Muriwai Downs Golf Course:

ECOLOGICAL EFFECTS ASSESSMENT

Report prepared for

The Bears Home Project Management Limited

Prepared by

RMA Ecology Ltd

Report number and date

Report number: 2042

December 2021

BETTER ECOLOGICAL OUTCOMES

PREPARED FOR:

The Bears Home Project Management Limited

710 Muriwai Road

Muriwai 0881

Prepared by:	Tony Payne Senior Ecologist
Reviewed and Authorised by:	Graham Ussher Principal Ecologist

Project No. 2042

Version date: December 2021

Version status: Final

Revision	*Date*	*Description*
Rev1-4	*17 December 21*	*Final*

Citation:

RMA Ecology Ltd. December 2021. Muriwai Downs Golf Course: Ecological Effects Assessment. Report prepared for The Bears Home Project Management Ltd. 111 pages + Appendices.

CONTENTS

Executive summary

The Bears Home Project Management Limited (Applicant) is applying for resource consents to develop an international standard 19-hole golf course at the ca. 507 ha property described as Muriwai Downs (the Property), located approximately 3 km northeast of Muriwai Beach Township, north Auckland.

The Property includes a patchwork of grazed pasture and exotic hedgerows on the upper hillslopes, and mature indigenous forest in steep gullies, relatively degraded wetlands and streams affected by historic agriculture and vegetation clearance within the Ōkiritoto Stream catchment, and Lake Ōkaihau at the western extent of the Property. Most of the Property supports pasture grassland that is used for sheep and beef and grazing, and (in parts) for dairy cattle production.

Within the Property, all the land to be used for the Muriwai Downs Golf Project (Project) is referred to as 'the site', and includes:

- All physical resources associated with the site; and
- All activities associated with designing, consenting, constructing, operating and maintaining the site.

The site comprises the following key components:

- A 19-hole golf course with warm-up Fairway and short-game practice area;
- A Clubhouse;
- A Sports Academy including; an academy building, academy driving range, practice Green, 9-hole short course, and indoor and outdoor tennis facilities;
- A golf and property maintenance complex;
- A luxury Lodge;
- Groundwater and surface water abstraction facilities;
- Off-stream water storage reservoir;
- Significant ecological restoration and enhancement works; and
- Various supporting infrastructure associated with the above items.

A key aspect of the proposed development is the incorporation of a sensitive design to avoid and minimise effects, including an iterative process of RMA Ecology Ltd providing descriptions of ecological values, and advice on methodologies and philosophies of sensitive design to be considered as part of the Project's design.

A total of ca. 77.3 ha of indigenous forest within the Property meets the Significant Ecological Area (SEA) criteria in the Auckland Unitary Plan (Operative in Part) (AUP). Approximately 1,396 m^2 of vegetation on the margins of one SEA (SEA_T_5525) will be affected by the proposed development, which constitutes ca. 1.3 % of the total area of SEA_T_5525 or 0.18% of the total area of SEA forest within the Property.

There are 21 wetlands within or near to the Project area, and these total 31 ha. All of these wetlands will be avoided by the Project development footprint, and works within 10 m of wetlands have been minimised where practicable.

There are ca. 13 km of streams within the Property. The Project affects 184 m of streams by culverting or infilling / reclamation. The associated loss of stream area or loss of stream values constitutes approximately 1.4 % of the stream length within the Property, and less than 0.01 % of the overall Ōkiritoto Stream catchment.

The enhancements proposed as part of this Project can be divided into several categories – primarily those that are required to remedy or mitigate effects and ecological management volunteered by the Applicant.

1. The ecological works required to address adverse effects that cannot be avoided:
    a. Mitigation – planting of forest margins for SEA_T_5525 to replace native vegetation clearance within SEA_T_5525;
    b. Offset – Stream daylighting and enhancement works to address residual adverse effects arising from culverting Stream P3.
2. Ecological restoration and enhancements volunteered by the Applicant to improve biodiversity corridors, linkages, buffering and creation of habitat for indigenous fauna, providing options for approximately 28.7 ha of restoration and enhancement works including:
    a. Extensive indicative ecological restoration works proposed within streams, Lake Ōkaihau and SEAs and other indigenous forest areas (**Figure 37** below illustrates the indicative restoration proposed) to protect and enhance ecological values; and
    b. Restoration of wetlands within the site; and
    c. Stream daylighting and riparian enhancement works to a section of piped Stream I2 (31 m).

To appropriately avoid, remedy or mitigate (minimise) any actual and potential adverse ecological effects, a number of recommendations are made in this report including:

- Works to be undertaken in accordance with Council standards and best practice, detailed in the draft Construction Environmental Management Plan (**CEMP**) (McKenzie and Co, 2021, Appendix 18 to AEE) developed for the Project; and
- The preparation of an Ecological Management Plan (EMP) with methods to minimise indigenous vegetation clearance, manage interventions with regards to native freshwater fish, avifauna, lizard and long-tailed bat, as well as management and monitoring protocols to ensure restoration and enhancement and restoration objectives are achieved.

Overall, the actual or potential adverse effects on ecological values that may result from construction activities and operation of the Project are mostly considered to be low or very low. This equates to minor or less than minor effects. For potential effects on ecological values that are considered to be minor or less than minor, no response through offset or compensation is considered to be necessary. Overall, if Project works are appropriately implemented, there should be an overall positive ecological outcome.

For potential effects that are considered to be more than minor, which includes the culverting of 175 m of permanent stream, ecological enhancements and protections are proposed as an offset package to address residual adverse effects.

The proposed indicative ecological restoration and enhancements will result in significant ecological benefits to Lake Ōkaihau, SEAs and indigenous forest, streams, wetlands and associated indigenous wildlife at the Property.

1.0 Introduction

The Applicant is applying for resource consents from Auckland Council to develop an international standard 19-hole golf course at the ca. 507 ha Property (**Figure 1** below).

RMA Ecology Limited has been commissioned by the Applicant to prepare an ecological effects assessment for the proposed Project. This report provides an assessment of ecological values, and an effects assessment which has been prepared with regard to the ecological provisions of the AUP, National Policy Statement for Freshwater Management 2020 (NPS-FM) and National Environmental Standards for Freshwater 2020 (NES-F).

Our scope of work included:

- A literature and database review to assess likely biodiversity values;
- Attendance of several design concept workshops, and liaison with a range of specialists involved with the golf course development, including golf course designers, landscape architects, hydrologists, agronomists, stormwater and geotechnical engineers, and planners. This engagement involved describing ecological values to the Project team, and an iterative process of science and ecology inputs into the overall golf course design to ensure ecological values are appropriately avoided and mitigated; and
- Preparation of an ecological site assessment report suitable for resource consent purposes (this report)[1].

1.1 Project background

The assessment has been undertaken in relation to plans to construct, operate and maintain a golf course complex on an approximately 507 pastoral farmland block currently known as Muriwai Downs located approximately 3 km northeast of Muriwai Beach Township, north Auckland (**Figure 1** below).

The Project will comprise the key components described above and show in (**Figure 2** below).

Further details of each of these aspects can be found in the Assessment of Environmental Effects (AEE). A description of the activities associated with each aspect relevant to this report are described in Section 5 below.

1.2 Methods

Site assessment methods and relevant planning policies and definitions are provided in **Appendices A**, **B** and **C** to this report.

Eight (8) site surveys were undertaken in August 2020, September 2020, May 2021, June 2021 and July 2021, September 2021, October 2021 and November 2021. The purpose of the site surveys was to identify and assess the extent (mapping) and general condition (values assessment) of the ecological features of the

[1] This work has been undertaken in accordance with the Master Services Agreement dated 15 October 2020, and Deed of Novation dated May 2021.

site, in particular vegetation, watercourses, wetlands, and habitat of indigenous wildlife. Targeted surveys of indigenous freshwater fish, lizards and avifauna were undertaken.

The ecological or environmental aspects of the site that were investigated were:

- Wetlands and streams;
- Lake Ōkaihau;
- Native lizards;
- Indigenous vegetation including SEAs;
- Threatened and rare (At Risk) species;
- Kauri;
- Native fish;
- Birdlife of forests, open country and wetlands (and seabirds that fly over the site); and
- Bats – by information review and habitat assessment.

Information was collected using range of methods. Refer to **Appendices A - C** for more detailed accounts:

- NPS-FM wetland delineation protocols, including updates by the Ministry for the Environment (MfE) to hydrology, hydric vegetation classes, classification flow charts and exclusions;
- Stream Ecological Valuation (SEV) stream evaluation method, AUP stream classification criteria and database records for fish;
- Lizard habitat assessment and manual searching;
- Bird counts, dawn playback surveys, incidental species lists, national database records;
- Bat habitat assessment and national database records;
- A wide range of published literature, previous site reports and national database information;
- Stream and wetland water quality sampling undertaken by Williamson Water and Land Development Ltd (WWLA, 2021a, b, c, d at Appendix 10 to AEE); and
- Mature native tree and kauri tree mapping across parts of the site near to proposed development envelopes.

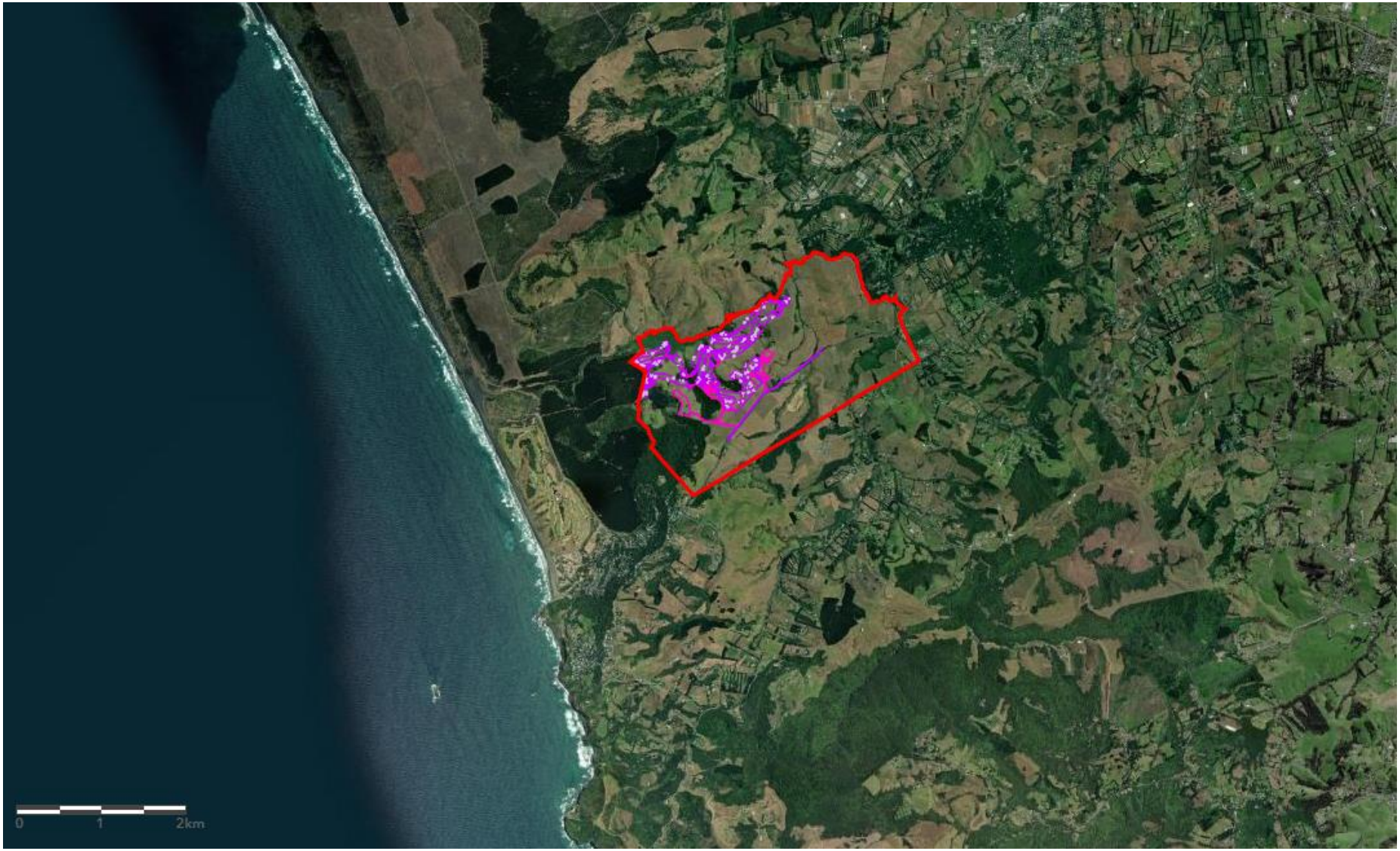

Figure 1. The Property and proposed Muriwai Downs Golf Course within the wider Muriwai landscape. The Property adjoins pine forest to the west, and mixed rural land use to the north, east and south. Proposed golf course layout and supporting infrastructure (pink/ purple features), Property boundary (red line).

Figure 2. The proposed Muriwai Downs Golf Course site and Property. Figure supplied by Kyle Phillips.

2.0 Ecological context

The Property is located within the Rodney Ecological District (generally encompassing the former Rodney District Council spatial area) within the Auckland Ecological Region.

The modification of native bush, wetlands and ecosystems, and the resultant loss of biodiversity is a characteristic of the state of biodiversity in the Rodney District. While certain areas, especially in the northern part of the District, still retain large areas of bush or relatively unmodified landscapes, most of the ecosystems within the District are fragmented, isolated pockets of bush, wetlands, dunes and dune lakes, estuaries and scrubland. Less than 15 % of the original bush remains, with the majority having been cleared between 1860 and 1984 to create pasture for stock grazing.

Watercourses within the catchment are soft-bottomed streams due to the underlying sandstones and mudstones. Original forest cover would have been dune forest (WF5)[2] on the western parts of the Property comprising tōtara (*Podocarpus tōtara*), kānuka (*Leptospermum robusta*) and broadleaved species (predominantly puriri (*Vitex lucens),* kohekohe (*Didymocheton spectabilis*) and nikau (*Rhopalostylis sapida*)), with localised areas of kauri (*Agathis australis*). Most of the low-lying central and eastern parts of the Property would have supported a mix of hardwood-podocarp-broadleaved forest and kauri (WF11 and WF13) with tawa (*Beilschmedia tawa*), kohekohe, rewarewa (*Knightia excelsa*) and hinau (*Elaeocarpus dentatus*) dominant. The low-lying flood-prone areas of the Property to the south-east would have once supported a mix of swamp forest and broadleaved species (WF7-3) comprising kahikatea (*Dacrycarpus dacrydoides*) and puriri as canopy dominants.

Within the Property there are eight (8) areas that meet the criteria in the AUP as SEAs, seven (7) of which are mapped in the AUP and one which is not listed. SEAs cover approximately 77.3 ha of the Property.

Less than 1 % of the wetlands within Rodent Ecological District remain, most having been drained between 1942 and 1977 for agriculture and urban development.

Over much of the low-lying areas and coastal areas of Rodney District the original vegetation cover has been removed, and this is the case for the Muriwai Downs Golf Course Property and surrounding areas. The catchment has been largely converted to pasture grazing with some gully areas remaining in mature or regenerating native forest, exotic shelterbelts around farm buildings and amenity plantings surrounding dwellings.

The loss of habitats for indigenous forest wildlife would have occurred at a similar level to the loss of botanical diversity once the original forest cover was removed. Most native animals – apart from a few birds and typically one native lizard – rarely survive the transition from indigenous habitats to exotic dominated landscapes in intensive agricultural use. Intensification of landscape use for agriculture and removal of riparian vegetation cover is often also accompanied by an associated reduction in habitat for native freshwater invertebrates and fishes and a reduction in water quality within watercourses.

While most of the Property has been converted to farming, areas of high ecological value are still present in steep gullies where kauri / broadleaved forest remnants have been retained, as well as aquatic features such as Lake Ōkaihau and an extensive riverine wetland complex at the base of Toroānui Falls.

[2] Singers *et al.* 2017.

3.0 Aquatic Ecology

3.1 Overview

The Property is located within rural coastal farmland to the south of the Kaipara Harbour. The Property is ca. 1.7 km inland from Muriwai Beach and approximately 50 m above sea-level, and is not within the Coastal Environment.

Lake Ōkaihau, a 6.2 ha dune lake (historically formed), is at the western portion of the Property and is classified in the AUP as SEA_T_5527.

There are 21 wetlands within the Property which cover approximately 37 ha.

The Property catchment is Ōkiritoto Stream (catchment area ca. 2,400 ha), which flows along the northern boundary of the Property from east to west. The catchment on the Property includes a network of small headwater streams and nine (9) permanent streams.

Together, the network of watercourses within the Property covers approximately 13 km, with an indictive breakdown by type provided in **Table 1** below. Aquatic features on the Property are shown on **Figure 3** and **Figure 4,** and aquatic features in relation to the site are provided on **Figure 5**.

Table 1. Summary of watercourse lengths and wetland areas within the Muriwai Downs Golf Course Property.

