitat loss and degradation (construction)	High	Mitigation and offset	Low
		Habitat loss and degradation (operational)	Moderate	Mitigation and offset	Low
		Collision risk (operational)	Uncertain*	Monitoring, and mitigation if required	Low*
Herpetofauna - Site 1A (excluding kanuka forest)	High	Habitat loss (construction)	Moderate**	Mitigation	Very Low

Ecological feature	Ecological value of feature being impacted	Activity/Effect	Magnitude of effect (from section 7.9)	Effects management	Level of ecological effect with recommended effects management
Herpetofauna – Sites 1B, 1C, 2 and 3	Moderate	Habitat loss (construction)	Moderate**	Mitigation	Very Low
Bat habitat	High	Loss of roost trees (construction)	Very High**	Mitigation	Low
		Loss of foraging habitat (construction)	Moderate	Mitigation	Low
		Loss of habitat (operational)	Moderate	Mitigation	Low

* Available data suggests risk is low but monitoring to confirm level of effect is recommended and if effect level is more than low, than management plan will be developed and implemented.

** If present.

9.0 Conclusion

The proposed solar park development avoids removal of the high value kānuka forest and shrubland on Site 1A. As the other terrestrial vegetation that is being removed is generally of low value and the majority of the Sites will be returned to the main current vegetation type (exotic grassland), the ecological effects on terrestrial vegetation values will be **Very Low.** As the kānuka forest and shrubland on Site 1A will be fenced with a 5 m planted buffer, other native planted buffers will be established around the Sites and pest management will be undertaken across all three Sites, a **Net Gain** in terrestrial vegetation values is expected in the medium term (~ 5 years).

The proposal includes retention and enhancement of 2 ha of open water pond wetland habitat that was identified to have the highest value on the south-eastern side on Site 1. The levelling of the remainder of the Sites to enable safe piling will result in removal of an estimated 17 ha of wetland habitat. Meridian Energy Limited are proposing to offset this loss of wetland extent by enlarging and enhancing the 2 ha open water pond wetland and constructing a large indigenous wetland in Site 3. As the loss of wetland habitat will be short term (~ 3 years), and the offset wetlands will have a larger total extent (~ 19 ha) and higher ecological value, the ecological effect of this temporary wetland habitat loss is **Low**.

The main concern of the proposed development on freshwater values is through sedimentation and stormwater runoff, impacting water quality. These potential impacts will be managed through appropriate sediment and erosion control measures (see below) and potential positive impacts are predicted due to the change of land use from cattle grazing to sheep grazing, where possible fencing of waterbodies to exclude sheep and buffer planting around wetlands.

Activities in and around wetlands, rivers and drains have the potential to result in sediment discharges, including earthworks and vegetation clearance, the construction of roads and other structures, eg, piling, wetland enhancement and construction, culvert installation and drain maintenance. If the Erosion and Sediment Control Plan (Beca 2023) is implemented effectively, in accordance with the Auckland Council's GD05 Guidelines (Leersnyder et al., 2016), the

ecological effects of these proposed activities on wetland and freshwater values will be **Very Low**.

As there will be removal of potential native bird, lizard, fish and bat habitat, that could lead to injury or mortality, and there are other potential effects during construction and operational stages, several mitigation measures have been proposed to ensure the level of effects of the proposed development are Very Low - Low. These measures include, for example, targeted lizard salvage, staged clearance, avoiding important seasons (eg, avoiding earthworks and vegetation clearance in nesting season for birds, avoiding drain clearance in spawning season for īnanga and avoiding debris removal and vegetation clearance in colder months for lizards), application of bat roost protocols, pest control of main mammalian predators and best practice for drain maintenance. Effective implementation of these mitigation measures will minimise the overall level of effect on bird, lizard, fish and bat ecological values to be **Very Low to Low**.

A review of available literature on potential impacts of solar farms on avifauna, with a focus on the 'lake effect', suggests that the effect is likely to be **Low.** However, the level of research available, means there is some uncertainty, and we consider there is a potential risk of an effect on avifauna due to solar panel collision. Consequently, we propose a monitoring period and collection of data to confirm the **Low-level** effect. In the event that an effect greater than **Low** was detected by the monitoring, we propose the implementation of a management plan to impose effect and species-specific effect management measures.

Overall, by implementing the proposed avoidance and mitigation strategies the level of ecological effects of the solar park development on terrestrial values is expected to be **Low** to **Very Low**, with an expected **Net Gain** in terrestrial vegetation, avifauna and herpetofauna values in the medium term (~ 5 years), on wetland values is expected to be **Low** for 2-3 years and a **Net Gain** in the short to medium term (~ 3 – 5 years) and on freshwater values is likely to be **Very Low**.

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Historical vegetation cover

Sites 2 and 3 were likely to be mostly wetlands with a small band of forest on the south-eastern corner of site 3. Site 1 was likely a mix of dunelands and wetlands (Figures 26 and 27).

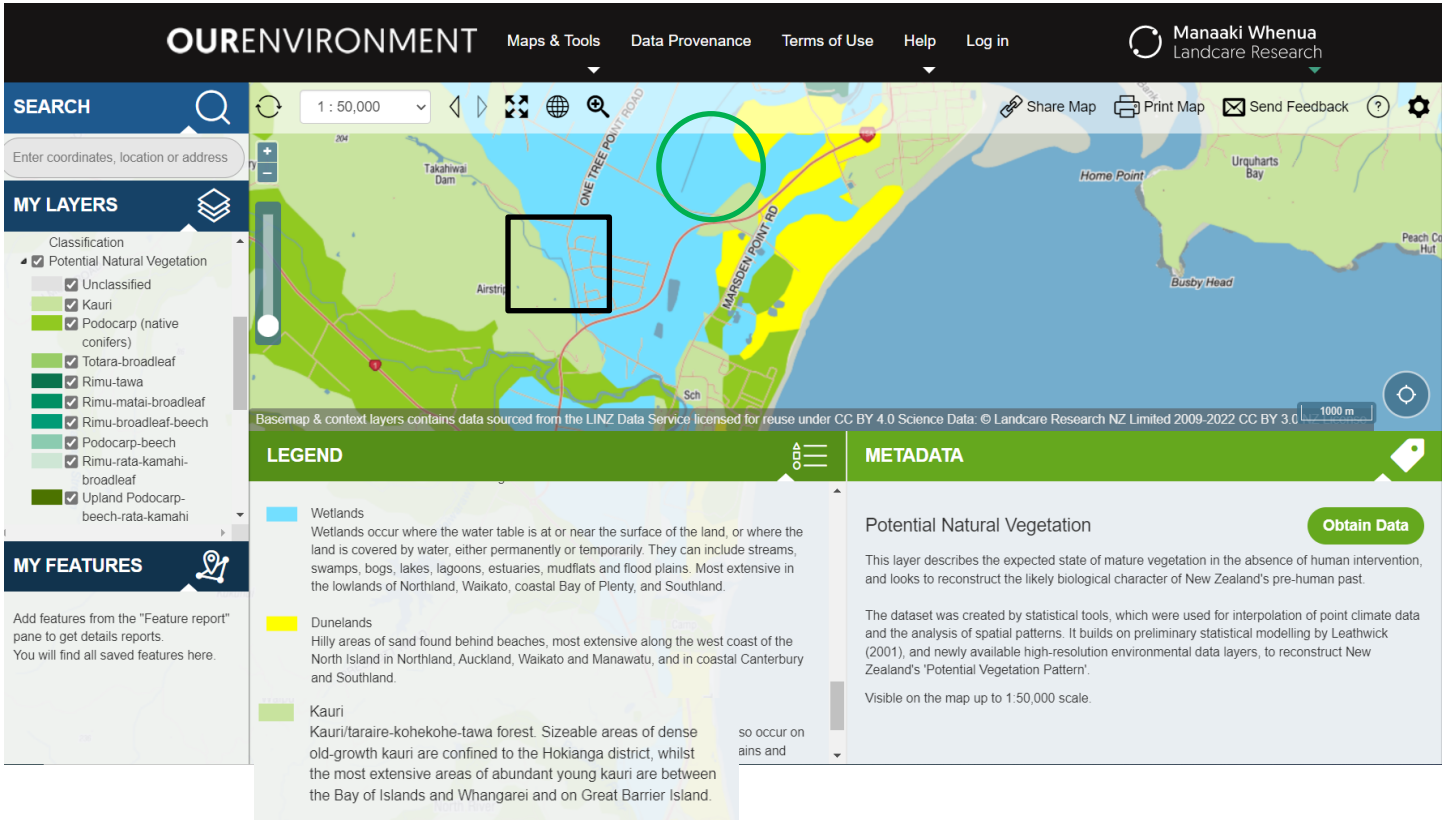


Figure 26: Predicted pre-human vegetation and habitats of New Zealand. Site 1 located in green circle and Sites 2 and 3 located in black square. Sourced from Manaaki Whenua Landcare Research Our Environment Map layer: Potential Natural Vegetation [18]

[18] Map retrieved from Manaaki Whenua Landcare Research: Our Environment map portal https://ourenvironment.scinfo.org.nz/maps-and-tools/app/ on 04/05/23.