Watercourse type	Number	Length	Area
Intermittent stream	13	4,134 m (4.1 km)	-
Permanent stream	9	8,998 m (9 km)	-
Wetlands	21	-	37 ha
Lake Ōkaihau	-	-	6.2 ha
Total	**42**	**13.1 km**	**37 ha**

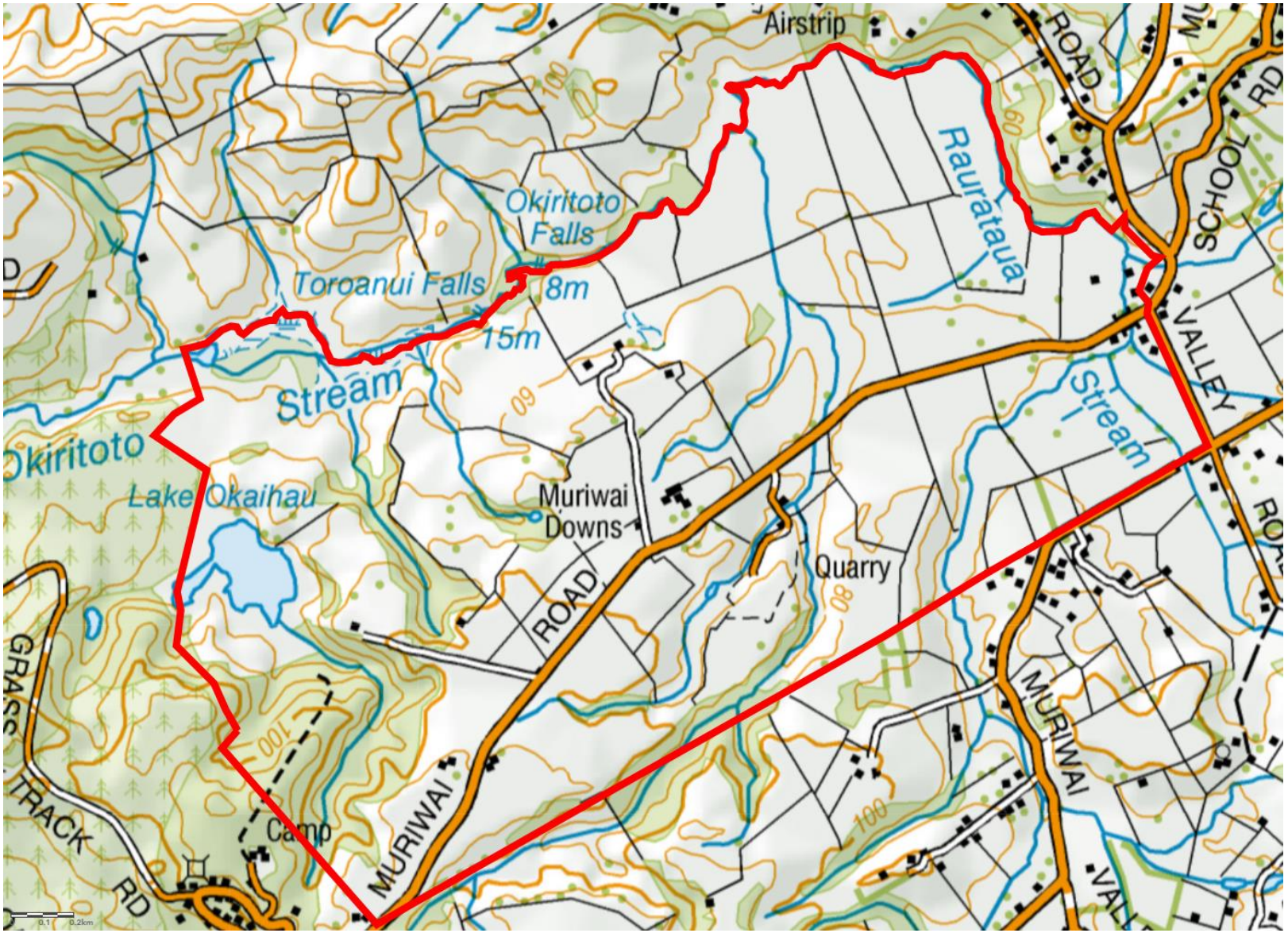

Figure 3. Topographic map of the Property (red boundary) depicting key aquatic features including Ōkiritoto Stream, Rauratāua Stream and Lake Ōkaihau.

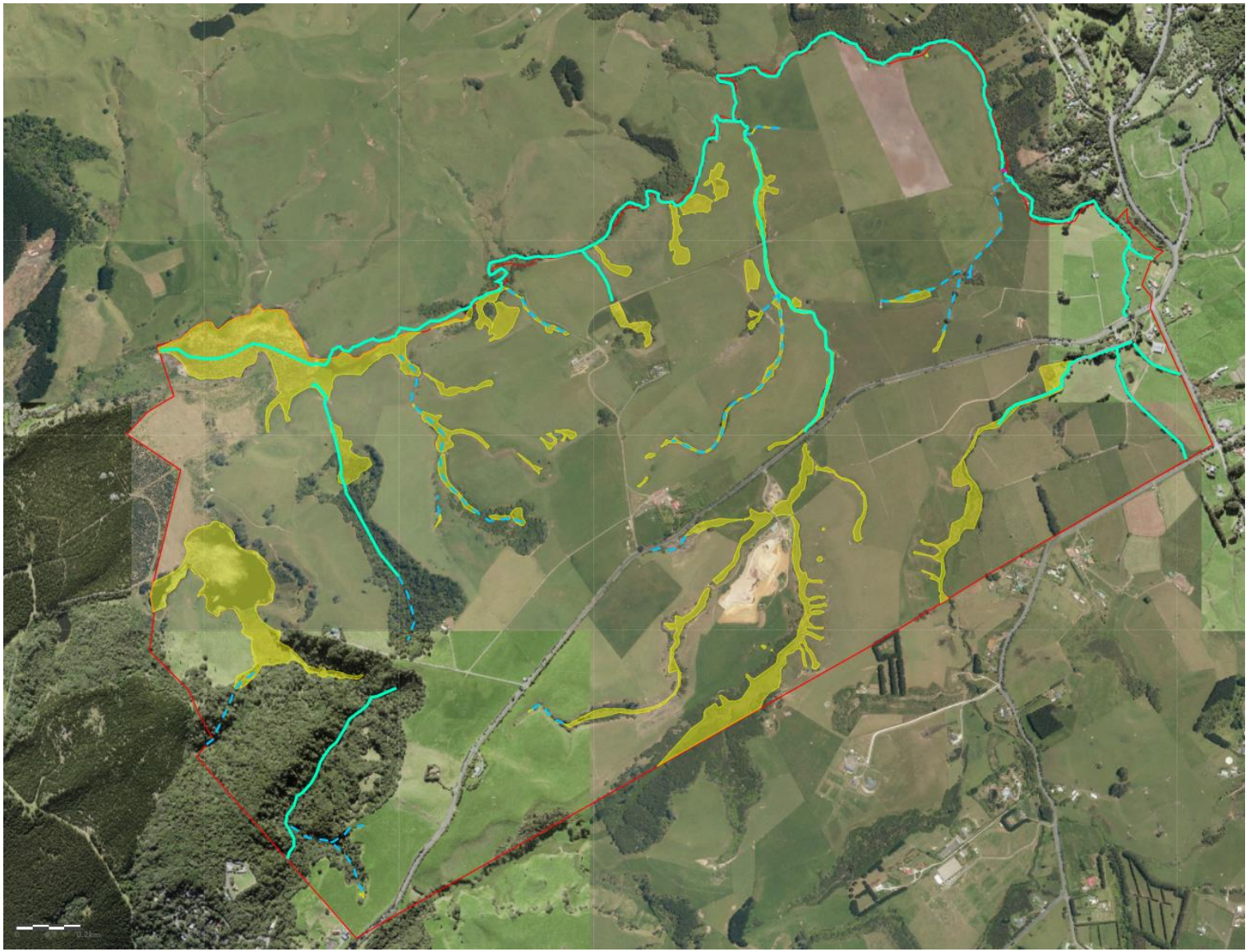

Figure 4. Aquatic features on Property. Wetlands (yellow area, including Lake Ōkaihau), permanent stream (solid blue line), and intermittent stream (dashed blue line) property boundary (red line).

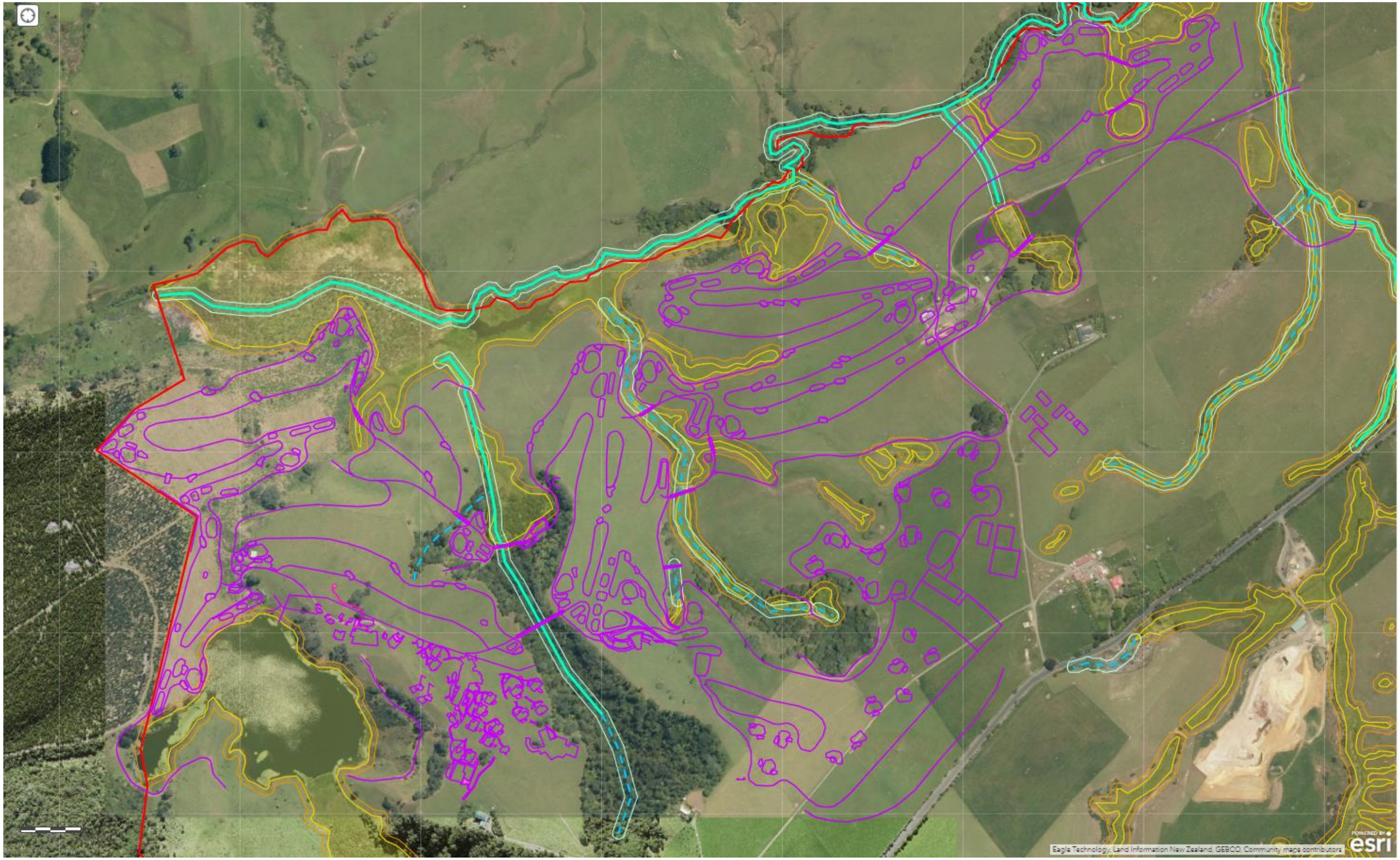

Figure 5. Aquatic features on site in relation to the proposed Muriwai Downs Golf Course layout. Wetlands (yellow area including Lake Ōkaihau), wetland 10 m buffer (orange outer line), permanent stream (solid blue line), intermittent stream (dashed blue line), stream 10 m buffer (blue outer line) proposed golf course layout and supporting infrastructure (pink/ purple features), site boundary (red line). 10 m buffers to streams and wetlands have been added in consideration of potential planning constraints in the AUP and NES-FM.

3.2 Existing environment

The Project area is and has historically been operated as a typical New Zealand rural farm. Based on information provided by other specialists, it is understood that 286 ha is currently in use for the farming of beef cattle and sheep, and 72 ha (mostly at the north-eastern end of the Property) is used for dairy farming.

The majority of the Project area is grazed farmland, with the significant areas of trees and vegetation largely confined to those areas unsuitable for conventional farming practices. The vast majority of vegetation growing within the Project area consists of the following tree and vegetation types:

- Stands and individual exotic species such as eucalyptus sp. and Monterey cypress (*Cupressus macrocarpa*) growing throughout the existing grassed areas;
- Common weed species vegetation such as gorse (*Ulex europaeus*) and tree lupin (*Lupinus arboreus*);
- Wetland areas consisting of a mixture of native and exotic vegetation. Native vegetation within these areas is dominated by ti kouka (*Cordyline australis*), karamu (*Coprosma robusta*) with exotic species such as Australian blackwood (*Acacia melanoxylon*), willow (*Salix* sp.), poplar (*Poplus* sp.) oak (*Quercus palustris* and *Quercus robur*) also present in several of the wetland margins;
- Individual specimens and groupings of native species within the main farmland areas. These trees comprise largely of pōhutukawa (*Metrosideros excelsa*), tōtara (*Podocarpus tōtara*), kauri (*Agathus australis*) and ti kouka;
- Unfenced gully areas throughout the farmland areas with mature native trees which are typically in poor to moderate condition. This is contributed to by the heavy stock use and current grazing of these areas, as well as forest edge effects caused by exposure to unbuffered environmental conditions. Mature trees within these areas largely comprise pōhutukawa, tōtara, kauri, with occasional puriri, karaka (*Corynocarpus laevigatus*) kahikatea and kānuka (*Kunzea robusta*). In general terms, these areas are devoid of re-generating native vegetation, due to the propensity of stock to browse on any new seedings or growth within reach; and
- Fenced gully and ridgeline areas. These areas consist of a mixture of indigenous broadleaved and kauri forest along ridgeline areas, and wetlands within lower gullies. Most of the existing forested gullies and wetlands have been fenced off from stock over time. In some areas, fencing is more recent, as demonstrated by the presence of stock tracks throughout some gully networks and forest areas. Most of these areas are subject to an SEA overlay.

Activities that are undertaken as part of the existing farming operation and which we have included as the assumed baseline for current management of the Property are:

- Stock grazing within grassland, and in some places on the site where stock can enter wetlands, tributary streams and forest areas. Stock access to wetlands, forests and tributary streams can lead to suboptimal environmental outcomes;
- Wetlands and streams are in a relatively poor or degraded state due to farming activities on the Property;
- The application of fertilisers to improve and manage pastoral grassland; and

- The removal of trees that are not protected by the AUP.

The activities that form the existing environment are important to acknowledge as they form a basis against which potential adverse effects of the Project is assessed, including providing an understanding of net-changes between potential changes to land use from grazing to golf and the associated overall changes expected to environmental pressures and benefits to this Property.

3.3 Coastal Environment

The Coastal Environment consists of two main zones, the Coastal Marine Area (CMA), which is below Mean Highwater Spring (MHWS), and the Coastal Significance (or Terrestrial) Zone, which includes an active coastal interface and a landward component where coastal processes are dominant. The New Zealand Coastal Policy Statement 2010 (NZCPS), recognises that the Coastal Environment includes (Policy 1(2)):

(a) the CMA;

(b) islands within the CMA;

(c) areas where coastal processes, influences or qualities are significant, including coastal lakes, lagoons, tidal estuaries, saltmarshes, coastal wetlands, and the margins of these;

(d) areas at risk from coastal hazards;

(e) coastal vegetation and the habitat of indigenous coastal species including migratory birds;

(f) elements and features that contribute to the natural character, landscape, visual qualities or amenity values;

(g) items of cultural and historic heritage in the CMA or on the coast;

(h) inter-related coastal marine and terrestrial systems, including the intertidal zone; and

(i) physical resources and built facilities, including infrastructure, that have modified the Coastal Environment.

The only assessment criteria which may be relevant for this Property in relation to the NZCPS are (c) and (e). We have assessed Lake Ōkaihau against the definition of a 'coastal lake', the vegetation on the Property against 'coastal vegetation' and the habitats on Property against 'habitat of indigenous coastal species including migratory bird' with regards to coastal bird species and migratory birds. Only coastal bird species and migratory birds are applicable to the Property due to the landward proximity. Indigenous coastal lizards (e.g. shore skink *Oligosoma smithi*) and invertebrates would not be found on the Property (i.e. an inland terrestrial environment).

3.3.1 Assessment of NZCPS

The Property is ca. 1.7 km inland from Muriwai Beach and approximately 50 m above sea-level. There is a band of pine forest separating the Property from the Coastal Environment, which also extends north and south of the Property along the wider west coast (**Figure 6**).

Lake Ōkaihau is fed by surface water flows and groundwater seepages from the southeast catchment, which is surrounded by broadleaved / kauri forest (WF11). The underlying geology is ancient dunes comprising of the Awhitu Group (WWLA report at Appendix 10 to AEE). There is no tidal level movement and the lake is not maintained by recent coastal process. As such, we have assessed Lake Ōkaihau as not having significant coastal processes, influences or qualities. Therefore, Lake Ōkaihau does not meet NZCPS criterion (c).