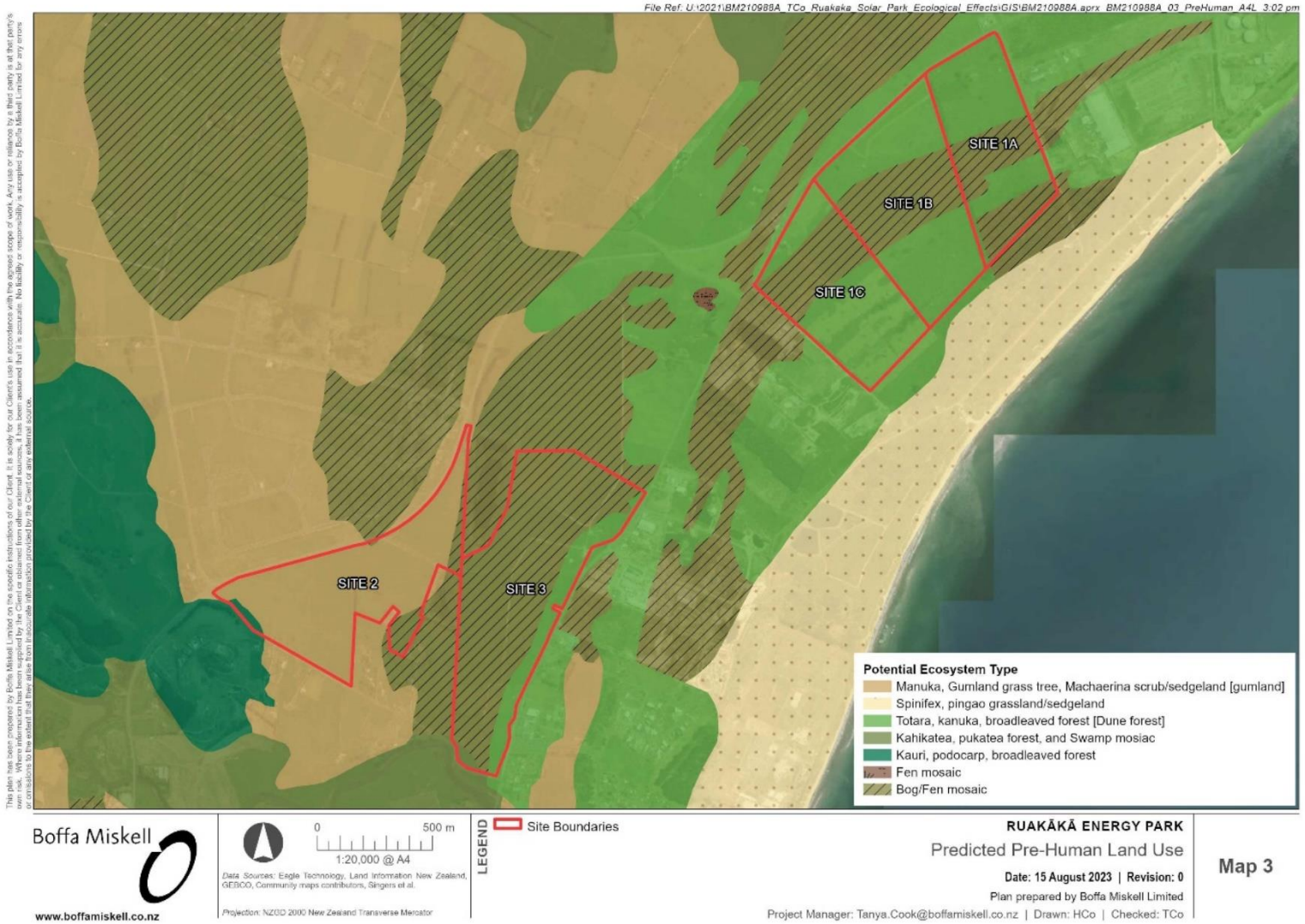


Figure 27: Predicted pre-human land cover, based on Singers & Lawrence (2018)

Threatened Environments

Figure 28 below shows the Threatened Environment Classification 2012 version for the Sites, which has been considered during our assessment of ecological values. There are six categories (Table 18), the first five environments are considered to be Threatened (Walker et al., 2015). The sixth is considered to be secure. Sites 2 and 3 and part of Site 1 is located in land classified as threat category 1 and the remainder of Site 1 is located in land classified as threat category 2.

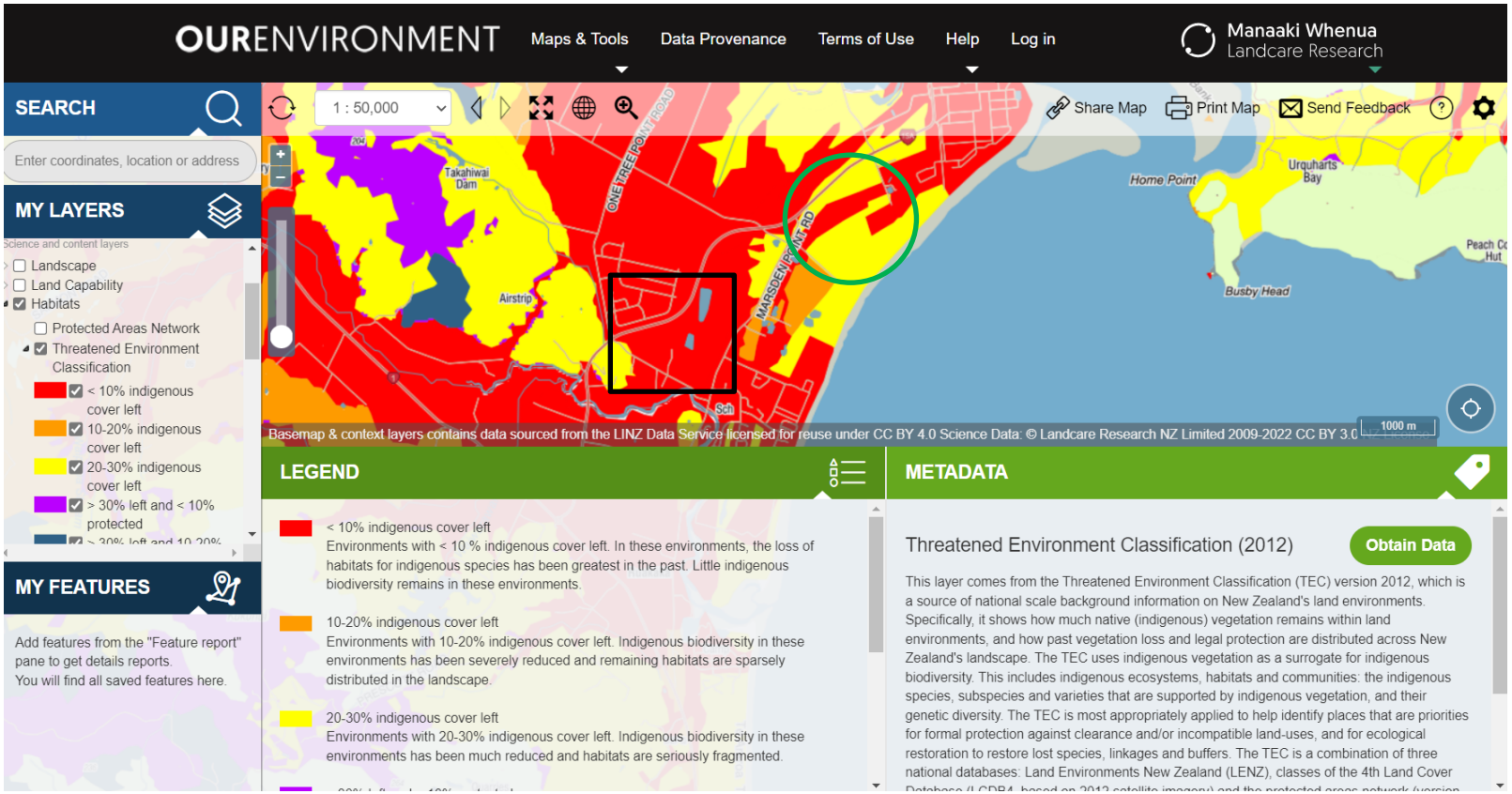


Figure 28: Threatened Environment Classification 2012. Site 1 located in green circle and Sites 2 and 3 located in black square. Sourced from Manaaki Whenua Landcare Research Our Environment Map layer: Threatened Environment Classification [19]

[19] Map retrieved from Manaaki Whenua Landcare Research: Our Environment map portal https://ourenvironment.scinfo.org.nz/maps-and-tools/app/ on 04/05/23.

Table 18: Threatened Environment Classification 2007 (colour coding as per mapping)

Category	Criteria
1	<10% indigenous vegetation left
2	10–20% indigenous vegetation left
3	20–30% indigenous vegetation left
4	>30% left and <10% protected
5	>30% left and 10-20% protected
6	>30% left and >20% protected

Appendix 2: Recent drone and satellite imagery

Figure 29: Drone imagery of Site 1, collected September 2022 and supplied by Meridian Energy Limited.