In terms of coastal vegetation, the Auckland Council Potential Ecosystem Extent lists the western portion of the Property (around Lake Ōkaihau) as 'WF5' tōtara, kānuka broadleaved forest (Dune Forest), and the eastern portion of the Property as WF13, tawa kohekohe, rewarewa, hinau, podocarp forest.

WF5 is described as a mosaic of communities, with changes in composition reflecting the major environmental gradients of age since dune stabilisation, soil development and fertility, and the varied topographical patterns of dunes. WF13 is distributed within inland hill country and higher ground where kauri is absent.

While the potential ecosystem extent of the western portion of the Property is classified as 'WF5' Dune Forest, this classification system is broad and provides a coarse indication of potential ecosystems. There are inconsistencies between the delineation of the WF5 area on Property, and where remnant forest vegetation within SEA_T_5524 and SEA_T_5525 are classified as WF11. The current vegetation extent within the WF5 area on the Property consists of forest type WF11, pasture grass, pine forest, and weed land/ scrub dominated by tree lupin. These vegetation types are not coastal vegetation, and therefore do not meet the NZCPS coastal vegetation criterion (e).

We have defined 'coastal bird species' as those that are entirely or partially reliant on coastal habitats during all, or part of their life cycle. We have defined 'migratory birds' as species with a regular seasonal movement along a flyway between breeding and wintering grounds. An assessment with regard to coastal bird species is provided in **Table 2**. The applicable coastal bird species are based on our site records, and online records from iNaturalist and E-Bird (bird Atlas). Our assessment is that while some coastal bird species may utilise parts of the Property (e.g. shag species for feeding or roosting at freshwater systems such as Lake Ōkaihau or Ōkiritoto Stream) they are not entirely or partially reliant on these habitats during all, or part of their life cycles. Based on targeted, systematic surveys of the terrestrial vegetation surrounding Lake Ōkaihau and the Ōkiritoto Stream, six five-minute bird counts within these areas, and multiple site visits, it is evident that coastal bird species do not use these habitats for nesting, but rather are occasionally present for roosting or feeding. The applicable shag species are widespread in both coastal and freshwater habitats which includes lakes, rivers, ponds and streams, and it is expected that these species within the local area would utilise numerous other inland freshwater systems such as these. However, this does not necessarily qualify these inland, freshwater habitats as being part of the coastal environment. We therefore do not consider the Property to contain core or important coastal habitat that can be considered 'habitat of indigenous coastal species' and as such it does not meet the NZPCS criterion (e).

Seabirds were not specifically surveyed across the Property. However, the Property is within the area identified as the 'North Auckland Petrel Flyway' (Flyway) [3]. This includes a broad swathe of land from the North Shore of Auckland up to Mangawhai and across to both coasts, which is a north-south distance of around 80 km. The Flyway is the general land area over the North Auckland Peninsula over which Cooks petrel and perhaps also grey-faced petrel and black petrel, fly over at night to access feeding grounds in the Tasman Sea during the summer breeding season. While there are records of grey-faced petrel breeding at Muriwai, this species and other petrels, prions and shearwaters are unlikely to breed at the Property because either insufficient habitat exists, the habitat is not located on coastal margins, or the history of the Property as a farm with long-term introduced predator presence makes the presence of burrowing seabirds extremely unlikely. The Property is not the only location over which these seabirds fly, and is more likely to constitute a small part of the Flyway through these birds travel.

Overall, we have assessed the Property (and any part of it) as not meeting the NZCPS coastal environment criteria in Policy 1(2).

[3] Gaskin and Rayner.2017. Seabirds of the Hauraki Gulf: Natural History, research and conservation. Report prepared for the Hauraki Gulf Forum.

Table 2. Coastal birds recorded within the local area and an assessment against habitats on the Property.

Scientific name	Common name	Threat Status (Robertson *et al.,* 2016)	Distribution/ habitat	Relevant records (E-Bird, iNaturalist)	Likelihood of utilising the Property	Applicable habitat on the Property	Entirely or partially reliant on Property habitats
Larus dominicanus	Southern black-backed gull	Native – Not threatened	Common in estuaries and harbours, rocky and sandy shores and riverbeds; occurs more sparsely inland over farmland, and even subalpine tussockland and herbfields, as well as human constructed areas such as landfills and sewerage ponds.	Muriwai Beach, 2.2 km west of the Property.	Confirmed	Pasture areas for feeding.	No. The Property provides feeding and roosting habitat for this species, but the species is not entirely or partially reliant on the habitat within the site.
Phalacrocorax carbo	Black shag	Native- At risk – Naturally uncommon	Black shags are found in a variety of habitats, including coastal waters, estuaries, harbours, rivers, streams, lakes and ponds, including up to the subalpine zone.	Bethells Beach, 9 km south of the Property.	Confirmed – one recorded within eucalyptus trees at Lake Ōkaihau margin for roosting.	Mature pōhutukawa and eucalyptus trees at Lake Ōkaihau margin. No nesting observed in these areas.	No. The Property provides feeding and roosting habitat for this species, but the species is not entirely or partially reliant on the habitat within the Property.
Phalacrocorax melanoleucos	Little shag	Native – Not threatened	Little shags are widespread in both coastal and freshwater habitats that include lakes, rivers, ponds and streams.	West coast south of Muriwai Beach, 3.5 km southwest of the Property.	Confirmed – Lake Ōkaihau for roosting.	Mature pōhutukawa and eucalyptus trees at Lake Ōkaihau margin. No nesting observed in these areas.	No. The Property provides feeding and roosting habitat for this species, but the species is not entirely or partially reliant on the

Scientific name	Common name	Threat Status (Robertson *et al.,* 2016)	Distribution/ habitat	Relevant records (E-Bird, iNaturalist)	Likelihood of utilising the Property	Applicable habitat on the Property	Entirely or partially reliant on Property habitats
							habitat within the Property.
Phalacrocorax sulcirostris	Little black shag	Native- At risk – Naturally uncommon	Little black shags occur mostly on harbours and lakes, but also occur on braided rivers, and muddy edges of inland and coastal inlets, lakes and ponds, including sewerage ponds.	Piha Beach, 15 km south of the Property.	High – Lake Ōkaihau for roosting.	Mature pōhutukawa and eucalyptus trees at Lake Ōkaihau margin. No nesting observed in these areas.	No. The Property provides feeding and roosting habitat for this species, but the species is not entirely or partially reliant on the habitat within the Property.
Phalacrocorax varius	Pied shag	Native- At risk – Recovering	Pied shags mainly forage in coastal marine waters, harbours and estuaries, but occasionally also in freshwater lakes and ponds close to the coast.	West coast south of Muriwai Beach, 3.2 km southwest of the Property.	Moderate – Lake Ōkaihau for feeding.	Mature pōhutukawa and eucalyptus trees at Lake Ōkaihau margin. No nesting observed in these areas.	No. The Property provides feeding and roosting habitat for this species, but the species is not entirely or partially reliant on the habitat within the Property.

Figure 6. The Property (red boundary) and proposed course layout (purple area) relative to the Muriwai Beach coastal environment.

3.4 Lake Ōkaihau

Lake Ōkaihau is classified as SEA_T_5527 and is a dune lake (historically formed) situated on the western portion of the Property. The lake is 6.2 ha and approximately 10 m deep at its deepest point towards the centre.

The conceptual hydrological functioning of Lake Ōkaihau was tested through the development of the Lake Ōkaihau Water Balance Model (WWLA report at Appendix 10F to AEE). Through the water balance assessment, the hydrological functioning is understood as follows:

- The lake bed consists of low permeability material that is thicker on the bottom, and pinches (i.e. thins) towards the margins of the lake;
- This results in low groundwater seepage loss from the lake during periods of low lake water levels (summer), and higher rates of seepage during periods of elevated water levels (winter);
- The largest inflow to the lake is from the stream catchment from the south; and
- The largest net loss from the lake is through groundwater seepage via the sand dunes to the north, towards the Ōkiritoto Stream.

Key hydrological components are presented in **Figure 7** below. In addition, direct rainfall additions, and evaporation losses occur directly from the lake surface.

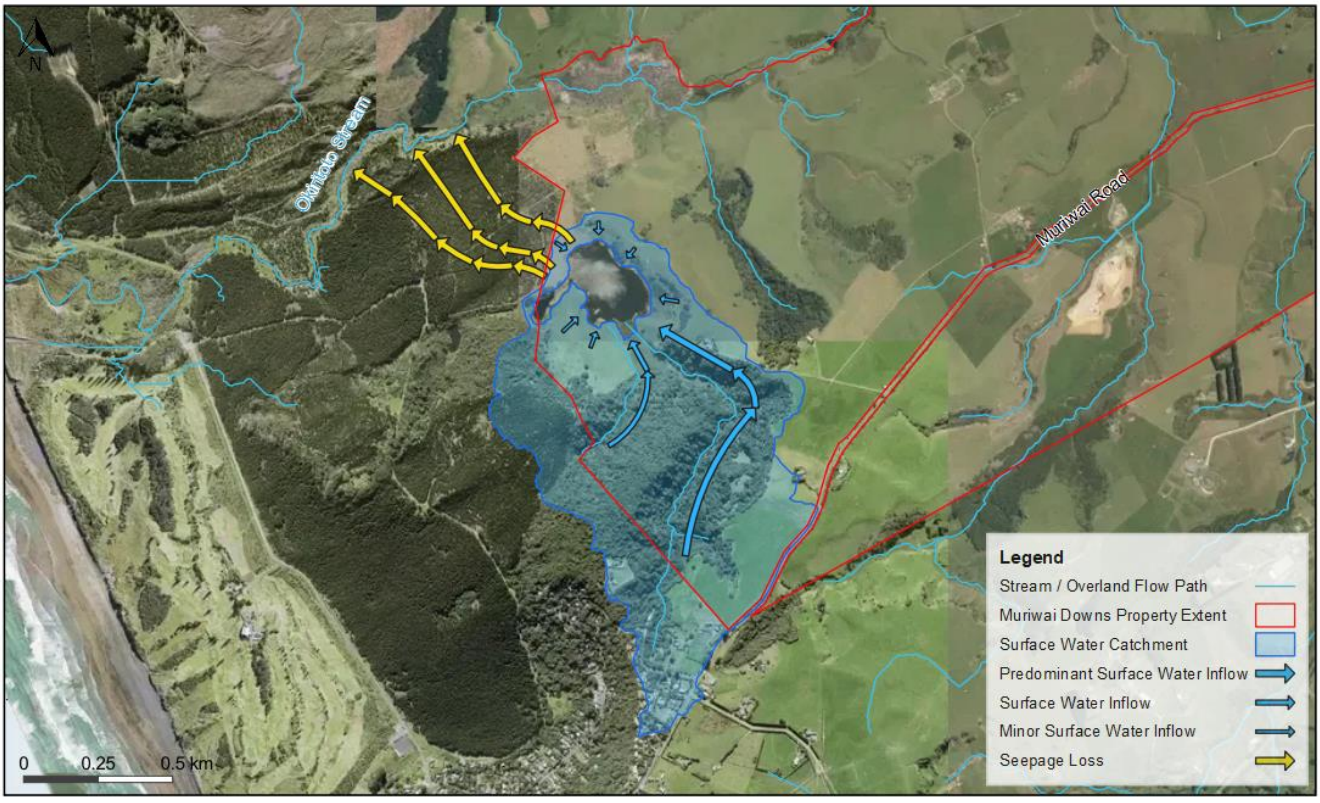

Figure 7. Conceptual hydrological functioning of Lake Ōkaihau. Sourced from WWLA report at Appendix 10 to AEE.

Lake Ōkaihau has been assessed by Auckland Council in 2012 and 2017 as having a poor ecological condition based on LakeSPI (Lake Submerged Plant Indicators) (Auckland Council technical report, TR2017/028).

Lake Ōkaihau has the following degrading factors:

- 60 % coverage of exotic submerged macrophytes (aquatic plants), and the emergent pest plant Mexican water lily (*Nymphaea mexicana*);
- Presence of the exotic pest fish rudd (*Scardinius erythrophthalmus*) which feeds on native macrophytes and creates turbid conditions by stirring up bottom sediments and muddying the water;
- Loss of riparian vegetation and the associated shading of riparian margins; and
- Poor water quality and possible eutrophication from surrounding stock access and farming practices.

While of poor ecological condition, Lake Ōkaihau provides habitat for several native freshwater fish (e.g. shortfin eel *Anguilla australis*), as well as functioning as a landscape 'stepping stone' providing food resources for waterfowl, shags and wading birds. A large marsh clubrush (*Bolboschoenus fluviatilis*) dominant wetland (referred to in this report as Wetland W14, see section 3.5 and **Figure 8** below) at the southern margin of the lake and forms a natural ecotone transition of high ecological value, and provides an opportunity for restoration. In general, the southern portion of the lake is less modified and has patches of regenerating mānuka, raupo and jointed *Baumea* reedland.

Overall, Lake Ōkaihau has been assessed as a significant ecological feature which currently has poor ecological condition, and margins where land management could be changed to benefit lake quality. Photos of Lake Ōkaihau are provided in **Plate 1** to **Plate 3** below.

Plate 1. The northern branch of Lake Ōkaihau, photograph taken facing west.

Plate 2. Lake Ōkaihau within the rural landscape, photograph taken facing north.

Plate 3. Native reedland on the southern margin of Lake Ōkaihau.

3.5 Wetlands

There are 21 wetlands on the Property that meet the NPS-FW definition of 'Natural Inland Wetland'. The wetlands are listed in **Table 3** and shown on **Figure 8** and **Figure 9**. These total approximately 37 ha. These areas have underlying characteristics, including permanently or intermittently wet soils, that support a natural ecosystem of plants that are adapted to wet conditions (i.e. they are wetlands) and are not dominated by (> 50 %) improved pasture grass (i.e. they do not qualify under the NPS-FM exclusion criteria).

The majority of wetlands on the Property have been degraded through historic agricultural activities, resulting in significant modification to the soils and plant communities (**Plate 4**). They are now dominated by exotic herbs and weed species (e.g. the exotic invasive reed sweet grass *Glyceria maxima*).

The largest wetland on the Property extends from the base of the Toroānui Falls along the northern boundary of the Property, occupying ca. 12.1 ha (W7, **Plate 5**). This wetland has been degraded by weed species such as pampas (*Cortaderia selloana*) and reed sweet grass. However, despite its degraded state there are still extensive beds of raupo (*Typha orientalis*) and stands of ti kouka (*Cordyline australis*) and the wetland could provide core or important habitat for native fish and native wetland birds. Willow control several years ago is apparent with many dead standing trees and stumps.

In addition to wetland W7, wetland W6 has a large area of raupo / flaxland with scattered ti kouka which could also provide important habitat for native avifauna such as North Island fernbird (*Bowdleria punctata vealeae*) (**Plate 6**).

The wetlands all have a history of being drained. Review of historic aerial photographs show clear signs of drainage works including channelisation and excavation in 1940, fresh drainage works around 1963, and again around 1984.

There are four wetland types on the Property (WWLA report at Appendix 10 to AEE):

- Wetland Type 1 - Palustrine – This includes wetland W7 forming a large reed sweet-grass dominant wetland along the margins of the Ōkiritoto Stream (**Plate 4**);
- Wetland Type 2 - Dune Lake – Lake Ōkaihau is a dune lake (historically formed) (see Section 3.4);
- Wetland Type 3 - Valley floor – these wetlands are maintained by stream flows (riparian margins); and
- Wetland Type 4 - Valley wall seepage – these wetlands are maintained by shallow groundwater flows and infiltration from the upper catchment. Typically found at the head of catchments or valley sides.

Overall ecological condition of the wetlands on the Property are summarised in **Table 3** below**.** An explanation of the categorisation of the wetlands overall ecological condition is provided in footnote 1.

Table 3. Details of wetlands at the Muriwai Downs Property.

Label	Size (m^2)	Wetland Type	Overall ecological condition[1]
W1	27,022	Type 3, Type 4	2- Poor
W2	4,245	Type 3	1 - Very poor
W3	4,381	Type 3	1 - Very poor
W4	5,191	Type3	1 - Very poor
W5	2,556	Type 3	1 - Very poor
W6	4,831	Type 4	3 - Moderate
W7	121,666	Type 1, Type 3	3 - Moderate
W8	3,038	Type 3	1 - Very poor
W9	11,942	Type 3	2- Poor
W10	580	Type 3	1 - Very poor
W11	873	Type 4	1 - Very poor
W12	1,044	Type 4	1 - Very poor
W13	207	Type 4	1 - Very poor
W14	83,630	Lake, Type 2	3 - Moderate

Label	Size (m^2)	Wetland Type	Overall ecological condition[1]
W15	19,358	N/A	1 - Very poor
W16	48,223	N/A	2- Poor
W17	3002	N/A	1 - Very poor
W18	25,898	N/A	3 - Moderate
W19	556	N/A	1 - Very poor
W20	2,458	N/A	2- Poor
W21	35	N/A	1 - Very poor

1Ecological condition based on parameters included in Handbook for Monitoring Wetland Condition (Landcare 2004).

Dominance of native plants parameters assessed as: monoculture of low weeds (1-very poor), few rushes (native or exotic) and monoculture of low weeds (2-poor), predominantly native species, several woody plant species either native or exotic (3-moderate), many reeds and or woody plants (mānuka); mixed exotic/ native/ successional species (4-good); highly diverse range of native plant species forming a mature or maturing wetland with intact canopy, understory and/ or ground tiers (5-very good).