Figure 30: Most recent satellite imagery of Site 1, dated 24 March 2023. Source: Google Earth.

Appendix 3: Historic images

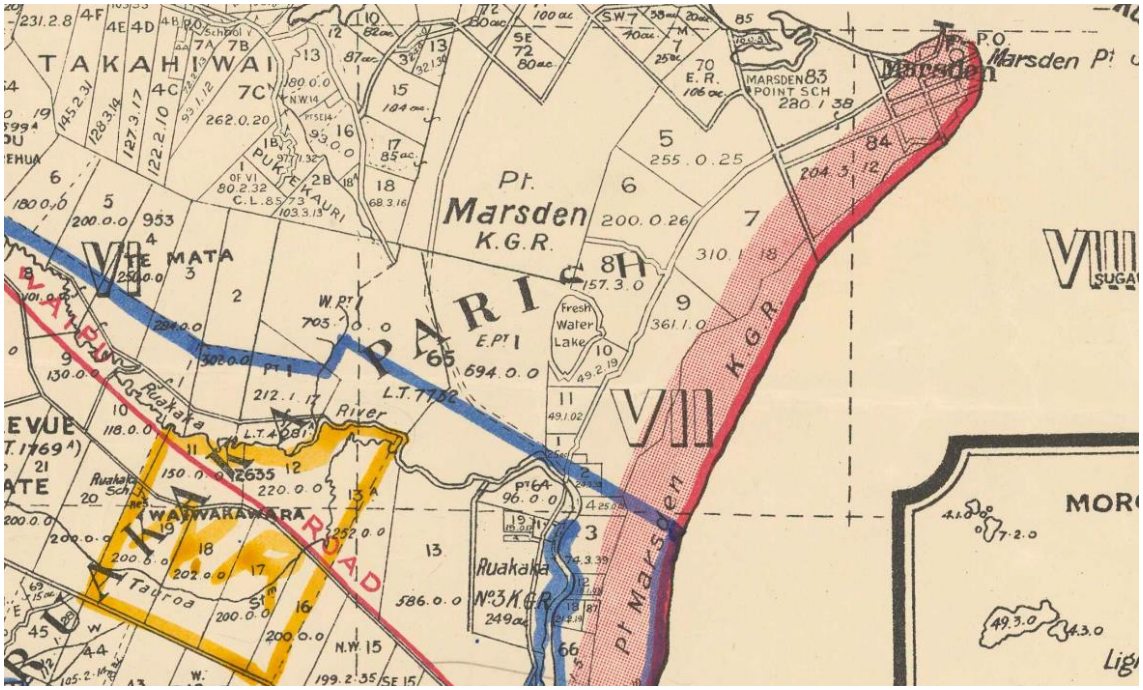


Figure 31: Screenshot of survey map from 1954 for Ruakākā area showing freshwater lake on Site 3. Source: Whangarei County - Ruakākā area, Turtons' deeds, Volume 1 Deed 96 (8.9.54) - scale 1 mile:1 inch - Lithograph (natlib.govt.nz)

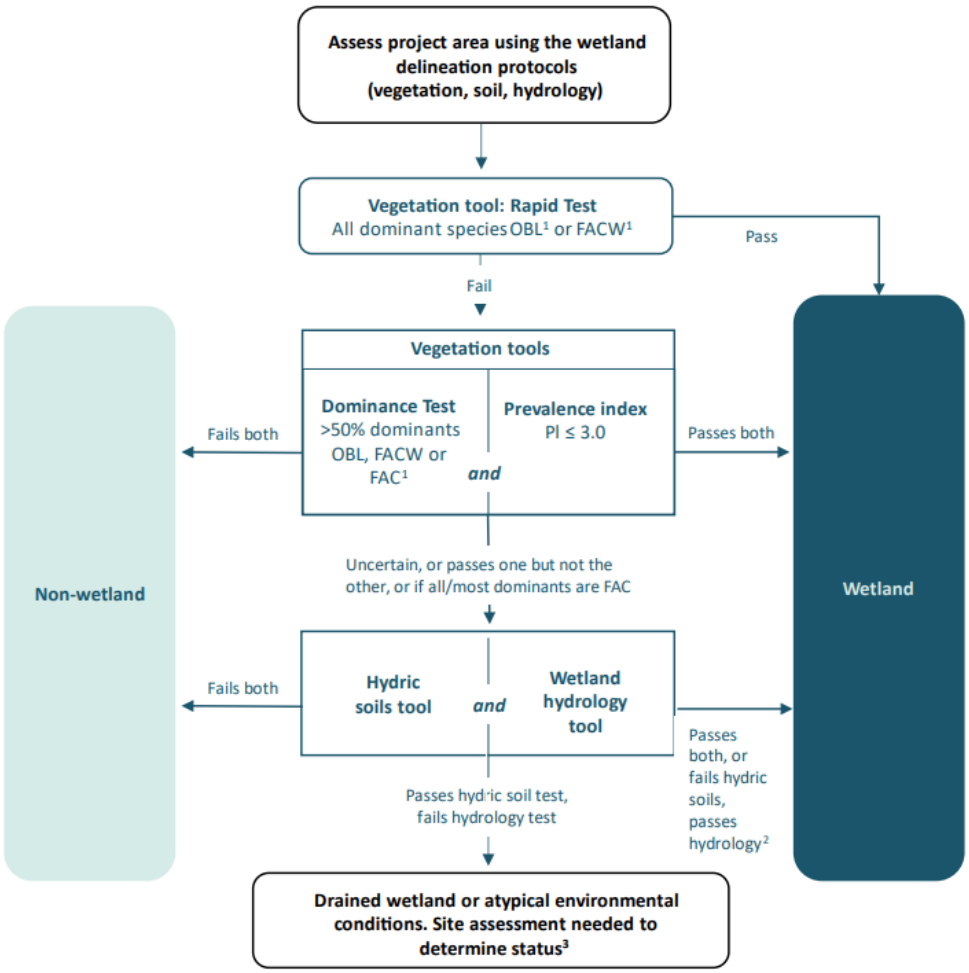
Figure 32: Aerial imagery of Marsden Point area, collected on 28 May 1942. Approximate Site 1 boundary shown in red. Source: Retrolens.nz.

Figure 33: Aerial imagery of Marsden Point area, collected on 13 March 1950. Approximate Site 1 boundary shown in red. Source: Retrolens.nz

Figure 34: Aerial imagery of Marsden Point area, in location of Sites 2 and 3, collected on 13 March 1950. Source: Retrolens.nz

Appendix 4: Delineation protocol flow chart

Figure 2: Hydrophytic vegetation determination



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 35: Key steps in hydrophytic vegetation determination (from NPS-FM Wetland Delineation protocols).

Figure 1: Rapid assessment to identify potential wetlands on farmland

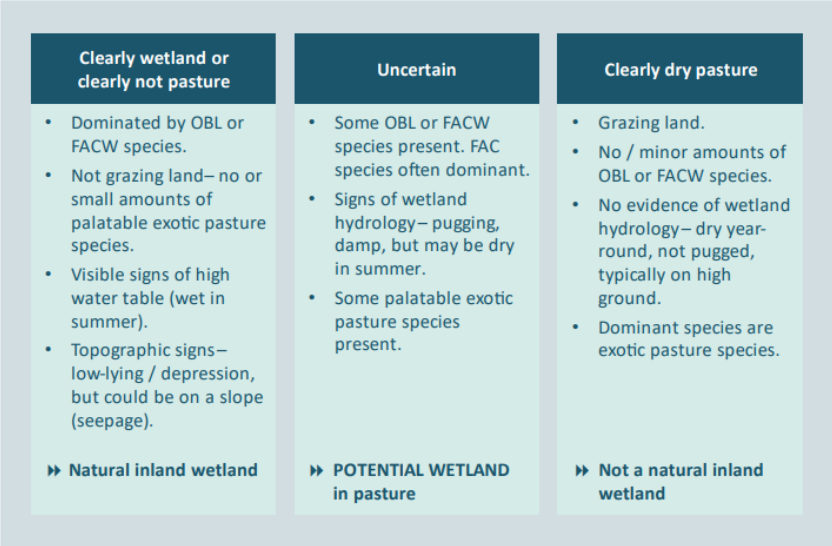


Figure 1: Determining if a potential wetland on pastoral land passes the pasture exclusion test

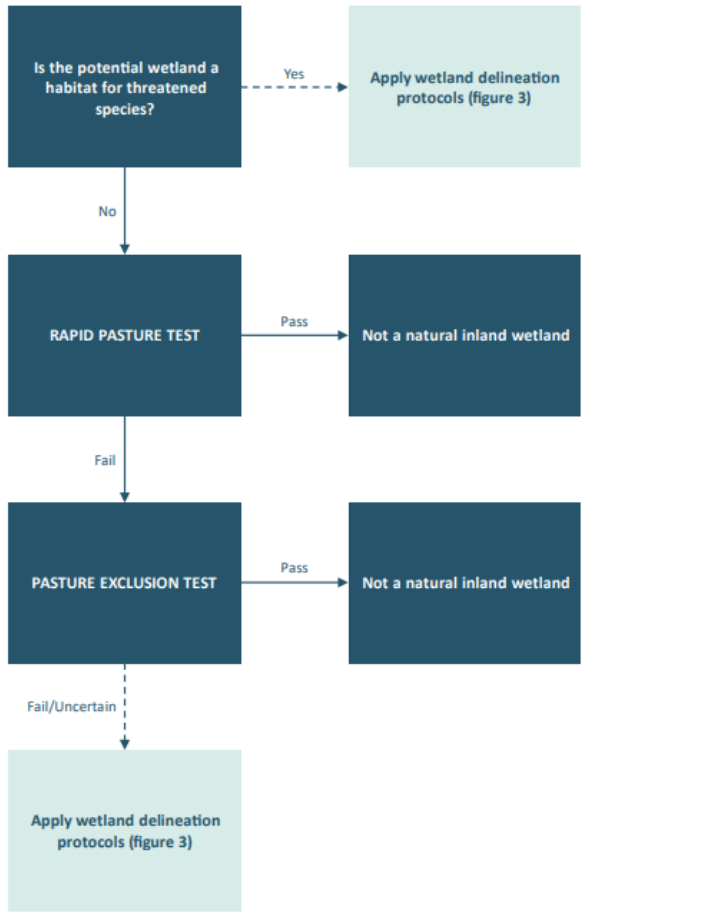


Figure 36: Key steps in applying the Rapid Wetland Test, Rapid Pasture Test and Pasture Exclusion Test to identify the percentage of pasture (from the Pasture exclusion assessment methodology).

Appendix 5: Wetland plot locations and results

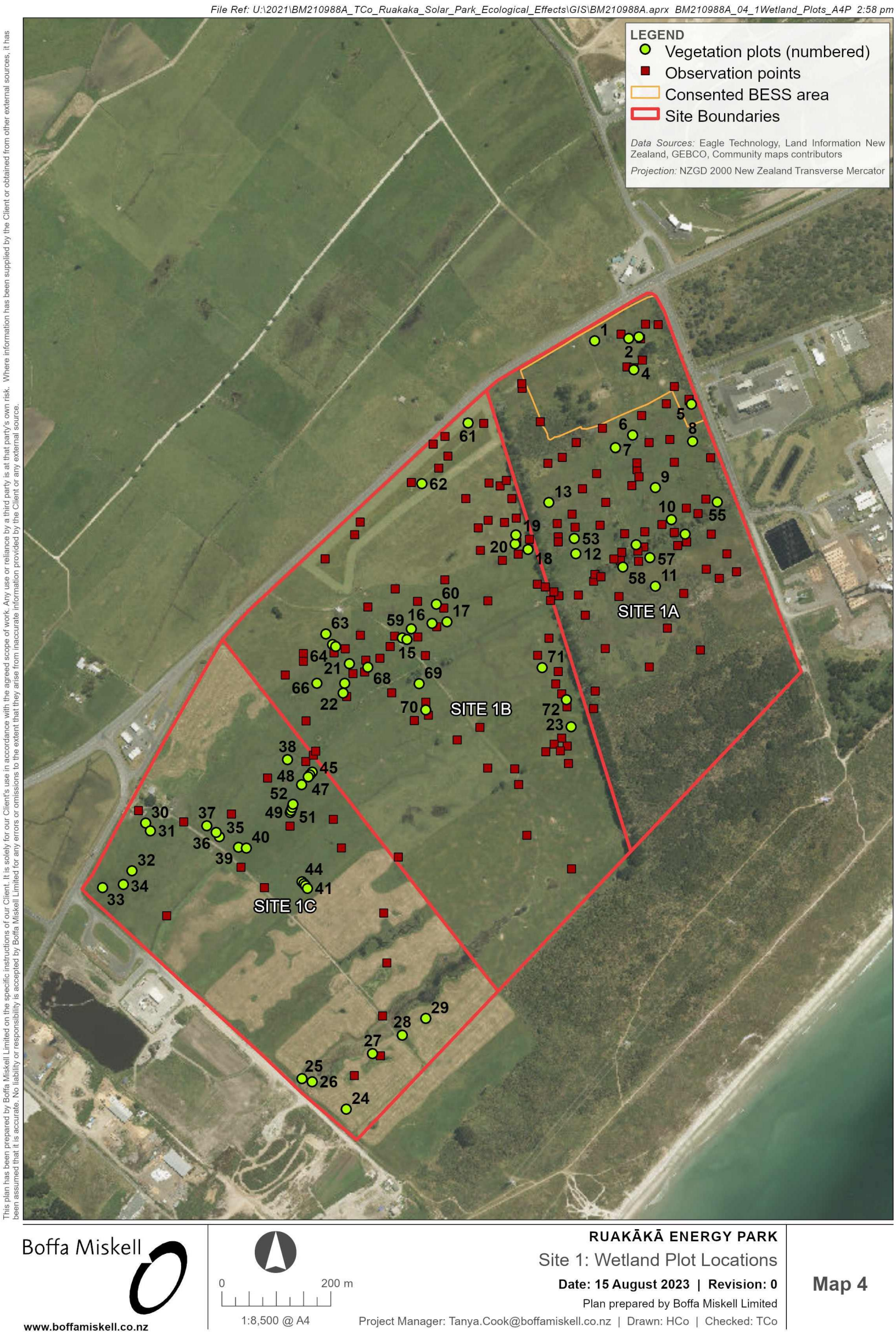


Figure 37: Wetland vegetation plot locations and location of observations in Site 1 (refer to Table 19 for plot results)

*Table 19: Summary of wetland vegetation plot, percentage of pasture species, hydric soil and hydrology indicators for Site 1 (refer to Figure 34 for plot locations). NA = Not applicable as Site 1A is no longer grazed pasture. * = All or most (>50%) of dominants are FAC, FACU or UPL, ** = Marginal.*

Date	Plot	Rapid Test	Dominance Test	Prevalence Test	% pasture	Hydric soil/ hydrology	Dominant species	NPS Wetland
27/10/21	1	N	0%	3.79	NA	N	Sweet vernal (FACU)	No
27/10/21	2	N	0%	3.9	NA	N	Kikuyu (FACU)	No
27/10/21	3	N	100%	2.41	NA	Y	Broom sedge (FACW)	Yes
27/10/21	4	N	100%*	2.96	NA	Y	Creeping buttercup (FAC)	Yes**
31/05/22	4	N	100%*	3.07	NA	N	Creeping buttercup (FAC)	No
27/10/21	5	N	100%	2.56	NA	Y	Yorkshire fog (FAC)	Yes
27/10/21	6	N	100%*	3.04	NA	Y	Yorkshire fog (FAC)	No**
27/10/21	7	N	100%*	3.20	NA	Y	Creeping buttercup (FAC)	No
27/10/21	8	N	100%*	3.05	NA	Y	Yorkshire fog (FAC)	No**
27/10/21	9	N	100%*	2.84	NA	Y	Creeping buttercup (FAC)	Yes
27/10/21	10	N	100%	2.40	NA	Y	Mercer grass (FACW)	Yes
27/10/21	11	Y	100%	2.19	NA	Y	Broom sedge (FACW)	Yes
7/03/23	11	N	33%	3.08	NA	Y	Gorse (FACU)	No
27/10/21	12	N	100%	2.31	NA	Y	Water pepper (FACW)	Yes
27/10/21	13	Y	100%	2.25	NA	Y	Broom sedge (FACW)	Yes
11/01/21	14	N	50%	3.26	52.8	Y	Rye grass (FACU)	No
11/01/21	15	N	83%	2.33	11.9	Y	Mercer grass (FACW)	Yes
11/01/21	16	N	67%	2.89	34	Y	Mercer grass (FACW)	Yes
11/01/21	17	N	100%	2.41	11.8	Y	Mercer grass (FACW)	Yes
11/01/21	18	N	100%	2.24	15.5	Y	Mercer grass (FACW); water pepper (FACW)	Yes
11/01/21	19	N	0%	3.32	56.3	Y	Rye grass (FACU)	No
11/01/21	20	N	100%*	2.45	8.1	Y	Mercer grass (FACW)	Yes
11/01/21	21	N	50%	2.53	26.5	Y	Mercer grass (FACW)	Yes
11/01/21	22	Y	100%	2.49	20.3	Y	Jointed rush (FACW)	Yes
11/01/21	23	Y	100%	2.04	1.9	Y	Water pepper (FACW)	Yes
20/06/22	24	Y	100%	2.09	1.0	Y	Soft rush (FACW)	Yes
20/06/22	25	Y	100%	1.9	7.0	Y	Broom sedge (FACW)	Yes
20/06/22	26	Y	100%	1.76	4.7	Y	Soft rush (FACW)	Yes
20/06/22	27	Y	100%	1.61	0	Y	Mercer grass (FACW)	Yes
20/06/22	28	Y	100%	1.08	0	Y	Water pepper (FACW)	Yes
20/06/22	29	N	100%	2.23	25.6	Y	Mercer grass (FACW)	Yes
20/06/22	30	N	0%	3.93	92	N	Kikuyu (FACU)	No
20/06/22	31	N	50%	3.06	48.6	Y	Soft rush (FACW); rye grass (FACU)	No
20/06/22	32	Y	100%	2.25	8.2	Y	Soft rush (FACW)	Yes
20/06/22	33	Y	100%	2.67	36.4	Y	Soft rush (FACW)	Yes
20/06/22	34	N	0%	3.7	75.0	Y	Rye grass (FACU)	No
20/06/22	35	N	0%	3.91	94.0	Y	Clover (FACU)	No
20/06/22	36	N	0%	3.78	83.0	Y	Rye grass (FACU)	No
20/06/22	37	Y	100%	2.26	5.9	Y	Soft rush (FACW)	Yes

Table 19 cont.