Hydrological integrity parameters assessed as: Severe impact of manmade structures, significant alteration of water table depth, extensive dryland plant invasion (1-very poor); High impact of manmade structures, significant alteration of water table depth, moderate dryland plant invasion (2-poor); Low impact of manmade structures, little or seasonal alteration of water table depth, some dryland plant invasion (3-moderate); Negligible impact of manmade structures, negligible alteration of water table depth, some dryland plant invasion (4-good); Negligible impact of manmade structures, negligible alteration of water table depth, negligible dryland plant invasion (5-very good).

Physio-chemical parameters assessed as Severe fire damage, high levels of sedimentation or erosion, significant increase of nutrient levels, poor water quality, or degradation of natural hydric soils (1- very poor); Some fire damage, moderate levels of sedimentation or erosion, notable increase of nutrient levels, poor water quality, or some degradation natural hydric soils (2- poor); No fire damage, some sedimentation or erosion, little increase of nutrient levels, moderate water quality, some degradation of natural hydric soils (3- moderate); No fire damage, little sedimentation or erosion, no increase of nutrient levels, good water quality, or some degradation of natural hydric soils (4-good); No fire damage, no sedimentation or erosion, no increase of nutrient levels, good water quality, and no degradation of natural hydric soils (5-very good).

Browsing and predation parameters assessed as: Very high impacts of predators on wildlife, severe damage by domestic stock or feral animals (1-very poor); High impacts of predators on wildlife, moderate damage by domestic stock or feral animals (2-very poor); Moderate impacts of predators on wildlife, low damage by domestic stock or feral animals (3-moderate); Low impacts of predators on wildlife, low damage by domestic stock or feral animals (4-good); Negligible impacts of predators on wildlife, Negligible damage by domestic stock or feral animals (5-very good).

Overall condition assessed as a combination of the four key characteristics with scores all or predominately of 'poor' returning an overall poor (score 2) condition or very poor (score 1), scores predominantly or mostly of 'moderate' returning an overall moderate condition (score 3), and scores all or predominately of 'good' returning an overall good condition (score 4), scores predominantly or mostly of 'very good' (score 5) .

Plate 4. Wetland W9, an example of a wetland in 'poor' ecological condition.

Plate 5. Wetland W7, a large contiguous wetland dominated by reed sweet grass, along the northern boundary of the Property.

Plate 6. Wetland W6, dense raupo and harakeke provides excellent habitat for North Island fernbird.

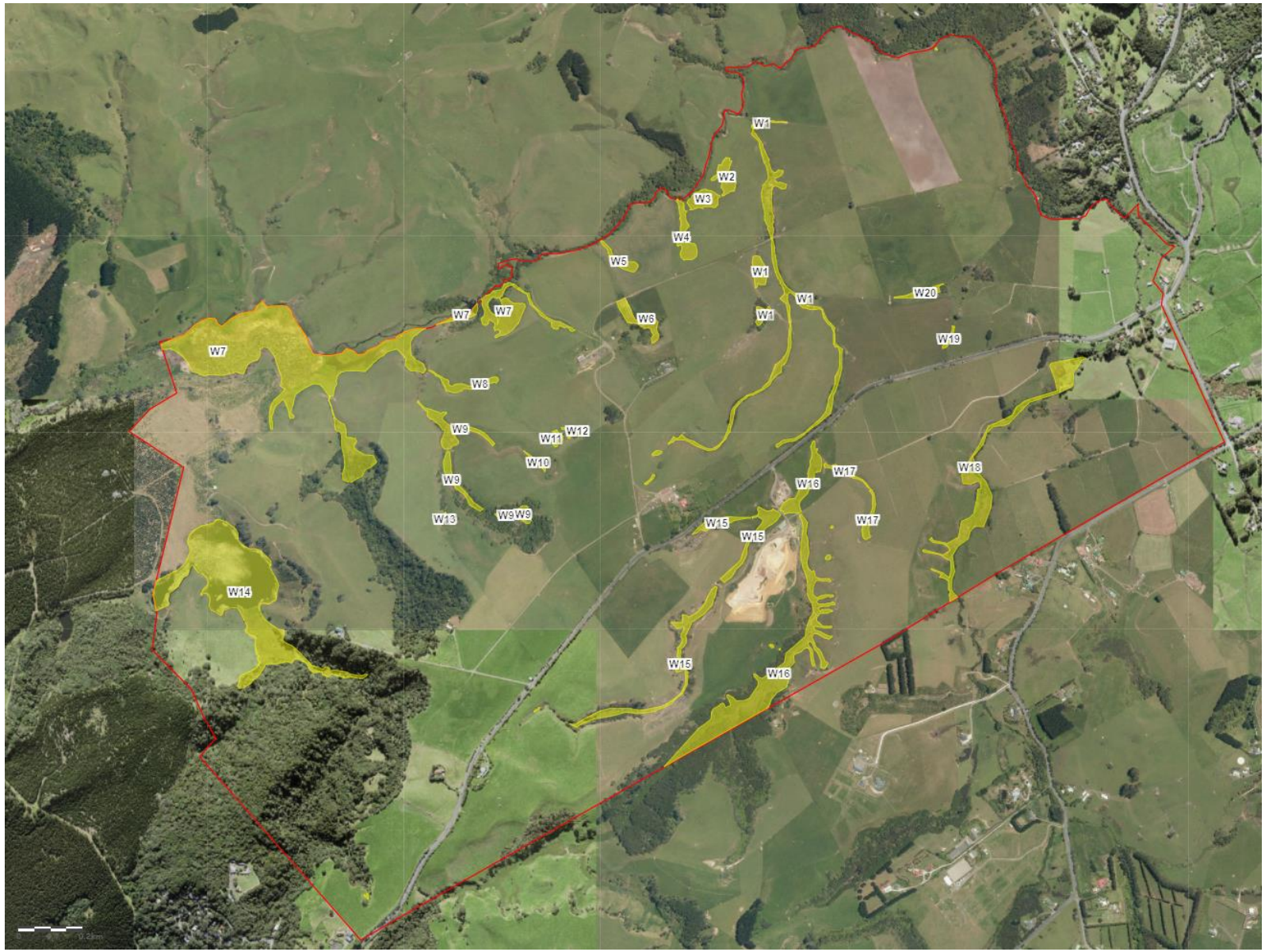

Figure 7. Wetlands on the Property (yellow area including Lake Ōkaihau).

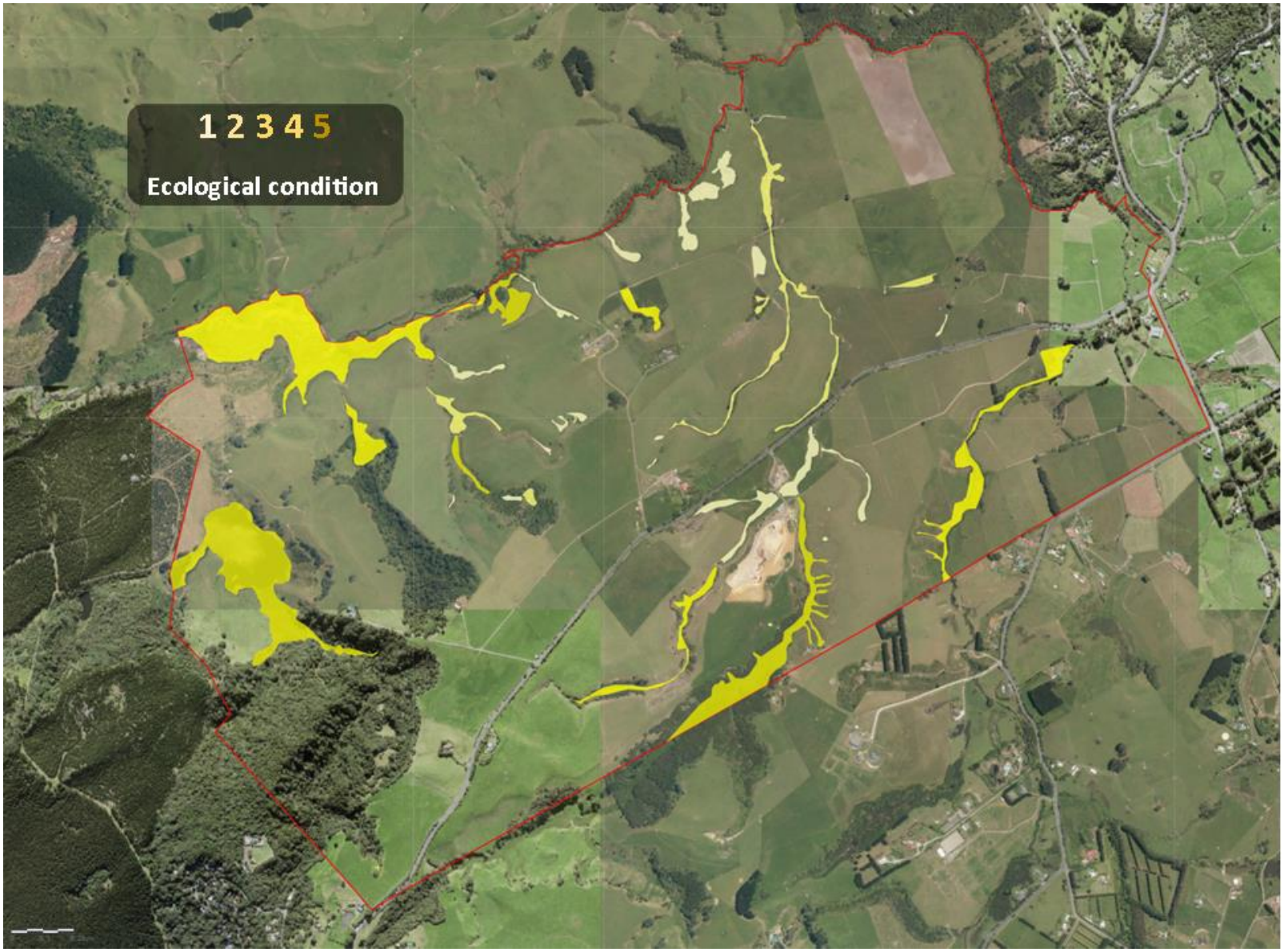

Figure 8. Wetlands on the Property assessed on ecological condition from 1-Very poor, 2- Poor, 3- Moderate, 4-Good, 5- Very good. See Section 3.5 above for discussion.

3.6 Streams

There are 22 streams within the Property, including nine (9) permanent streams (P) and thirteen (13) intermittent streams (I). These are shown in **Table 4** and **Figure 10**. Permanent streams within the Property total 8,998 m (9 km) and intermittent streams total 4,134 m (4.1 km).

The main streams on the Property are the Ōkiritoto Stream and Raurataua Stream, which run along the north eastern boundary (**Plate 7**), flowing west to southwest over Toroānui Falls (**Plate 8**) before discharging at Muriwai Beach. The Ōkiritoto Stream is downstream of the Toroānui Falls and the Raurataua Stream, a tributary of the Ōkiritoto Stream, is upstream of Toroānui Falls. The Ōkiritoto Stream within the Property is largely bounded by wetland dominated by the exotic invasive wetland plant, reed sweet-grass (*Glyceria maxima*), with little woody riparian cover, and consists of a slow-flowing, low-gradient, soft-bottomed stream which predominantly has a run morphology. The Raurataua Stream is well shaded by seral (young) native forest along the true right bank, providing excellent stream habitat for native fish. Upstream of the Toroānui Falls, the stream consists of a sluggish, hard-bottomed stream with predominantly run, pool, riffle habitats. During the site survey in June 2021 the average wetted width in this reach was approximately 3-5 m with a central channel depth of varying from roughly 0.3 m to 1.5 m (in deep pools).

Overall, the streams on the Property within pastoral areas are highly modified and degraded from the surrounding rural land use, with distinct commonalities including poor riparian cover, degraded stream beds with high sediment loading, channelised reaches, and a limited range of habitats for freshwater fauna (**Plate 9**). In contrast, streams within vegetated gullies are well shaded, hard bottomed and, overall, exhibit good ecological condition.

Of the 22 permanent and intermittent streams surveyed, eight (8) were assessed as having either good or very good condition, seven (7) were assessed of having moderate condition, and nine (9) were assessed as having either poor or very poor ecological condition.

Table 4. Overall ecological condition of streams present on the Property.

Label	Length	Overall ecological condition[1]
I1	896 m	2 – Poor
I2	137 m	1 – Very poor
I3	76 m	1 – Very poor
I4	717 m	1 – Very poor
I5	251 m	1 – Very poor
I6	752 m	1 – Very poor
I7	60 m	2 – Poor
I8	214 m	5 – Very good
I9	206 m	3 – Moderate
I10	303 m	5 – Very good

Label	Length	Overall ecological condition[1]
I11	472 m	5 – Very good
I12	144 m	1 – Very poor
I13	129 m	2 – Poor
Ōkiritoto/ Raurataua Stream	4,919 m	5 – Very good
P1	88 m	2 – Poor
P2	1,162 m	2 – Poor
P3	190 m	1 – Very poor
P4	691 m	4 – Good
P5	703 m	5 – Very good
P6	481 m	3 - Moderate
P7	567 m	3 - Moderate
P8	198 m	3 - Moderate

[1] Ecological condition based on based on the semiquantitative scoring system laid out below.

1 Riparian diversity assessed as: no vegetation (very poor), pasture or grass or monoculture of low weeds (poor), several woody plant species either native or exotic (moderate), many woody plant species; mixed exotic/ native/ successional species (good); highly diverse range of native plant species forming a mature or maturing canopy with understorey and ground tiers (very good).

2 Channel shade assessed as: fully open; lack of canopy cover (very poor); <20 % water surface shaded (poor); 20 – 60 % water surface shaded; mostly open with shaded patches (moderate); 60 – 80 % water surface shaded; mostly shaded with some open patches (good); > 80 % water surface shaded; full canopy (very good).

3 In stream habitat assessed as: favourable habitats (woody debris, rooted aquatic vegetation, leaf packs, undercut banks, root mats, stable habitat) limited and coverage <10 % channel (very poor); favourable habitat diversity limited to 1-2 types; woody debris rare, coverage 10 – 30 % of channel (poor); moderate variety of habitat types (3-4 types) covering 30 – 50 % channel (moderate); most habitat types present, covering 50 – 75 % channel (good); all habitat types present covering >75 % of channel (very good).

4 Bed characteristics assessed as: Very high loading of un-natural silt and uniform hydrologic conditions (very poor); un-natural siltation with limited variety of hydrological conditions (poor); mostly natural bed substrates with moderate variety of hydrologic conditions (moderate); natural bed substrates with a good variety of pools, runs, riffles (good); natural bed substrates with the full range of hydrologic conditions present (deep and shallow pools, chutes, runs, riffles) (very good).

5 Overall condition assessed as a combination of the four key characteristics with scores all or predominately of 'poor' returning an overall poor condition or very poor, scores predominantly or mostly of 'moderate' returning an overall moderate condition, and scores all or predominately of 'good' returning an overall good condition.

Additional stream assessment data is provided in **Appendix B**.

Plate 7. The Raurataua Stream upstream of Toroānui Falls. This reach of stream has little modification, high shading and bank filtering, stable banks, and excellent habitat for native fish. The ecological condition is rated as 5 = very good.

Plate 8. Toroānui Falls.

Plate 9. Stream P3, an example of stream that has been highly modified and has an ecological condition rated as 1= Very poor.

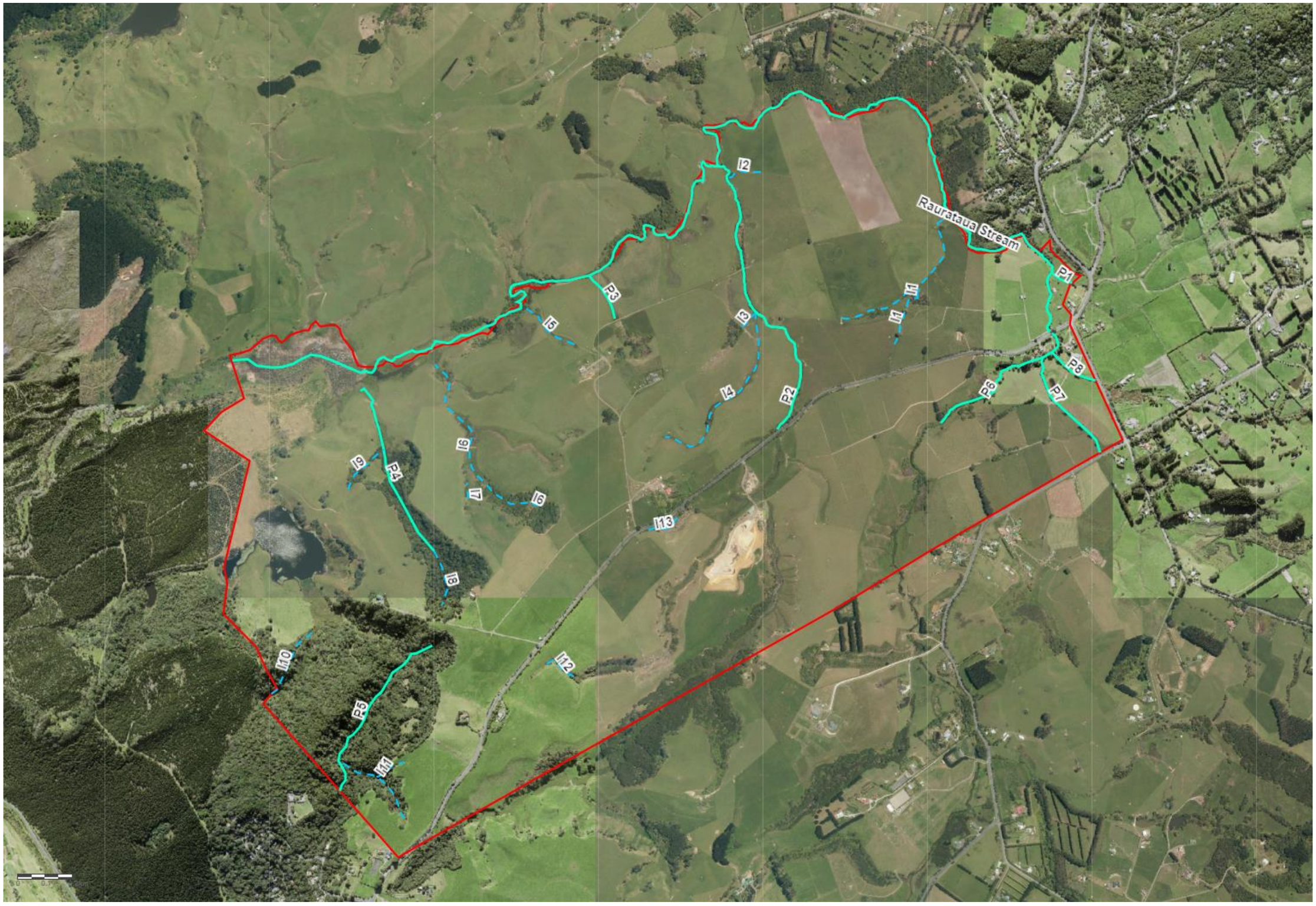

Figure 9. Streams on the Property. Permanent stream (solid blue line), intermittent stream (dashed blue line), Property boundary (red line).