Date	Plot	Rapid Test	Dominance Test	Prevalence Test	% pasture	Hydric soil/ hydrology	Dominant species	NPS Wetland
20/06/22	38	Y	100%	2.01	0	Y	Mercer grass (FACW)	Yes
20/06/22	39	N	50%	3.2	45.0	Y	Buttercup (FAC); paspalum (FACU)	No
20/06/22	40	N	100%	2.26	5.8	Y	Soft rush (FACW)	Yes
20/06/22	41	Y	100%	1.9	0	Y	Soft rush (FACW)	Yes
20/06/22	42	N	100%	2.2	0	Y	Soft rush (FACW)	Yes
20/06/22	43	Y	100%	1.66	0	Y	Water pepper (FACW)	Yes
20/06/22	44	N	0%	3.77	73.0	Y	Rye grass (FACU)	No
20/06/22	45	N	33%	3.47	60.0	Y	Rye grass (FACU)	No
20/06/22	46	Y	100%	2.05	2.9	Y	Mercer grass (FACW)	Yes
20/06/22	47	Y	100%	2.15	5.0	Y	Soft rush (FACW)	Yes
20/06/22	48	Y	100%	2.41	9.8	Y	Soft rush (FACW)	Yes
20/06/22	49	N	30%	3.10	55.0	Y	Kikuyu (FACU)	No
20/06/22	50	Y	100%	2.30	15.0	Y	Soft rush (FACW)	Yes
20/06/22	51	Y	100%	2.30	20.0	Y	Soft rush (FACW)	Yes
20/06/22	52	Y	100%	2.50	17.1	Y	Soft rush (FACW)	Yes
8/03/23	53	Y	100%	2.16	NA	y	Mercer grass (FACW)	Yes
8/03/23	54	N	0%	3.55	NA	N	Kikuyu (FACU)	No
8/03/23	55	N	0%	3.86	NA	N	Pohuehue (FACU), Kikuyu (FACU)	No
7/03/23	56	N	0%	3.72	NA	N	Kikuyu (FACU)	No
7/03/23	57	N	50%	2.79	NA	Y	Kikuyu (FACU), soft rush (FACW)	Yes
7/03/23	58	N	0%	3.90	NA	N	Kikuyu (FACU)	No
22/03/23	59	N	50%	3.64	73.3	N	Kikuyu (FACU)	No
22/03/23	60	N	75%*	3.19	58.6	N	Forked rush (FACW)	No
22/03/23	61	N	50%	3.54	74.8	N	Kikuyu (FACU)	No
22/03/23	62	N	33%	3.02	49.1	N	Forked rush (FACW)	No**
22/03/23	63	N	0%	3.65	85.0	N	Kikuyu (FACU)	No
22/03/23	64	Y	100%	2.00	0	Y	Mercer grass (FACW)	Yes
22/03/23	65	N	0%	3.85	94.1	N	Kikuyu (FACU)	No
22/03/23	66	N	0%	3.86	93.8	N	Kikuyu (FACU)	No
22/03/23	67	N	50%	3.33	66.7	Y	Kikuyu (FACU)	No
22/03/23	68	N	33%	3.13	57.0	Y	Kikuyu (FACU)	No
22/03/23	69	N	50%	3.09	55.7	N	Kikuyu (FACU)	No
22/03/23	70	N	0%	3.88	96.0	N	Kikuyu (FACU), clover (FACU)	No
22/03/23	71	N	25%	3.71	77.9	N	Kikuyu (FACU)	No
22/03/23	72	N	50%	3.42	76.0	N	Kikuyu (FACU)	No

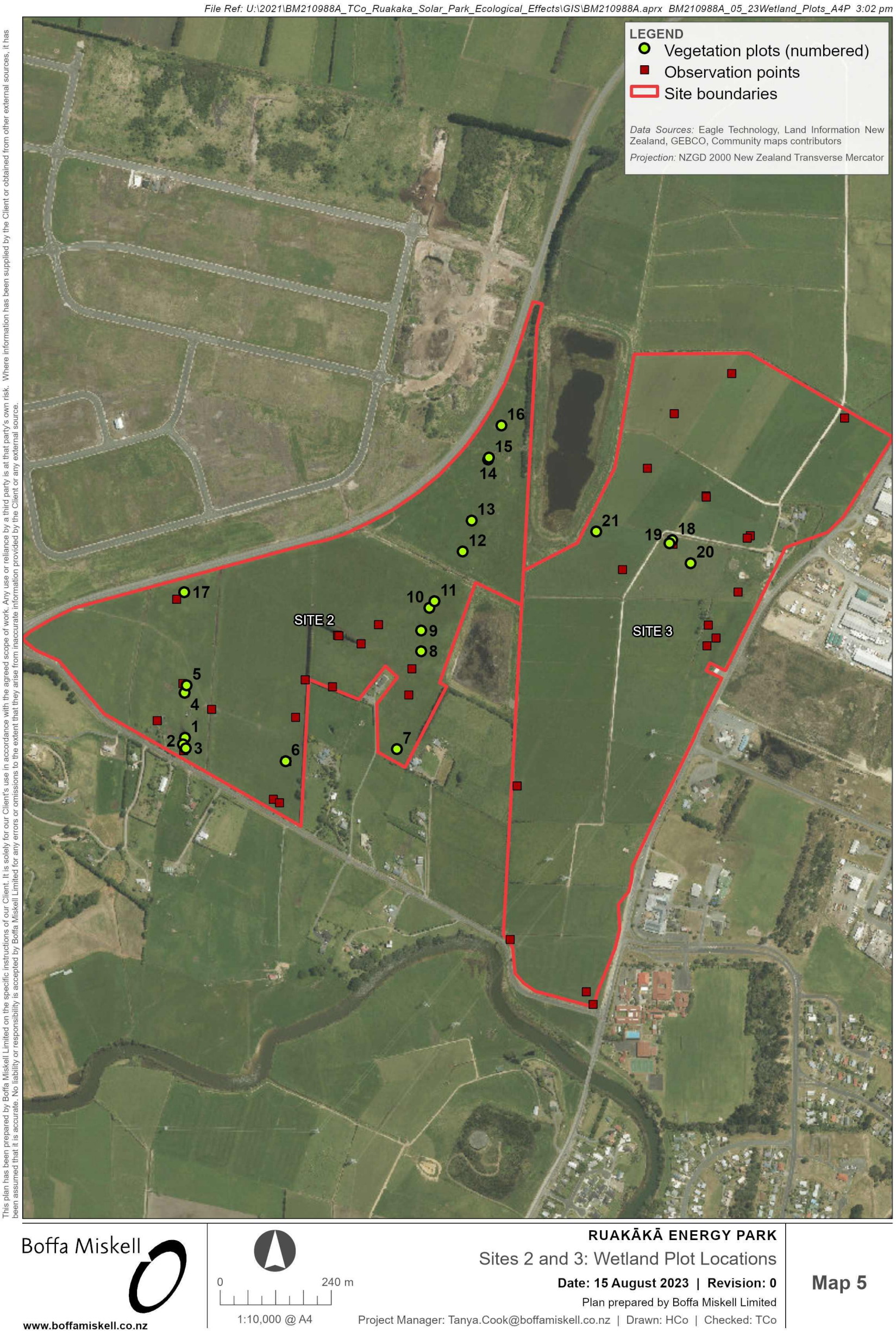


Figure 38: Wetland vegetation plot locations and location of observations in Sites 2 and 3 (refer to Table 20 for plot results).

*Table 20: Summary of wetland vegetation plot, percentage of pasture species, hydric soil and hydrology indicators for Sites 2 and 3 (refer to Figure 35 for plot locations). * = Marginal. ** = Rapid wetland test.*

Survey Date	Plot Number	Rapid Test	Dominance Test	Prevalence Test	% Pasture	Hydric Soil/ Hydrology Indicators	Dominant species	Wetland?
15/11/22	1	Y	100%	2.19	8	Y	Water pepper	Yes
15/11/22	2	N	0%	3.51	65	Y	Kikuyu	No
15/11/22	3	N	50%	2.86	30	Y	Water pepper	Yes*
15/11/22	4	Y	100%	2.19	8	Y	Water pepper	Yes
15/11/22	5	Y	100%	2.4	16	Y	Water pepper	Yes
15/11/22	6	N	100%*	2.97	21	Y	Creeping buttercup	Yes*
15/11/22	7	N	0%	3.51	75	Y	Kikuyu	No
15/11/22	8	Y	100%	1.92	6	Y	Water pepper	Yes
15/11/22	9	Y	100%	2.47	10	Y	Water pepper	Yes
15/11/22	10	Y	100%	2.26	7	Y	Water pepper	Yes
15/11/22	11	Y	100%	2.2	6	Y	Mercer grass	Yes
15/11/22	12	N	0%	3.64	85	Y	Clover / rye grass	No
15/11/22	13	Y	100%	2.14	2	Y	Water pepper	Yes
15/11/22	14	N	100%*	2.69	20	Y	Creeping buttercup / toad rush	Yes
15/11/22	15	Y	100%	2.21	10	Y	Water pepper	Yes
15/11/22	16	Y			< 50%**	Y	Water pepper	Yes
15/11/22	17	N	0%	3.72	75	Y	Kikuyu	Yes
15/11/22	18	Y	50%	2.55	25	Y	Water pepper	Yes
15/11/22	19	N	50%	3	45	Y	Water peper / rye grass	Yes
15/11/22	20	N	50%	2.9	40	Y	Water peper/ kikuyu	Yes*
15/11/22	21	N	50%	2.48	20	Y	Alligator weed	Yes

Appendix 6: Lizard monitoring device locations

Figure 39: Location of lizard monitoring devices (tracking tunnels and ACOs) in Site 1A surveyed in Summer 2023 and Sites 1B and 1C surveyed in Autumn 2023.

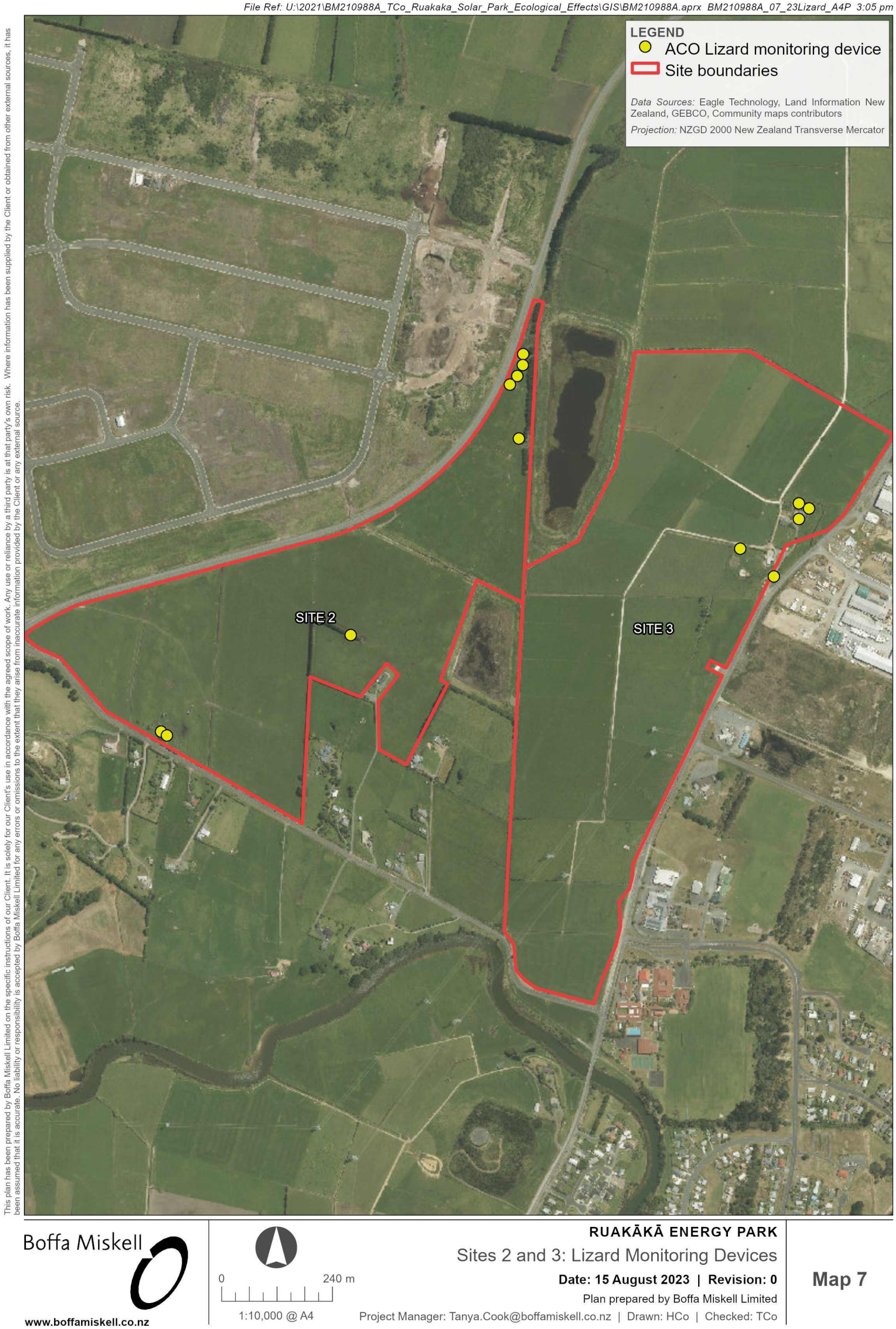


Figure 40: Location of lizard monitoring devices (tracking tunnels and ACOs) in Sites 2 and 3, surveyed in Autumn 2023.

Appendix 7: Ecological Impact Assessment Guidelines tables of criteria and assessment matrices

Assessing ecological values

Table 21: Criteria to consider for ecological value of terrestrial habitats and species (modified from EIANZ (2018))

Matter	Assessment considerations Terrestrial
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 uncommon species • Regional or national distribution limits of species or communities • Unusual species or assemblages • Endemism
Diversity and pattern	• Level of natural diversity, abundance and distribution • Biodiversity reflecting underlying diversity • Biogeographical considerations – pattern, complexity • Temporal considerations, considerations of lifecycles, daily or seasonal cycles of habitat availability and utilization.
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 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

Table 22: Criteria to consider for ecological value of freshwater habitats and species (modified from EIANZ (2018))

Matter	Assessment considerations Freshwater
Representativeness	• Extent to which site/catchment is typical or characteristic • Stream order • Permanent, intermittent or ephemeral waterway • Catchment size • Standing water characteristics
Rarity/distinctiveness	• Supporting nationally or locally Threatened, At Risk or uncommon species • National distribution limits • Endemism • Distinctive ecological features • Type of lake/pond/wetland/spring.
Diversity and pattern	• Level of natural diversity • Diversity metrics • Complexity of community • Biogeographical considerations - pattern, complexity, size, shape.
Ecological context	• Stream order • Instream habitat • Riparian habitat • Local environmental conditions and influences, site history and development • Intactness, health and resilience of populations and communities • Contribution to ecological networks, linkages, pathways • Role in ecosystem functioning – high level, proxies.
Ecological Integrity[20]	Nativeness – the degree to which an ecosystem's structural composition is dominated by the indigenous biota characteristics of the particular region Pristineness – relates to a wide array of structural, functional, and physico-chemical elements (including connectivity), but is not necessarily dependent on indigenous biota constituting structural and functional elements Diversity – richness (the number of taxa) and evenness (the distribution of individuals amongst taxa); link to a possible reference condition; the use abundance weighting; and geographical scale Resilience (or adaptability) – quantifying the probability of maintaining an ecosystem's structural and functional characteristics under varying degrees of human pressure or stressors such as climate change.

Table 23: Guidelines for assigning ecological value to species (from Roper-Lindsay et al., (2018)).

Threat category	Assigned Value
Threatened – Nationally Critical, Endangered or Vulnerable	Very High
Nationally At Risk – Declining	High
Nationally At Risk – Recovering, Relict or Naturally Uncommon	Moderate
Locally (ED) uncommon or distinctive species	Moderate

[20] In addition to the measures prescribed in *Table 21*, an additional matter is considered when assigning ecological value to freshwater environments as described in (Roper-Lindsay et al., 2018). Ecological Integrity is considered as a way of integrating structural and functional components of freshwater systems into the ecological values matrix.

Nationally and locally common indigenous species	Low
Exotic species, including pests, species having recreational value	Negligible

Table 24: Criteria for assigning ecological values to habitats or project sites (Roper-Lindsay et al., 2018).

Value	Description
Very high	Area rates High for 3 or all of the four assessment matters (representativeness, rarity/ distinctiveness, diversity/pattern, ecological context)
High	Area rates High for 2 of the assessment matters, Moderate and Low for the remainder, or Area rates High for 1 of the assessment matters, Moderate for the remainder
Moderate	Area rates High for one matter, Moderate and Low for the remainder, or Area rates Moderate for 2 or more assessment matters Low or Very Low for the remainder
Low	Area rates Low or Very Low for majority of assessment matters and Moderate for one. Limited ecological value other than as local habitat for tolerant native species.
Negligible	Area rates Very Low for 3 matters and Moderate, Low or Very Low for remainder.

Assessing magnitude of effect

Table 25: Criteria for assessing magnitude of effect (Roper-Lindsay et al., 2018). NB. criteria exclude mitigation.