3.6.1 Stream Ecological Valuation

A total of four Stream Ecological Valuations (SEV(s)) were undertaken on the Property at streams that are impacted by the Project (Streams P3 and I9), or which are proposed to be restored. See **Figures 11** to **13** for diagrams of relevant streams:

- Stream P3 – 160 m is proposed to be piped, with 15 m of riprap at the outlet, a total of 175 m;
- Stream I9 – 16 m is proposed to be infilled;
- Stream P2 – 326 m is proposed to be restored via planting riparian margins; and
- Stream I2 – 15 m is proposed to be restored via planting riparian margins and an additional 16 m is proposed to be restored via 'daylighting', a total of 31 m.

For Streams P3 and I9 representative SEVs were undertaken from the most downstream extent within the proposed development footprint. For restoration Stream P2, a representative SEV was undertaken from the confluence with Stream I2. For restoration Stream I2 a representative SEV was undertaken from the confluence with Stream P2.

Figure 10. The reach of Stream P3 (blue line) within the proposed earthworks extent (purple lines)

Figure 11. The reach of Stream I9 (blue dashed line) within the proposed earthworks extent (purple lines)

Figure 12. Stream P2 (blue line) and Stream 12 (blue dashed line) proposed for restoration.

SEV is a method for quantifying the values of streams based on the performance of their key ecological functions (see **Table 5** below for a summary).

A range of qualitative and quantitative variables are used to assess the main ecological functions of streams, including in-stream and riparian aspects. Field work typically includes obtaining aquatic macroinvertebrate samples, fish surveys (or review of existing records of fish presence), cross-sectional

measurements of the stream to record depth, velocity and substrate, and a reach scale qualitative visual assessment to record various parameters.

The data is analysed using a series of algorithms to produce a score of between 0 (a stream with no ecological value) and 1 (a pristine stream with maximum ecological value). A score below 0.40 indicates poor ecological function and health and a score above 0.80 indicates excellent ecological function and health (summarised in **Table 6**). For this assessment, macroinvertebrate samples and fish surveys were not undertaken, as these Biodiversity Provision Functions are not used for the SEV model when calculating overall SEV scores for ecological compensation ratios (ECR).

It is advised in the relevant technical publications (Neale *et al.* 2016 and Storey *et al.* 2011) not to undertake an SEV within about three weeks of a major flood (typically defined as a stream flow greater than three times the median flow). Site visits were undertaken during periods of minimal rainfall and site observations indicated a typical spring baseflow during the month of November 2021.

The specific methodology applied for the SEV is detailed in the Auckland Council technical report 2016/023 for intermittent streams (Neale *et al.* 2016) and for permanent streams (Storey *et al.* 2011).

Table 5. The 14 ecological functions used to calculate the SEV score.

Hydraulic Functions	Biogeochemical Functions	Habitat Provision Functions	Biodiversity Provision Functions
• Natural flow regime	• Water temperature control	• Fish spawning habitat	• Fish fauna intact
• Floodplain effectiveness	• Dissolved oxygen levels maintained	• Habitat for aquatic fauna	• Invertebrate fauna intact
• Connectivity for species migrations	• Organic matter input		• Riparian vegetation intact
• Natural connectivity to groundwater	• In-stream particle retention		
	• Decontamination of pollutants		

Table 6. Range of categories for SEV scores relating to overall indicative stream health.

Score	Category
0 – 0.40	Poor
0.41 – 0.60	Moderate
0.61 – 0.80	Good
0.81 – 1.0	Excellent

For this site we have used the SEV method to derive environmental compensation ratios (ECR) based on the functions that will be lost at the impact site and the potential improvements to be gained at an environmental compensation site. This provides a scientific basis for determining an environmental compensation ratio scaled to the streams where the development and environmental compensation is intended. The rationale for the formula selected is that it compares the loss of functions at the impact site relative to the functions gained at an environmental compensation site. However, the functions lost at the impact site include not only those that are actually degraded as a consequence of the development, but also the potential for improvement in these functions that is forgone by development of the site. Failure to take this component into account is likely to result in a steady decline of stream values on a regional scale. Our application of this method follows accepted practice.

For this Property, the potential state (SEVi-P) assumes native shrub and tree planting along 10 m wide riparian margins and exclusion of stock. This assumption follows a standard potential state advocated by Auckland Councils as part of land use development within the region.

The current state SEV function scores (SEVi-C) for Stream P3 and Stream I9 are 0.279 and 0.469, respectively, and potential state SEV function score (SEVi-P) are 0.405 and 0.475, respectively. The SEV current state scores for Streams P3 and I9 indicate that the biodiversity values are very low and that most ecological functions are severely impaired. This is especially so for Stream P3 where the scores approximate the function scores associated with some culverted streams elsewhere in Auckland. The low overall SEV score is not surprising given that this stream has been excavated out at least three times in the last few decades (based on our review of historic aerial imagery) and has been effectively treated as a farm drain to convey water.

Following the standard SEV method the potential future state and improvements to streams proposed for restoration (SEVm-P), including identification of an appropriate baseline state against which to calculate gains that are additional and able to be claimed by the developer, assumes stock removal, planting 20 m wide riparian margins, weed control, fencing, and protection in perpetuity. In addition, Stream I2 assumes daylighting of an upper infilled reach of the stream, and recontouring banks of the lower reach.

The current state SEV function score for restoration streams (SEVm-C) for Stream P2 and Stream I2 are 0.570 and 0.324, respectively, and predicted state SEV function score for restoration streams (SEVm-P) are 0.783 and 0.876, respectively.

The SEVi-P score is used for calculating the SEV:ECR summarised in **Table 7** and **Table 8** and are presented in full in **Appendix C.**

Table 7. SEV function scores for impact streams.

Function	Stream P3 SEVi-C	Stream P3 SEVi-P	Stream I9 SEVi-C	Stream I9 SEVi-P
Hydraulic mean score	0.49	0.49	0.61	0.61
Biogeochemical mean score	0.19	0.41	0.50	0.50
Habitat provision mean score	0.19	0.24	0.33	0.33
Biodiversity mean score	N/A	N/A	N/A	N/A
Overall mean SEV score	**0.279**	**0.405**	**0.469**	**0.475**

Table 8. SEV function scores for restoration streams.

Function	Stream P2 SEVm-C	Stream P2 SEVm-P	Stream I2 SEVm-C	Stream I2 SEVm-P
Hydraulic mean score	0.73	0.85	0.61	1.00
Biogeochemical mean score	0.50	0.83	0.21	0.87
Habitat provision mean score	0.60	0.69	0.19	0.67
Biodiversity mean score	N/A	N/A	N/A	N/A

Overall mean SEV score	**0.570**	**0.783**	**0.324**	**0.876**

3.7 Freshwater Fish

The New Zealand Freshwater Fish Database (NZFFD) contains records of six (6) species of fish from the catchment (including one exotic species), of which four are listed as 'At Risk' in the latest threat classification (Dunn *et al.,* 2018[4]) (**Table 9**).

In addition to the NZFFD, other fish species within the Ōkiritoto Stream catchment include the 'Not Threatened' banded kōkopu (*Galaxias fasciatus*), as well as the exotic pest fish Koi carp (*Cyprinus carpio*) observed in the Toroānui Falls plunge pool. Other exotic pest fish include rudd which has previously been recorded in Lake Ōkaihau and mosquito fish (*Gambusia affinis*) which are abundant in sluggish water.

Most native species recorded in the catchment are diadromous (spend portions of their life cycles partially in fresh water and partially in salt water). However, it is possible that Toroānui Falls prevents some downward migration resulting in resident longfin eels to grow to large sizes as they are trapped in the stream section behind the falls.

To understand the species of fish that may inhabit the reach of Raurataua Stream upstream of Toroānui Falls, a fish survey was undertaken over two days in July 2021. The survey consisted of setting two baited fyke nets in pool and riffle habitats upstream of Toroānui Falls. Over two days a total of four 'At Risk' longfin eel, the largest of which was over 1 m long, and three banded kōkopu including a female with eggs (**Plate 10**), were caught. The results of the survey indicate that the Raurataua Stream above the Toroānui Falls is healthy and supports native fish classified as 'At Risk'.

Table 9. Fish species recorded from the Ōkiritoto Stream catchment in the NZFFD, as of July 2021.

Scientific Name	Common Name	Threat Status (Dunn *et al.,* 2018)
Anguilla australis	Shortfin eel	Native - Not threatened
Anguilla dieffenbachii	Longfin eel	Native – At Risk declining
Galaxias maculatus	Inanga	Native – At Risk declining
Gobiomorphus cotidianus	Common bully	Native - Not threatened
Gobiomorphus huttoni	Redfin bully	Native - Not threatened
Retropinna retropinna	Common smelt	Native - Not threatened
Gambusia affinis	Mosquito fish	Exotic – pest fish

Plate 10. A gravid (egg carrying) banded kōkopu caught in the Rarautaua Stream in July 2021

4.0 Terrestrial Ecology

4.1 Vegetation

The Property is situated within the Rodney Ecological District which lies within the Auckland Ecological Region.

The Property occupies approximately 507 ha, the majority of which has been cleared of native forest and has been farmed for many decades.

In total, 114 species of plants were recorded (excluding exotic grasses and herbs). A plant species list is attached in **Appendix D**. In general, terrestrial vegetation on the Property includes large areas of native forest within gullies and next to streams, mature native trees within pasture grassland (**Plate 13**), exotic shelter belts, amenity plantings around dwellings, and an area of tree lupin (*Lupinus arboreus*) scrub in the north western corner of the Property. Currently, weed infestations are restricted to discrete patches, and predominantly include tree lupin, gorse (*Ulex europaeus*) and woolly nightshade (*Solanum mauritianum*).

Eighty (80) native species recorded on the Property are listed as 'Not Threatened', and five (5) species are listed as either 'At Risk' or 'Threatened' in the most recent threat classification list (de Lange *et al.* 2018). This includes several small stands of 'At Risk -Declining' mānuka (*Leptospermum scoparium* var. *scoparium*), large areas of 'Threatened – Nationally Vulnerable' kauri (*Agathis australis*) within SEAs and individual trees within open pasture, several stands of 'Threatened – Nationally Vulnerable' pōhutukawa (*Metrosideros excelsa*) and 'Threatened – Nationally Vulnerable' young kānuka (*Kunzea robusta*), as well as white rātā 'Threatened – Nationally Vulnerable' (*Metrosideros perforata)*.

Kauri, kānuka, mānuka, pōhutukawa and white rātāwere recently added to the Department of Conservation (DOC) Threat Classification Lists (as Threatened - Nationally Vulnerable; 2018) in response to the threat of kauri dieback (*Phytophthora agathidicida*) and myrtle rust (*Austropuccinia psidii*) disease on kānuka, mānuka, pōhutukawa, rātā and other related species – rather than being a reflection of their relative rarity in the environments (these are common and widespread native plants locally and across the region).

Of the 114 species of plant recorded, 20 species were environmental pest plants (ecological weeds), 14 of which are listed in the Regional Pest Management Plan (2020-2030) as 'Sustained Control – Whole Region'. All these species have the potential for economic and/or environmental impacts, and for all of these species there is value in removing these infestations in order to reduce the risk of further spread within and outside of the Property.

There are eight areas on the Property that meet the criteria in the AUP as SEAs, covering approximately 77.3 ha of the Property. Detailed botanical surveys were undertaken in areas where proposed infrastructure may be within or close proximity to, or span ecological areas (e.g. the proposed bridge across SEA T 5525). The native forest remnants comprise a diverse, multi-tiered assemblage of coastal kauri-broadleaved forest (e.g. **Plate 11** and **Plate 12**). These areas largely transition from the WF11 to the WF13 (Singers 2017) vegetation types. Prominent canopy trees within these forests include pōhutukawa, tōtara (*Podocarpus tōtara*), kauri, puriri, karaka (*Corynocarpus laevigatus*), kahikatea, taraire (*Beilschmiedia taraire*), kohekohe (*Didymocheton spectabilis*), tawa, and rewarewa (*Knightia excelsa*).

Our assessment checked the boundaries of the various vegetation units on the Property against the SEA criteria. Delineation of SEAs listed in the AUP is, for the most part, accurate. There were several areas where over or underestimation of the SEA layer in the AUP was apparent.

These were:

- SEA T 5525, where part of the lower section of the listed SEA includes a substantial area of rank exotic kikuyu grassland. A nearby kikuyu patch surrounded by native forest has been excluded from the SEA mapped layer, in which case this additional kikuyu patch should also be excluded;
- SEA T 5525, where the extent of the existing qualifying native shrubland or forest has been under-estimated by the existing SEA layer, and the SEA line should be moved to encompass these areas. These areas are shown as blue polygons on **Figure 10**; and
- A 30 ha block of mature kauri forest that meets all five AUP SEA criteria (labelled SEA in the AUP layer not numbered).

A summary of SEAs is provided in **Table 10** and are shown on **Figure 14**.

Table 10. Summary of SEAs within the Muriwai Downs Golf Course Property.

Label	Area	Ecological feature	SEA criteria met
SEA (not numbered)	29,413 m^2	Native forest	1, 2
SEA T 2763	3,914 m^2	Forest riparian margin and wetland	1, 2
SEA T 5524	358,334 m^2	Native forest	1, 2, 3, 4, 5
SEA T 5525	107,637 m^2	Native forest	1, 2, 3
SEA T 5527	81,972 m^2	Lake Ōkaihau	2, 4
SEA T 5482	61,583 m^2	Native forest	3, 4
SEA T 6575	124,335 m^2	Wetland	1, 2, 3, 4
SEA T 6730	6,233 m^2	Native forest	1, 2
Total	**77.3 ha**		

Plate 11. The canopy of mature native forest in SEA T 5525 (at the proposed hole 1 crossing).

Plate 12. An example of the diverse, multi-tier indigenous forest in SEA T 5525.

Plate 13. A windswept mature tōtara tree within pastoral grass land.

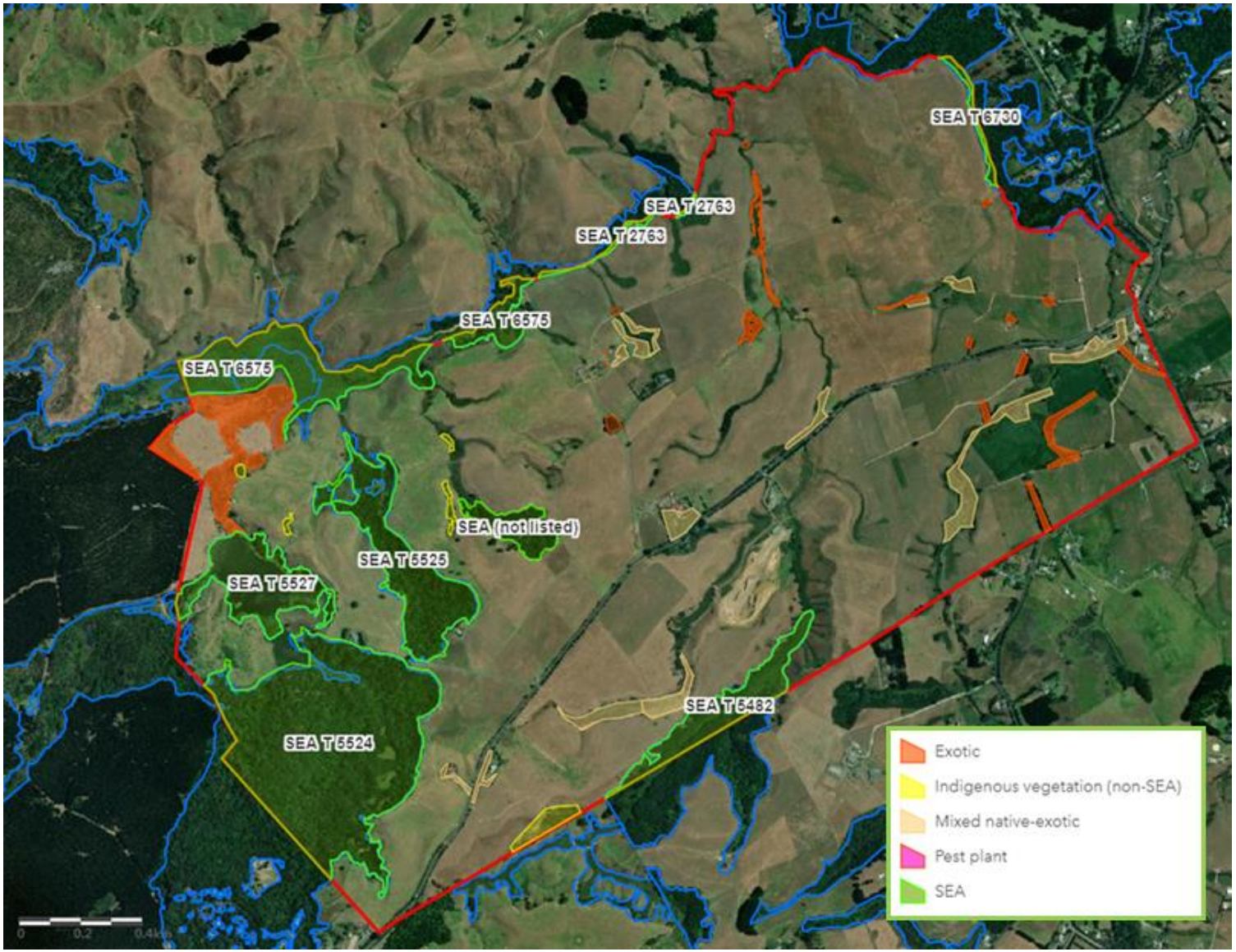

Figure 13. Vegetation communities across the Property. Blue areas outside of the Property are the continuation of SEAs in the surrounding landscape. Areas not coloured are dominated by exotic pasture grasses for pastoral grazing or by crops or are wetlands.

4.2 Kauri and mature native trees

Kauri trees (*Agathis australis*) were mapped on the periphery of forests and in locations where preliminary site development plans indicate interaction may occur. This included either mapping each singular tree, or clusters of trees (**Plate 14**). The following information was collected for each kauri tree recorded:

- Estimate of tree height;
- Estimate of tree dripline radius; and
- A health rating based on the symptoms of Kauri Dieback[5]

Kauri are predominantly on the edges of SEA T 5524 and SEA T 5525 and the SEA not listed (**Figure 14** for SEA areas and **Figure 15** for kauri map).

A total of 163 trees were identified (**Figure 15**). Kauri of poor health with symptoms of Kauri Dieback disease were common. Drip lines were estimated to be up to 20 m for the largest trees, and on average 9.5 m. A standard Kauri Dieback exclusion buffer of 3x the dripline distance from trunk to dripline edge would therefore indicate that a Kauri Dieback buffer zone is typically 30 m radius from the trunk and up to 60 m radius for larger trees.

Plate 14. Kauri forest adjacent to the western boundary of SEA T 5525.

Mature native trees outside of SEAs or in general locations where preliminary site development plans indicate interaction may occur were also recorded (**Figure 16** for example).

[5] Bleeding Gum. Basal trunk lesions. Yellowing of Leaves. Thinning Canopy. Dead Branches.

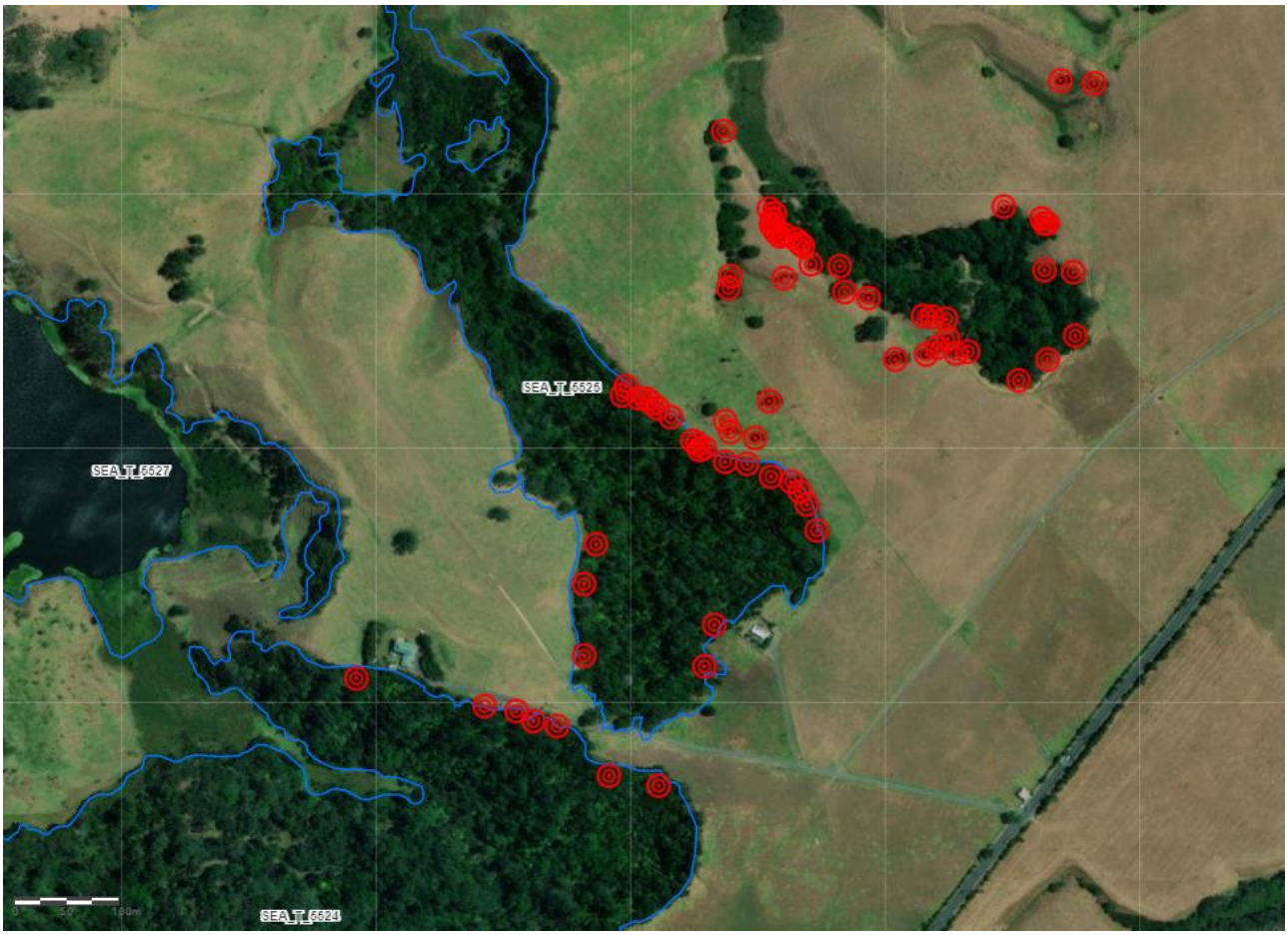

Figure 14. Kauri (red circles) recorded on site. Blue polygons are SEA boundaries.

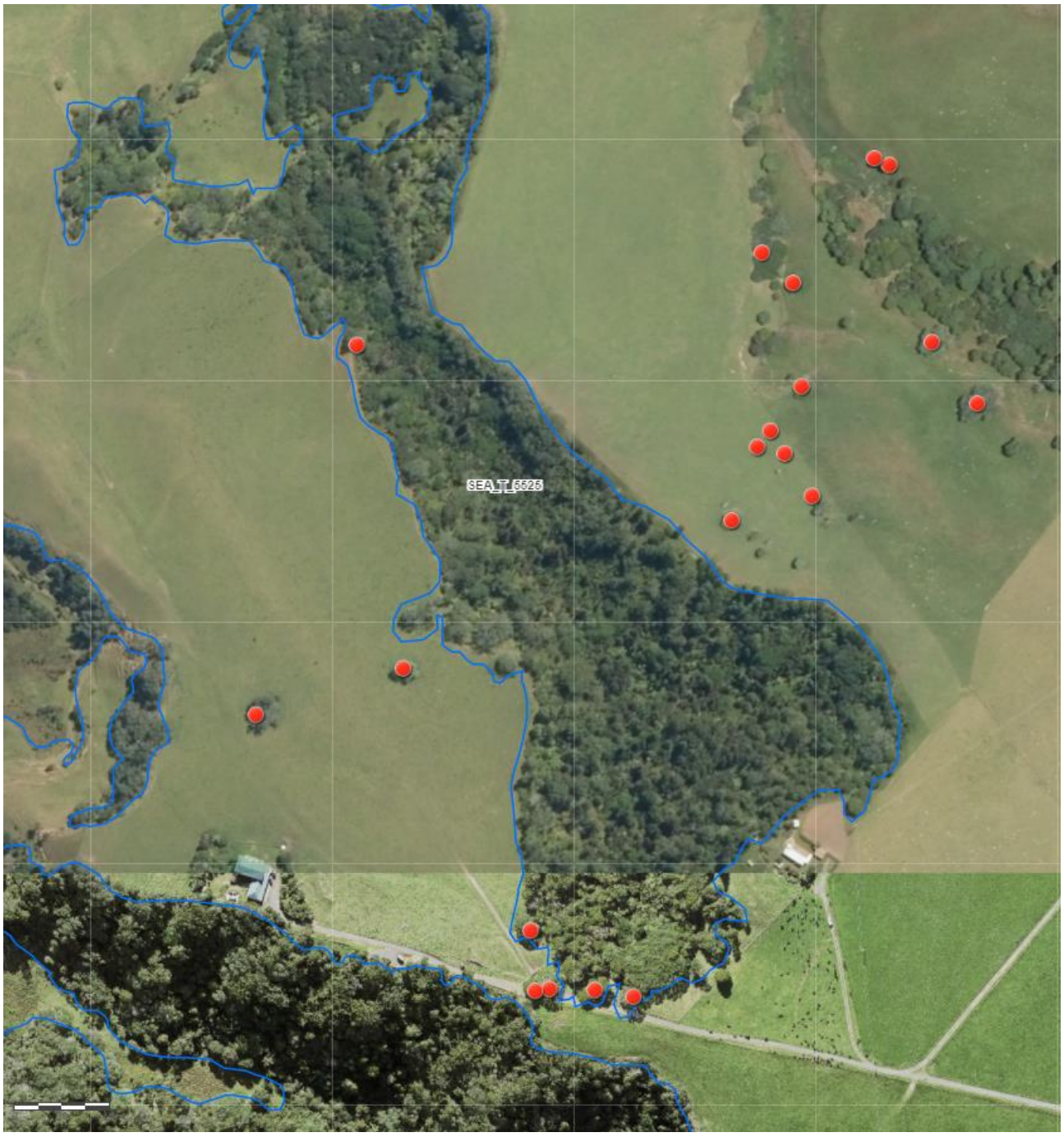

Figure 15. Mature native trees (solid red circles) within pasture surrounding SEA T 5525 (blue polygons).

4.3 Native Fauna

4.3.1 Lizards

All native lizards are protected under the Wildlife Act 1953. A Wildlife Act Authority from DOC is required to undertake activities within habitat that may support native lizards and where those activities may result in a significant impact on a lizard or its habitat. Searches and handling of native lizards at this Property were undertaken under Wildlife Act Authority 78350-FAU issued to RMA Ecology Ltd for the Auckland Region.

During the site survey, one exotic lizard species was recorded, the pest species plague skink (*Lampropholis delicata)*. The site survey involved general visual observations of potential lizard habitats, and inspecting beneath debris (e.g. logs) within the Property. However, it did not constitute a comprehensive survey using a range of methods (e.g. the use of artificial cover objects, pitfall traps etc.). The approach taken for the site survey was informed by preliminary site development plans and design principles which indicated clear avoidance of effects on almost all areas that could be suitable lizard habitat. Therefore, the lizard assessment was scaled to suit, and was not considered to require a comprehensive survey for arboreal geckos or forest edge and interior skinks.

The national lizard, frog and tuatara database managed by DOC (Herpetofauna) confirms records of native lizards within 1 km of the Property, including the 'At Risk' species ornate skink (*Oligosoma ornatum*) and elegant gecko (*Naultinus elegans*) – both forest species.

The areas of rank grass, and thick weedy vegetation surrounding the edges of forests, wetlands, and riparian vegetation on the Property provide suitable habitat for native skinks. In addition, the mature native forest and regenerating kānuka shrublands provide suitable habitat for native arboreal geckos.

Plague skinks are well distributed across the Property, particularly within paddocks, shelterbelts, riparian margins, and house and garden amenity areas (**Plate 15**). Copper skinks are most likely present in lower numbers and in a narrower subset of habitats including areas of rank grass, and thick weedy vegetation surrounding the edges of the wetlands, as well as thick riparian vegetation.

Lizards that have been recorded within the area and DOC Bioweb database that may occupy the Property are provided in **Table 11**. Applicable habitat has been sourced from van Winkel *et al*., 2018.

Table 11. Lizard species recorded in the national Herpetofauna database from nearby the Property.

Scientific name	Common name	Threat Status (Hitchmough *et al.,* 2021)	Likelihood of occupying the Property	Applicable habitat
Naultinus elegans	Elegant gecko	At risk - declining	High	Indigenous forest (SEAs) and associated seral scrub
Mokopirirakau granulatus	Forest gecko	At risk - declining	High	Indigenous forest (SEAs) and associated seral scrub.
Oligosoma ornatum	Ornate skink	At risk - declining	High	Indigenous forest (SEAs) and associated seral scrub, riparian margins.
Oligosoma aeneum	Copper skink	At risk - declining	High	Seral scrub. Wood stacks and rank grass. Riparian margins.
Lampropholis delicata	Plague skink	Introduced and naturalised	Confirmed	Seral scrub. Wood stacks and rank grass.

Plate 15. An exotic plague skink recorded in long grass under a pile of debris. Note fused fronto-parietal scale on top of the head, and characteristic 'iridescent' colour along the dorsal (back) surface – both of which are characteristic identifying features for this species.

4.3.2 Avifauna

Avifauna were surveyed throughout the Property during winter 2020, winter 2021 and spring 2021. Targeted dawn chorus surveys were undertaken on 13 and 14 July 2021 during fine, calm weather conditions following the standard 5-minute bird count (5mbc) methodology (Dawson and Bull 1975) whereby an observer records the number and species of all birds seen and heard over a 5-minute period. 5mbcs were undertaken at seven locations (**Figure 17**). Locations were selected to target sampling of lake and wetland habitats and the potential for rare species of avifauna that utilise these systems. In addition to 5mbc, playback calls of North Island fernbird, Australasian bittern, marsh crake, spotless crake and banded rail were undertaken adjacent to areas of suitable habitat (dense scrub adjacent to wetlands). Incidental records of birds were made throughout the entire Property during each of the seven property surveys, making particular note of species that utilise native forest as well as any potential migratory coastal species.

Twenty-seven species of birds were recorded during the site visits (see Section 1.2), including 15 native species, one of which, the black shag (*Phalacrocorax carbo*) is classified as 'At Risk- Naturally Uncommon'.

A single black shag was recorded roosting on mature eucalyptus trees adjacent to Lake Ōkaihau, and four little shag (*Phalacrocorax melanoleucos*) were recorded roosting on fence posts within Lake Ōkaihau. Waterfowl utilising Lake Ōkaihau included black swan, mallard, Canada goose and paradise shelduck.

A number of avifauna classified as 'Threatened' or At Risk' could utilise the Property, even just to transit through, with key habitats on the Property including the areas of mature native forest (SEAs), the large contiguous wetland (W7), raupo reed land in wetland W6, patches of mānuka scrub in wetlands W7 and W9, as well as Lake Ōkaihau.

It is also possible that 'At Risk' New Zealand pipit (*Anthus novaeseelandiae*) could utilise the pasture areas of the Property and could breed in areas of fernland in rough pasture clumps (e.g. W7). There are many records of pipit from beach areas along this part of the coastline at Muriwai, Te Henga,

Anawhata, Piha, Karekare and Whatipu. However there are none in inland areas of farmland or bushland. No pipit were seen during the formal survey in July, and none during other site visits during summer 2021 when pipit should have been visible and easily detectable.

The mature native trees on the Property provide suitable roosting and nesting habitat for a range of small native passerines such as grey warbler (*Gerygone igata*), and fantail (*Rhipidura fuliginosa*), as well as valuable food and nesting resources for tui (Prosthemadera novaeseelandiae) and kereru (Hemiphaga novaeseelandiae).

A nocturnal survey for birds – particularly with respect to birds that may be transiting across the Property within the Flyway – was not undertaken. As note in Section 3.3, several coastal birds are known to transit over the North Auckland area including Cooks petrel and perhaps also grey-faced petrel and black petrel. It is not known the degree to which these species only utilise the airspace above the Property. However, it is unlikely that the Property is the only, or even a key, transit route given the small size of the size compared to the indicative extent of the Flyway overall (see section 3.3.1 above).