Magnitude	Description
Very high/severe	• Total loss of, or very major alteration to, key elements/features/ of the existing baseline conditions, such that the post-development character, composition and/or attributes will fundamentally change 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/medium	• Loss or alteration to one or more key elements/features of the existing baseline conditions, such that the 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	• Minor shift away from existing 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 or patterns; and/or • Having a minor effect on the known population or range of the element/feature
Negligible	• Very slight change from the existing baseline condition. Change barely distinguishable, approximating to the 'no change' situation; and/or • Having negligible effect on the known population or range of the element/feature

Assessing level of impact

Table 26: EIANZ criteria for level of ecological effect (Roper-Lindsay et al., 2018).

Magnitude	Ecological Value					
		Very High	**High**	**Moderate**	**Low**	**Negligible**
	Very High	Very High	Very High	High	Moderate	Low
	High	Very High	Very High	Moderate	Low	Very Low
	Moderate	High	High	Moderate	Low	Very Low
	Low	Moderate	Low	Low	Very Low	Very Low
	Negligible	Low	Very Low	Very Low	Very Low	Very Low
	Positive	Net gain	Net gain	Net gain	Net gain	Net gain

Appendix 8: Rapid Stream Habitat Assessment results

Table 27: Rapid stream habitat assessment results for Bercich Drain in Site 1 and Unnamed Drain in Site 3

Habitat parameter	**Bercich Drain – Site 1A** **Surveyed: March 2023**	**Bercich Drain – Sites 1B/C** **Surveyed: June 2022**	**Unnamed Drain – Site 3** **Surveyed: March & November 22, Feb 23**
Deposited sediment	1 > 90% cover	1 Difficult to assess but likely to be > 75% cover	1 >75% cover
Invertebrate habitat diversity	2 Stream bed/sediment, root mats	4 Stream bed/sediment, macrophytes, root mats	2 Stream bed/sediment, macrophytes, root mats
Invertebrate habitat abundance	1 Unsuitable habitat for EPT taxa	1 Unsuitable habitat for EPT taxa	1 Unsuitable habitat for EPT taxa
Fish cover diversity	4 Overhanging vegetation, root mats and undercut bank on northern side	4 Encroaching vegetation, root mats, macrophytes	4 Overhanging/encroaching vegetation, root mats and macrophytes
Fish cover abundance	3.5 Between 10-20% cover	10 > 90% cover	9 ~ 75% cover
Hydraulic heterogeneity	1 All slow run habitat	1 All slow run habitat	1 All slow run habitat
Bank erosion	9 Less than 5% on both banks	4 Stock pugging throughout most of Site 1B and some of 1C (~ 50% of total length)	9 Less than 5% on both banks
Bank vegetation	6 Left bank: regenerating native shrubs, exotic shrubs and grasses and native sedges (8) Right bank: long exotic grasses (4)	2 Both banks: heavily grazed exotic grass	4 Both banks: heavily grazed exotic grass with narrow strip of long grass in fenced area with occasional native shrub
Riparian width	9 Both banks: shade creating vegetation on left bank 2-10 m, dense groundcover >30 m, no fences as stock excluded from all of Site 1A	1 Both banks: mostly not fenced, where fenced < 1 m wide	4 Both banks: 2-3 metres in most places
Riparian shade	5 ~40%	1 ~5%	2 ~10%
Total	**41.5**	**29**	**37**

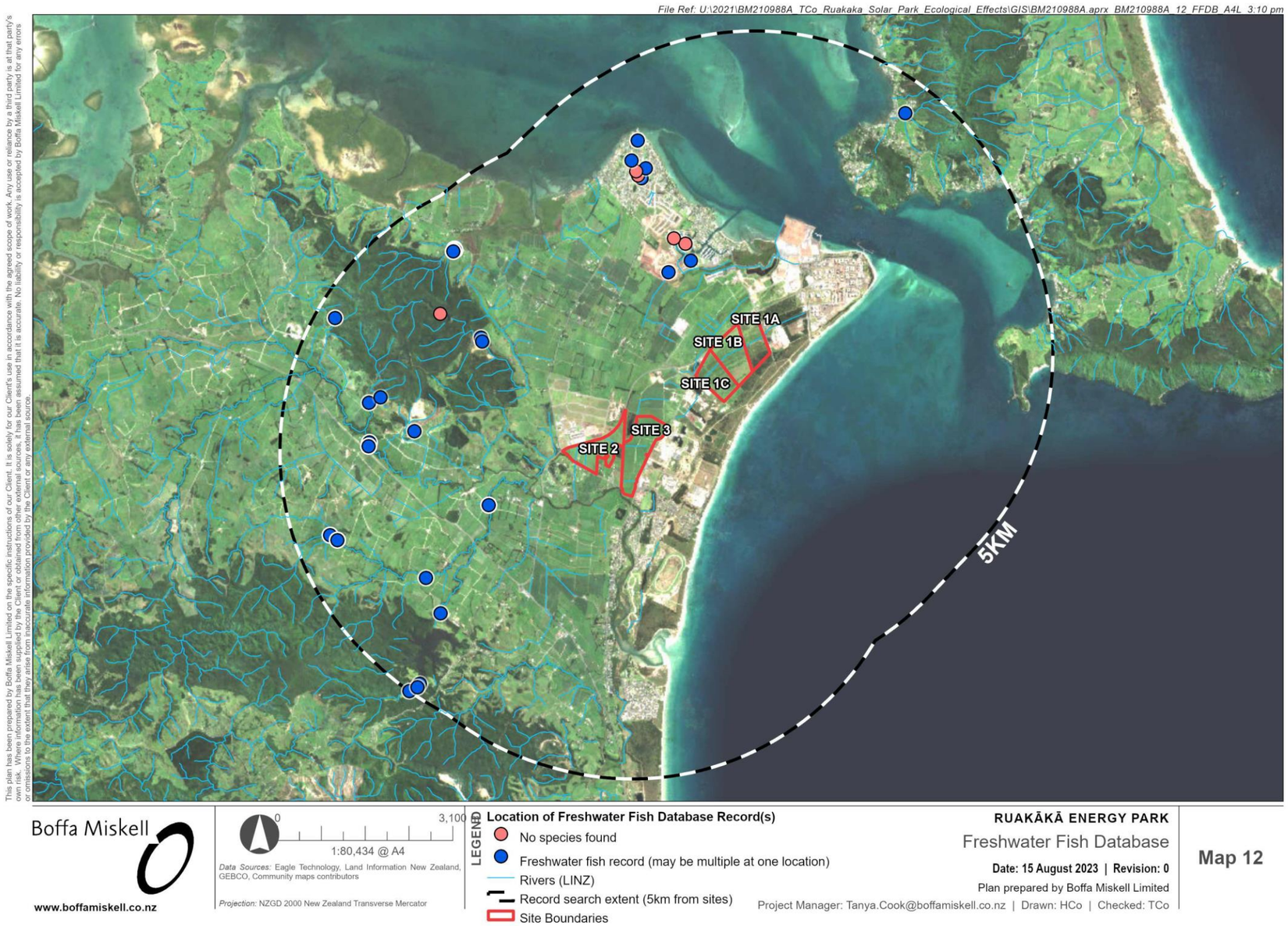


Figure 41: Location of NZ Freshwater Fish Database records within 5 km of the Sites

Appendix 10: Avifauna database records and site observations

Table 28: Native species found within a 20 km^2 area surrounding the Sites (data compiled from: https://ebird.org/atlasnz/effortmap. Note: list restricted to species associated with the habitats available within the sites, eg, ocean birds not included.

Species	Scientific	Threat classification
Matuku-hūrepo/Australasian bittern	*Botaurus poiclioptilus*	Threatened - Nationally Critical
Matuku-moana/Pacific reef heron	*Egretta sacra*	Threatened - Nationally Endangered
Pārera/grey duck	*Anas supercillosa*	Threatened - Nationally Vulnerable
Pāteke/brown teal	*Ana chlotoyis*	Threatened - Nationally Increasing
Weiwea/New Zealand dabchick	*Poilocephalus rufopectus*	Threatened - Nationally Increasing
Mohu perurū/banded rail	*Gallirallus phillippensis*	At Risk - Declining
Pīhoihoi/New Zealand pipit	*Anthus novaeseelandiae*	At Risk - Declining
Tōrea/South Island oystercatcher	*Haematopus finschi*	At Risk - Declining
Pūweto/Spotless crake	*Zapornia tabuensis*	At Risk - Declining
Rarāpunga/red-billed gull	*Larus novaehollandiae scopulinus*	At Risk - Declining
New Zealand kaka	*Nestor meridionalis*	At Risk - Recovering
Kāruhiruhi/pied shag	*Phalacrocorax varius*	At Risk - Recovering
Tōreo pango/variable oystercatcher	*Haematopus unicolor*	At Risk - Recovering
Kawau tūī/little black shag	*Phalacrocorax sulcirostris*	At Risk - Recovering
Kuruwhengu/Australasian shoveler	*Spatula rhychotis*	Not Threatened
Kakīānau/Black swan	*Cygnus atratus*	Not Threatened
Tete/grey teal	*Anas gracilis*	Not Threatened
Karoro/southern black-backed gull	*Larus dominicanus*	Not Threatened
spur-winged plover	*Vanellus miles*	Not Threatened
New Zealand fantail	*Rhipidura fulginosa*	Not Threatened
Keruru/New Zealand pigeon	*Hemiphaga novaeseelandiae*	Not Threatened
Pāpango/New Zealand scaup	*Aythya novaseelandiae*	Not Threatened
Poaka/pied stilt	*Himantopus leucocephalus*	Not Threatened
Pukeko	*Porphyrio melanotus*	Not Threatened
Kōtare/sacred kingfisher	*Todiramphus sanctus*	Not Threatened
Tauhou/silvereye	*Zosterops lateralis*	Not Threatened
Tūī	*Prosthemadera novaeseelandiae*	Not Threatened
welcome swallow	*Hirundo neoxena*	Not Threatened
Matuku moana/white-faced heron	*Egretta novaeholliandiae*	Not Threatened