A list of bird species observed during the site survey is provided in **Table 12**.

Table 12. Birds recorded at the Muriwai Downs Golf Course Property during the site surveys.

Scientific name	Common name	Threat Status (Robertson *et al.*, 2016)
Circus approximans	Swamp harrier	Native – Not threatened
Cygnus atratus	Black swan	Native – Not threatened
Egretta novaehollandiae	White-faced heron	Native – Not threatened
Gerygone igata	Grey warbler	Native – Not threatened
Hemiphaga novaeseelandiae	Kereru	Native – Not threatened
Hirundo neoxena	Welcome swallow	Native – Not threatened
Larus dominicanus	Southern black-backed gull	Native – Not threatened
Phalacrocorax carbo	Black Shag	Native- At risk – Naturally uncommon
Phalacrocorax melanoleucos	Little shag	Native – Not threatened
Porphyrio melanotus	Pukeko	Native – Not threatened
Prosthemadera novaeseelandiae	Tui	Native – Not threatened
Rhipidura fuliginosa	Fantail	Native – Not threatened
Tadorna variegata	Paradise shelduck	Native – Not threatened
Todiramphus sanctus	Sacred kingfisher	Native – Not threatened
Vanellus miles	Spur-winged plover	Native – Not threatened
Zosterops lateralis	Silvereye	Native – Not threatened
Acridotheres tristis	Common myna	Exotic – Introduced and naturalised
Alauda arvensis	Eurasian skylark	Exotic – Introduced and naturalised
Anas platyrhynchos	Mallard	Exotic – Introduced and naturalised
Branta canadensis	Canada goose	Exotic – Introduced and naturalised
Carduelis carduelis	European goldfinch	Exotic – Introduced and naturalised
Gymnorhina tibicen	Australian magpie	Exotic – Introduced and naturalised

Scientific name	Common name	Threat Status (Robertson *et al.,* 2016)
Passer domesticus	House sparrow	Exotic – Introduced and naturalised
Platycercus eximius	Eastern Rosella	Exotic – Introduced and naturalised
Sturnus vulgaris	Common starling	Exotic – Introduced and naturalised
Turdus merula	Blackbird	Exotic - Introduced and naturalised
Turdus philomelos	Song thrush	Exotic - Introduced and naturalised

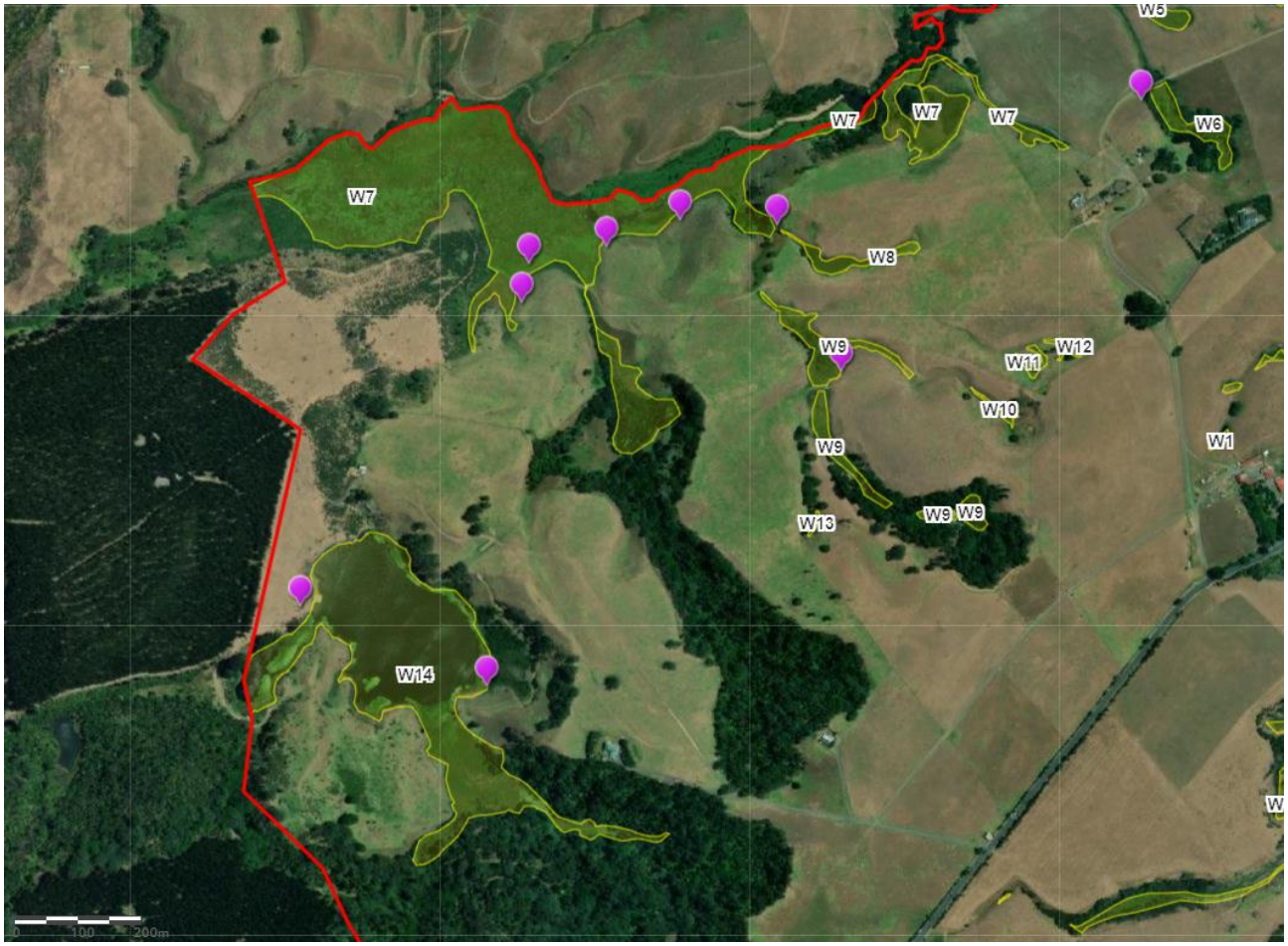

Figure 16. 5mbc locations (purple points) targeting the large contiguous wetland W7, raupo habitats in wetland W6, mānuka scrub in wetland W9 and Lake Ōkaihau.

4.3.3 Long-tailed bats

Long-tailed bats / pekapeka (*Chalinolobus tuberculatus*, currently classified 'nationally vulnerable' - O'Donnell *et al.,* 2011), require large trees (including standing dead trees) with cavities (e.g. deep knot holes), epiphytes or loose bark for roosting; and typically use linear landscape features such as bush edges, gullies, water courses and roadways to transit between roosting and feeding sites (Borkin and Parsons 2009).

The closest confirmed record of long-tailed bat is 3.5 km to the south of the Property, in the Waitākere Forest Park.

The Property supports some characteristics preferred by bats, (e.g. mature native trees along watercourses and extensive old-growth forest within gully SEAs, as well as old shelterbelts) and it is possible that a resident long-tailed bat population could utilise parts of the Property (e.g. with mature trees), if only to transit through the Property.

Whilst the removal of a small proportion of habitat may not be deemed ecologically significant, any direct effects on long-tailed bats (e.g. from vegetation clearance) are considered significant. If bats are present, the possibility of harming bats triggers provisions of the Wildlife Act 1953 that require avoidance of effects. Avoidance of effects is usually achieved by a pre-clearance site survey and, if necessary, relocation of bats if roosts are substantial or permanent (which is likely in this type of environment).

5.0 Assessment of ecological effects

The following sections, including Section 6.0 and Section 7.0, detail the Ecological Impact Assessment in general accordance with the Environment Institute of Australia and New Zealand (EIANZ) Ecological Impact Assessment guidelines (EIANZ 2018). This assessment considers the ecological values of the Property and assesses the level of effects that the proposed development may have on the ecological features and values.

5.1 Development description

A summary of the Project is provided in the Executive Summary.

Some elements of the Project are at a preliminary design stage, and a certain amount of flexibility is sought within any consents granted to provide for minor changes that may be needed to the Project following the subsequent developed design and final design stages. To address this, the Applicant is adopting a "maximum envelope" approach for the Project, while providing opportunities to reduce any adverse effects on significant indigenous biodiversity and ecological values. This report assesses the Project's maximum envelope of actual, potential and cumulative environmental effects with respect to ecology.

Aspects of the Project relevant to actual and potential adverse ecological effects are as follows:

- The removal of protected and non – protected vegetation required to construct the main golf playing areas, landscape features and general contouring of the existing farmland as part of the formation of approximately 73 hectares (ha) of maintained turf for the 19 hole golf course which will include: 41.1 ha of Fairways and Tees, 28.6 ha of secondary (naturalised Rough), and 3.4 ha of Greens.
- A total of 13 bridges are required over streams, wetlands and gully areas within the golf course to provide safe and efficient access around the course for golfers and maintenance staff. Bridges over streams and wetlands have been designed to avoid these features, while two bridges span gullies within the indigenous vegetation at SEA_T_5525.
- A 168 m long culvert is proposed within permanent stream P3 which flows perpendicular to the 14th Hole Fairway;
- Infilling of the uppermost 16 m reach of intermittent stream I9;
- An alteration to sub-catchment drainage flows through shaping and recontouring Fairways and Greens, designed to ensure minimal net change in catchment runoff volume and drainage pathways between pre and post golf course construction;
- To fulfil the Property's water demand, potable and domestic water and irrigation water will be supplied from the local groundwater resource and the Raurataua Stream via a surface water take. The Project also involves construction of a purpose-built off-stream reservoir on the quarry side of the Property.
- Installation of an irrigation system. The irrigation system for this proposed development will be designed with water efficiency optimisation and to ensure minimal net change in catchment runoff volume, and appropriate treatment of any potential overland flow prior to entering wetlands or streams. Final irrigation design plans will be available prior to golf

course construction and will include detailed specifications for pumps, pipe routing plans, pipe sizes, valve and sprinkler locations, electrical components and details describing treatment of potential overland flows and discharge points of those flows before entering wetlands or streams;

- The Lodge, Clubhouse and Sports Academy and associated lighting. Lighting plans for all buildings within the Property are not yet developed. It is likely buildings will include some outdoor lighting for general pedestrian and operational safety, and to enhance specific architectural features or landscape planting. Low lux lighting is also contemplated at ground level to illuminate interconnecting pedestrian pathways within the lodge area and between the Clubhouse and the Lodge; and
- Landscape planting around Fairways, Greens, Clubhouse, Sports Academy, Lodge and associated roads, accessways, built and amenity areas.
- Extensive indicative ecological restoration and enhancement planting around Lake Ōkaihau, wetlands, streams and SEAs within the site.

Following resource consenting, developed design, building consenting and final design stages, the construction project will involve the following key elements:

- Finalisation, submission and implementation of all pre-construction requirements in accordance with resource consent conditions;
- Implementation of sediment and erosion control devices;
- Site clearing, minor vegetation removal and trimming. This includes the eradication of unwanted vegetation such as weed grasses, shrubs and exotic plant material. This will be carried out by spraying out undesirable vegetation, or physical removal (exotic trees) that if left unchecked will require more comprehensive herbicide use in the future;
- Topsoil stripping and stockpiling;
- Bulk earthworks;
- Construction of bridges and a stream culvert;
- Golf course shaping;
- Construction of tees, greens, and bunkers;
- Topsoil respreading;
- Trenching and installation of golf course drainage and irrigation systems;
- Turf grow-in;
- Construction of roads, tracks and paths;
- Construction of site buildings;
- Importation of clean fill and other construction materials; and
- Landscape and restoration planting activities.

A detailed assessment of the proposed development activities and associated the potential and actual adverse ecological effects are detailed in Section 5.4.

5.2 Constraints to development

There are a number of ecological values on the Property that constrain the location of the proposed development footprint and the proposed activities undertaken in these areas. For this Property the principle ecological values that constrain development include:

- Lake Ōkaihau and a 10 m wide buffer around it (1.3 ha), which together total approximately 7.5 ha. A 10 m buffer around Lake Ōkaihau has been applied with a view to avoid and/or minimise earthworks and vegetation clearance in close proximity to the lake.
- 21 wetlands that meet the NPS-FW definition of a 'natural inland wetland', and an associated 10 m buffer surrounding each wetland. A 10 m buffer around each wetland has been applied with a view to avoid and/or minimise earthworks, land disturbance and vegetation clearance in close proximity to wetlands. The wetlands on the Property total approximately 31 ha, and when accounting for a 10 m buffer the area on the Property totals approximately 58 ha. Constraints to the development also include the hydrological sources for these areas such as seepages with underlying hard-pan aquitards. Further information is provided in the Water Effects Summary Report (WWLA report at Appendix 10 to AEE);
- 22 streams, including nine (9) permanent streams and thirteen (13) intermittent streams, and an associated 10 m buffer along both banks of each stream. A 10 m buffer around each stream has been applied with a view to avoid and/or minimise earthworks and vegetation clearance in close proximity to streams. Overall, streams on the Property total 13,132 m (13.1 km) including 8,998 m (9 km) of permanent streams and 4,134 m (4.1 km) of intermittent streams. The total area of 10 m wide riparian buffers of streams is approximately 26 ha;
- 8 areas on the Property that meet the criteria in the AUP as SEAs (including one area not listed as an SEA), covering approximately 77.3 ha of the Property;
- Indigenous vegetation on the Property not listed as an SEA, including mature native trees;
- Over 100 mature kauri trees along forest margins and stand-alone trees within close proximity to the proposed development, and a Kauri Exclusion Zone consisting of 3x the individual trees dripline, which overall in aggregate is approximately 7 ha.

5.3 Avoidance of effects

Overall, the proposed development has been designed to avoid actual and potential adverse effects to ecological values on the Property to the greatest extent practicable. In terms of the current design layout and its avoidance of adverse effects on ecological values – in particular streams, wetlands and indigenous vegetation – we are advised that the current layout represents all of the areas and values that can be avoided to the extent practicable.

We have provided considerable input into the design work that has resulted in this proposed footprint, by undertaking site investigations and mapping to assist with informing the layout and engaging in discussions with the Project team to continue to refine the design. The layout provided to us for this ecology assessment is the result of a range of considerations, of which we understand that ecology is but one part. We understand that planning and national regulations do not require absolute avoidance (apart from some specific circumstances) of all adverse effects on ecology values.

The proposed layout represents a refined version of the original layout, with considerable benefits for the preservation and enhancement of wetlands, streams and indigenous vegetation, which have resulted from a great number of design group meetings, workshops, field sessions and problem-solving for specific parts of the layout.

All 21 wetlands, totalling 31 ha on the Property, have been avoided, and works within 10 m of wetlands have been minimised where practicable.

A total of 12,948 m of streams within the Property will be avoided. Of the total, 184 m of streams will be affected by the proposed development, which constitutes approximately 1.4 % of the streams within the Property, and estimated as < 0.1 % of the overall Ōkiritoto Stream catchment.

A total of 773,421 m^2 of forest within the Property that meets the SEA criteria in the AUP will be avoided. Approximately 1,396 m^2 of vegetation on the margins of SEA_T_5525 is proposed to be removed by the proposed development, which constitutes ca. 1.3 % of the total area of SEA_T_5525 or 0.18 % of the total area of SEA forest within the Property. Where vegetation is proposed to be removed within the SEA (SEA_T_5524), careful consideration was given to minimising clearance (e.g. by crown lifting) and avoiding higher value vegetation such as mature trees or vegetation with unique habitat values (e.g. trees with epiphytes).

5.4 Potential and actual adverse ecological effects

Adverse effects on ecological values have been avoided, remedied, or mitigated to the extent that is practicable feasible by the Applicant, and are summarised in **Table 13.**

Further detail on the works proposed and a more detailed analysis for each of the potential adverse effects listed in **Table 13** is provided in the following text sections.

The level of actual or potential adverse effects after mitigation for the various ecological values of the Property is addressed in Sections 6 and 7.

Table 13 does not separate out specific construction activities (for example, of bridges or buildings). However consideration of these is incorporated into assessments of potential effects on SEA and non-SEA indigenous vegetation, Lake Ōkaihau, stream and wetland areas.

Table 13. Potential adverse effects of the development on ecological values.