Appendix 11: Matuku-hūrepo (bittern) observation locations

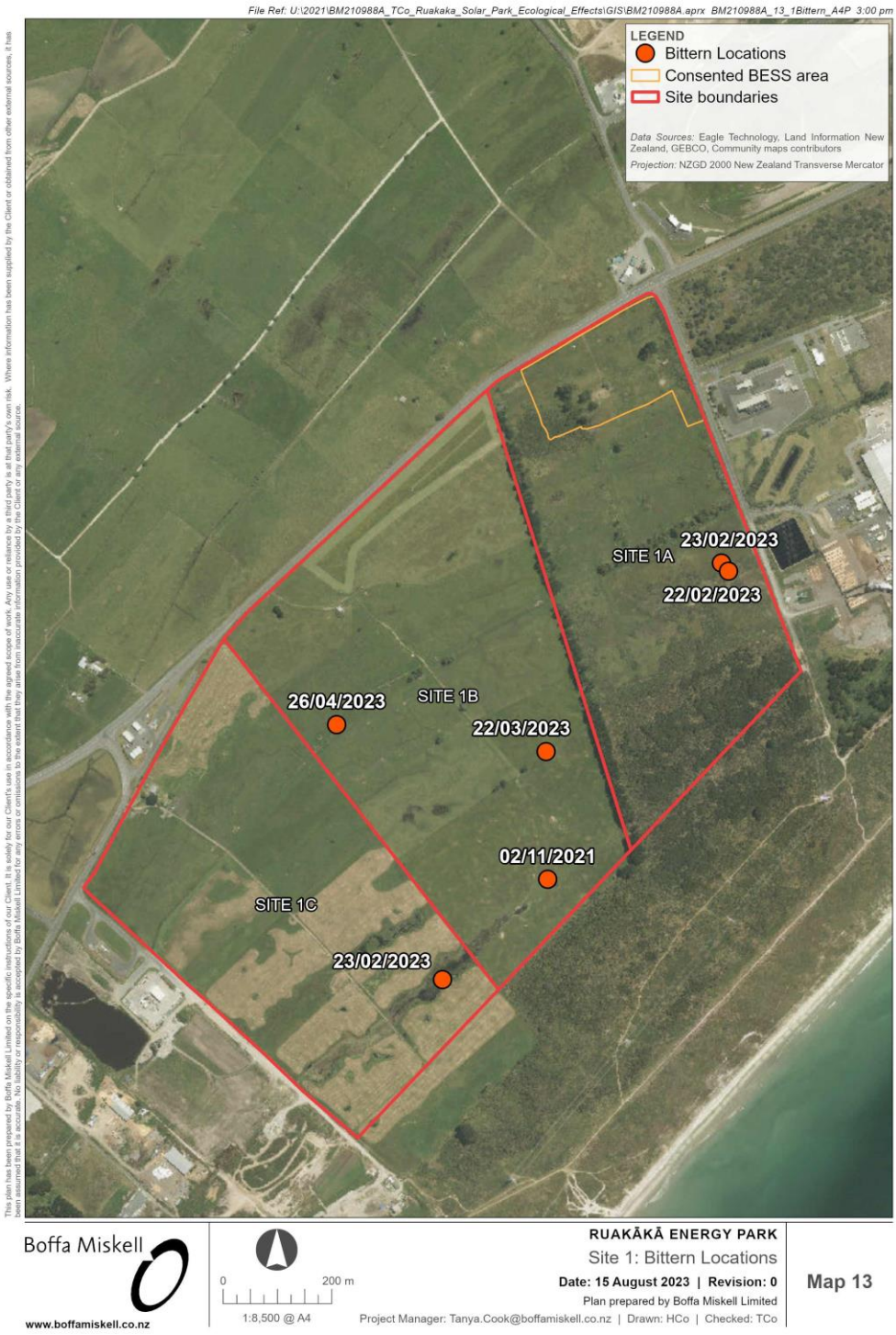


Figure 42: Locations of sighting of Matuku-hūrepo in Site 1 during site visits and bird surveys, 2021-2023

Figure 43: Locations of sighting of Matuku-hūrepo in Site 2 and3 during site visits and bird surveys, 2022-2023

Appendix 12: DOC bat database records

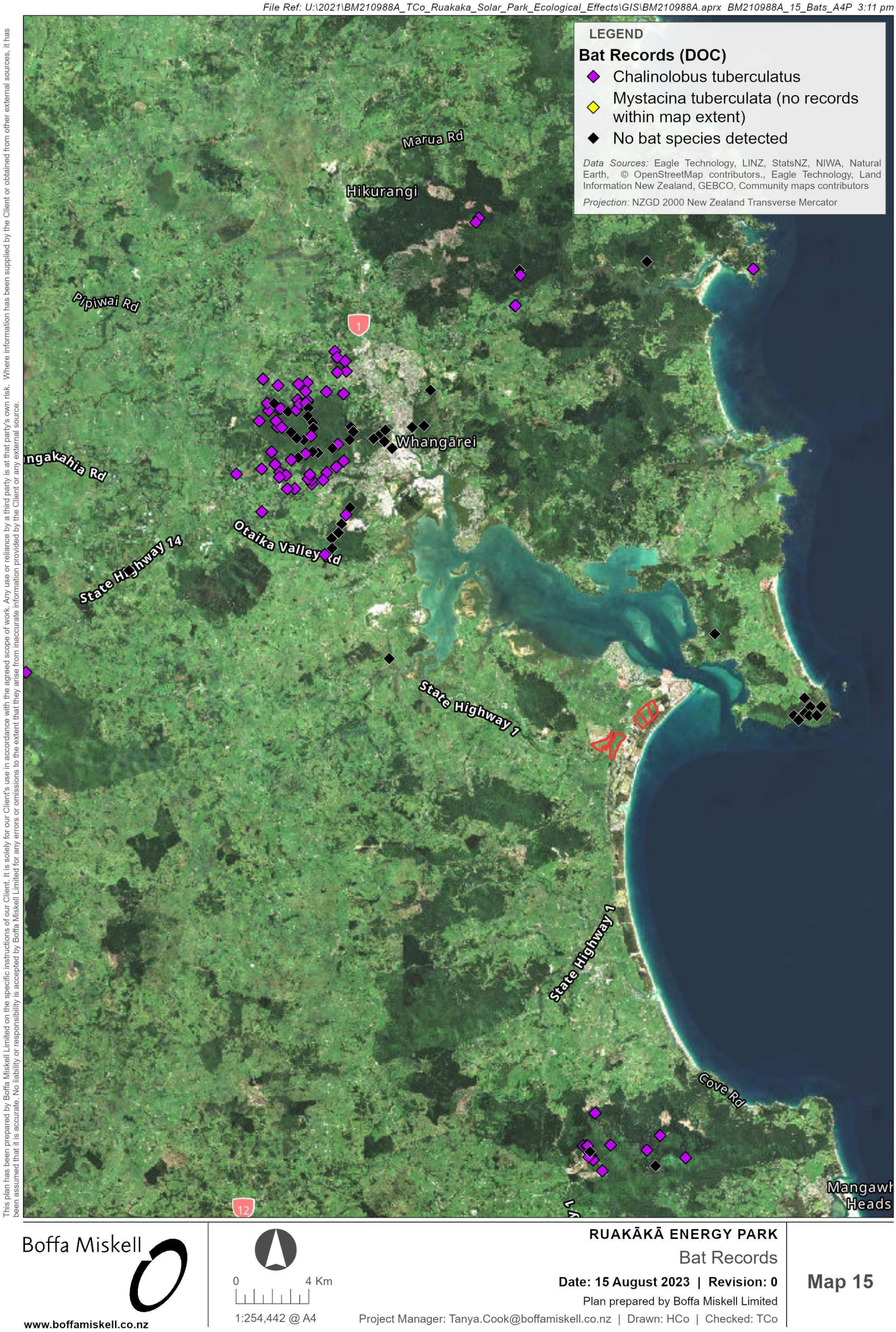


Figure 44: Locations of bat records in the DOC bat database (based on data up to March 2022)