Activity	Potential adverse effect	Length or area affected	Mitigation proposed	Level of effect (after mitigation)
Indirect effects				
Earthworks and shaping, irrigation, wastewater, nutrient regime change, near and within streams and wetlands	Potential to release sediment into downstream areas and marine environment, affecting habitat	n/a	Undertake works in accordance with Erosion and Sediment Control Plans.	Low (provided plans implemented and effective)
Direct effects				
Construction of off-stream water reservoir	Land development associated with water storage infrastructure	3.7 ha	Creation of habitat for native eels and waterfowl.	Positive (net benefit)
Water take - Raurataua Stream (no wetlands are within 220 m of the proposed water take)	Reduction in water for in stream ecological values and stream bank disturbance	To be confirmed; likely to be in either no bank disturbance or minor (5 m long) disturbance	Water take only during high-flow in accordance with AUP standards. Stabilisation of bank area where works occur.	Low
Wetlands – hydrology, earthworks and vegetation clearance	Drainage or partial drainage	Project area wetlands	Avoid works within wetlands, and avoid most works within 10 m of wetlands Apply erosion and sediment controls to avoid sediment discharges. Design avoids deep cuts where wetland recharge/ seeps may be affected.	Positive (net benefit)

Activity	Potential adverse effect	Length or area affected	Mitigation proposed	Level of effect (after mitigation)
			Extensive restoration proposed for wetland areas.	
Infilling of intermittent stream I9	Loss of watercourse habitat and function	16 m	Nil	Low (at stream level) Negligible (at catchment level)
Culverting and placement of erosion protection riprap at permanent stream P3	Loss of habitat for shortfin eels	175 m	Fish passage design considerations incorporated into structures. Development of a Native Fish Relocation Plan for the stream; salvage of fish.	Moderate at stream level Negligible (at catchment level)
Removal of pasture grasslands, exotic amenity trees, shelterbelts, and exotic scrub	Loss of food supply and nesting sites for native (and exotic) birds	Site wide	Clearance outside of native bird nesting season, or pre -clearance survey for nesting native birds. Clearance outside of maternal roosting period and undertake a pre -clearance survey for roosting bats. Preparation of an Ecological Management Plan, including extensive planting along wetlands, streams and forests, will provide replacement habitat for all species.	Positive (net-benefit)
Removal of indigenous vegetation	Loss of ecological value associated with individual trees	1,362 m^2 and 9 mature trees	Preparation of an Ecological Management Plan including	Positive

Activity	Potential adverse effect	Length or area affected	Mitigation proposed	Level of effect (after mitigation)
	and contiguous forest and associated habitats for indigenous fauna		extensive planting of forests which will provide replacement of indigenous vegetation and habitat for indigenous fauna.	(net-benefit)
Removal of habitat for native lizards and possible adverse effects on resident populations	Loss of lizard populations – primarily copper skink	Up to 1 ha in aggregate of potential habitat (estimated)	Development of a Lizard Management Plan for the Property; salvage of lizards prior to vegetation clearance. Preparation of an Ecological Management Plan including extensive planting along wetlands, streams and forests will provide replacement habitat for all species.	Positive (net-benefit)
Removal of vegetation as food and nesting resources for birds	Loss of food supply and nesting sites for native (and exotic) birds	1,362 m^2 and 9 mature trees	Clearance outside of nesting season, or pre-clearance survey for nesting native birds Preparation of an EMP including planting along wetlands, streams and forests will provide replacement habitat for all species.	Positive (net-benefit)
Removal of vegetation as food and roosting resources for long-tailed bats	Loss of food supply and potential roosting sites for long-tailed bats	1,362 m^2 and 9 mature trees	Clearance outside of maternal roosting period and pre -clearance survey for roosting bats.	Positive (net-benefit)

Activity	Potential adverse effect	Length or area affected	Mitigation proposed	Level of effect (after mitigation)
			Preparation of an EMP including planting along forests will provide replacement habitat.	
Lighting	Disturbance to wildlife in forest and wetland habitats	Lodge, Clubhouse, Sports Academy, driving range areas	Designed to reduce ambient light spilling into forest and wetland habitats.	Low
Golf balls in the environment	Disturbance to wildlife, potential toxins in the environment	Golf course footprint	Course design to minimise balls in the environment, Operating Procedure for ball retrieval.	Low
Landscape planting and management	Use of exotic plant species that are invasive, or have the ability to spread into adjoining SEAs, natural areas and proposed restoration areas	Project area, specifically around buildings, roads and golf areas	The landscape planting guidelines prepared by Boffa Miskell have been reviewed to ensure that no plant species that could hybridise, invade or other establish outside of the intended landscape context are included in the landscape planting suites.	Nil or Negligible

5.4.1 Indirect effects

During the development and construction of the proposed golf course, the largest potential water quality impact is sediment runoff associated with earthworks during recontouring and grading of the golf course area.

Preliminary erosion sediment control plans (ESCP) have been prepared and are described in the draft CEMP (McKenzie and Co report, Appendix 18 to AEE). The ESCP have been designed in accordance with Auckland Council Guideline Document GD05 – Erosion and Sediment Control for Land Disturbing Activities in the Auckland Region. Prior to construction, the consent holder will require that the contractor reviews the approved resource consent conditions and prepares a final Environmental Erosion and Sediment Control Plan for review and approval by the site Engineer and to the satisfaction of Auckland Council.

Sediment control measures will be constructed on the Property prior to stripping of topsoil and earthworks. Sediment control measures will include sediment erosion ponds, decanting earth bunds, flocculation equipment, contour drains, separate clean water and dirty water diversion bunds, and silt fences.

Where work is undertaken in close proximity to streams and wetlands, works are recommended to be undertaken, where practical, between October and April, during which time rain events and runoff are lowest. Silt fences and straw bales are recommended to catch any falling debris. These provisions are included in the draft CEMP.

Earthworks in areas closer than 10 m from wetlands will be managed in accordance with special procedures (detailed in the draft CEMP). These areas are known by golf course designers and constructors as transition areas. They include areas between the outside perimeter of the golf course and the edges of the farm or environmentally sensitive areas such as wetlands, stream beds and SEAs. To minimise risk in these locations, the following specific construction method will be adopted:

- Farm pasture within transition areas of the golf course located immediately adjacent to wetlands or streams, will be replaced with mature turf (i.e. ready-turf).
- This will be done by first manually removing, or “opening up” in small sections, the existing pasture within a buffer zone of approximately two metres from the wetland or stream bed.
- Pasture removal in these areas would not be undertaken in wet weather or on days where rain is expected.
- The furf would then be installed and secured with biodegradable stakes.
- All areas “opened up” would be turfed before the end of that same day.
- The furf would not be mown for a period of at least 6 months.
- Seeding up-gradient of the furf would be hydroseeded (including a tackifier) to secure the seed/seed bed *in situ*.

Specific stream works methodologies will be prepared by the contractor for each works location and type, and these will be approved and signed off by the site Engineer and Regulatory Monitoring Representative (see draft CEMP for further detail on this).

Overall, the risk of earthworks resulting in a water quality risk is considered low provided final ESCP are designed and implemented in accordance with best practice guidelines of GD05. Therefore, the potential adverse ecological effects on the Ōkiritoto Stream catchment associated with erosion and sedimentation during and after earthworks are assessed as being a **low likelihood** of occurring.

5.4.2 Off-line Water Reservoir

To enable sufficient and reliable water supply for irrigation, an off-stream water reservoir, which will be filled by a water take from the Rarautaua Stream (surface water take) and groundwater from a deep aquifer (see section 5.4.3 for assessment), is proposed to be constructed on the quarry site of the Property (Reservoir).

The water supply for the Reservoir includes a proposal to take water from the Raurataua Stream (yellow point **Figure 19**) when stream flow is greater than the median flow, ensuring the total take does not exceed 10 % of the flow in the stream at the time of abstraction. In order to achieve this, surface water takes from the Raurataua Stream will be carried out using continuous stream flow information and a programmable logic control system programmed to maintain the following water take regime. Non-invasive monitoring equipment near the point of take will be utilised to provide the continuous stream flow information required for this regime. A small pump shed will also be installed near the point of take to house water pumps, flow meters and control systems.

The surface water take is not considered to have an adverse effect on ecological values because:

- The existing Muriwai Links Golf Course water take is approximately 5 kilometres further downstream of the proposed take site, and a number of tributaries join the stream, thereby further increasing the flow prior to location of the existing consented take. Therefore, harvested flow as a proportion of total flow decreases with increasing distance downstream;
- As the high-flow take will only operate during periods of high-flow during and / or following high rainfall, irrigation requirements are likely to be nil on these days that the high-flow take is operating; and
- Given the take is under high flow conditions, plenty of surface water would remain available for potential permitted activity takes downstream of the site.

The proposed high-flow surface water take is considered to have no negative impact on stream habitats or fauna, as the take is a low proportion of the flood flow, and will only operate at times of high (flood) flow. Sites that qualify as wetlands under the NPS-FM or the RMA have been mapped over this part of the Property. The take point is 220 m downstream from the nearest wetland (W18; which is a riparian floodplain extending upstream towards the quarry).

The exact design of the water take structure and supporting infrastructure linking the Reservoir has not been confirmed, but examples are provided in WWLA's report at Appendix 7 of the AEE. The structure take will be designed in accordance with standards outlined in the AUP, including a protective screen mesh size < 1.5 mm aperture, and intake velocities < 0.3 m/s.

The water take construction will be undertaken in such a manner to minimise disturbance to the stream bank, with any required excavations (e.g. for a weir/ chamber design) expected to include a discrete bank incision in the order of 5 m. The proposed water take location includes a reach of the Raurataua Stream which we have assessed as having a wetted width between 3-5 m, depth ranging between 0.3 m and >1.0 m, velocity <0.1 m/s, predominantly soft bottomed with minor cobbles and gravels, incised banks, and exotic pasture grass and mature willows and poplars along the riparian margin that partially shade the stream channel (**Plate 16**). If the surrounding stream bank is disturbed as part of the installation of the water take inlet, the surrounding area should be planted in native riparian vegetation (e.g. harakeke and ti kouka) to promote stabilisation of the surrounding bank.

The water intake structure used will be designed, constructed, operated and maintained to avoid adverse effects on biota, including the entrapment of fish.

The proposed Reservoir will cover approximately 3.7 ha, excavate approximately 4 m deep and will have a storage volume of 140,000 m^3 (**Figure 18**). The proposed Reservoir will be excavated into the existing ground surface slope and will include visual and amenity planting embankments up to 3 m high along the northern, eastern, and western sides of the Reservoir. When completed, the Reservoir, like many other created waterbodies of this scale, will provide additional feeding and roosting habitat for native avifauna utilising Lake Ōkaihau, including black shag, little shag, black swan, and paradise shelduck. Over time, the water Reservoir is expected to be naturally colonised by shortfin eel.

The proposed Reservoir and associated pipe infrastructure are located to the east of the quarry within areas of grazed pasture grassland and have been located to avoid ecologically sensitive areas, including wetlands, streams, indigenous vegetation and habitats for indigenous fauna as well a 10 m minimum setback from these features (**Figure 19**). The exact location of the supporting piping infrastructure is still to be determined, and is expected to follow existing services (e.g. Muriwai Road).

The overall actual and potential adverse ecological effects associated with the Reservoir and associated infrastructure are assessed as low and an overall net-gain ecological outcome will result from the creation of a 3.7 ha waterbody that provides habitat for native avifauna and fish.

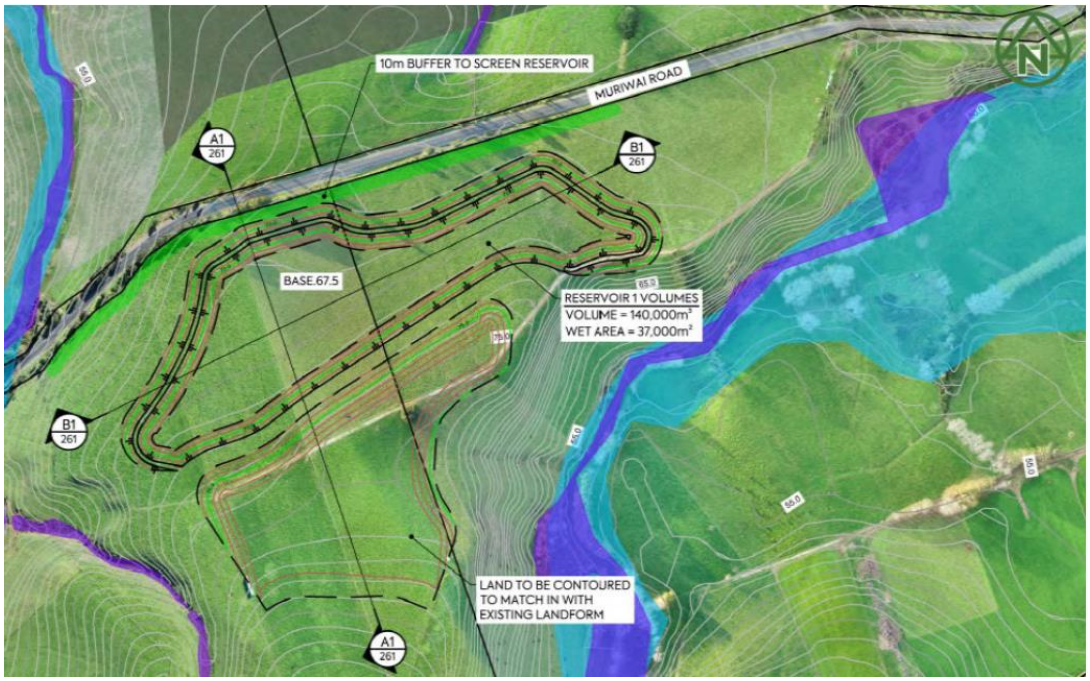

Figure 17. The off-stream water reservoir development footprint. Figure supplied by McKenzie and Co (see Appendix 7 to AEE).

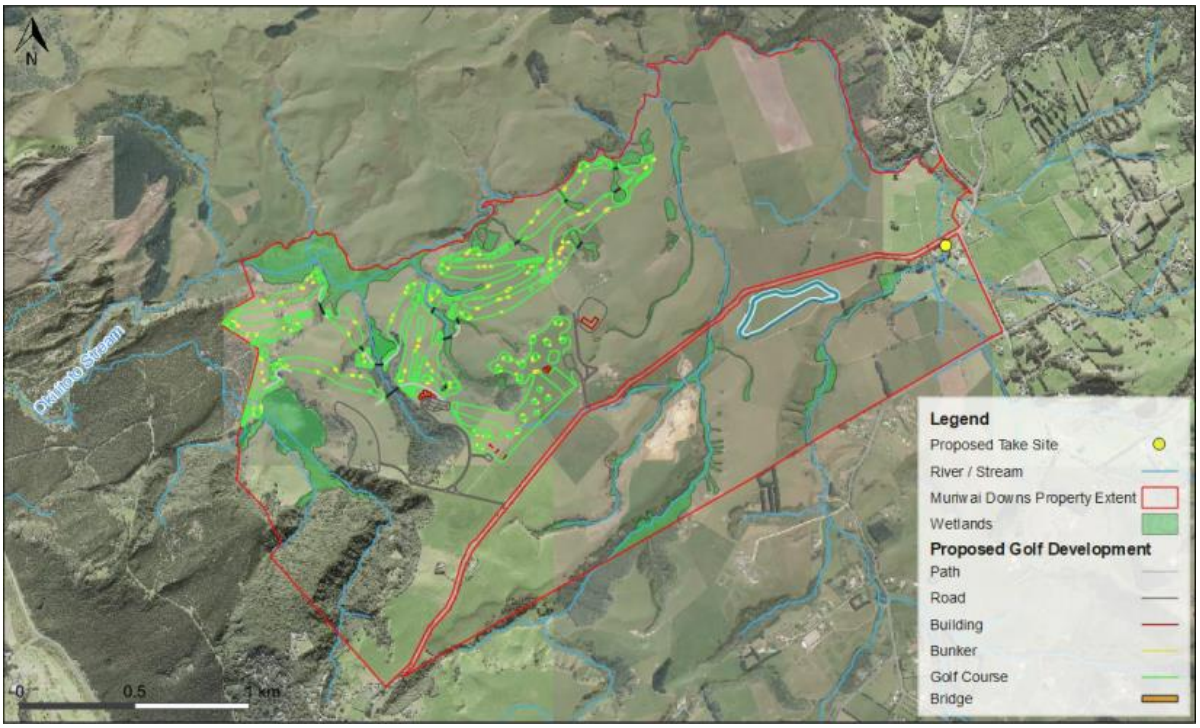

Figure 18. The off-stream water reservoir development footprint and approximate water take location (yellow point) in relation to the golf course. Figure supplied by WWLA, see Appendix 7 to AEE.

Plate 16. The Raurataua Stream at the proposed water take location. This is 220 m downstream from the closest wetland (riparian floodplain wetland associated with Raurataua Stream (northern extent of W18)).

Structure type	Example
Stream Intake (Fixed).	
Screen Intake on Swivelled Winch (Removeable).	
Stream Bank Chamber and Pump. Consists of a pump chamber formed alongside the river with a simple overflow weir or small intake gates to allow above the median flow level into the chamber.	

Figure 19. Example water take options, (WWLA 2021d; see Appendix 7 to AEE)).

5.4.3 Effect of Groundwater-Surface Water interactions and impacts on ecological features (streams, wetlands and Lake Ōkaihau)

Effects on groundwater surface water interactions are detailed in WWLA's report at Appendix 10 to AEE) and summarised as follows:

- For streams, the findings are consistent with the conclusions derived from monitoring data that baseflows are responsive to conditions in the shallow aquifer that are largely disconnected from the deep aquifer where the abstraction will take place. Based on these results the effects of abstraction from the deep aquifer on stream flows are predicted to be less than minor.
- For wetlands, the proposed groundwater take will have little to no impact on wetland water levels because of the disconnection between shallow and deep groundwater and the influence of aquifer porosity limiting the effect on standing water levels. On the whole, the effect on wetlands from groundwater abstraction will be less than minor.

- For Lake Ōkaihau, the stream flowing into Lake Ōkaihau is within the Natural Stream Management overlay in the AUP. However, the predicted impact on baseflow in this stream, which is 1.9 km from the abstraction bore and in a separate catchment, is unmeasurable (WWLA report 2021d; see Appendix 7 to AEE). For these reasons, flow into Lake Ōkaihau will not be affected by the proposed groundwater abstraction. The predicted effect on the net leakage out of Lake Ōkaihau is negligible.

5.4.4 Surface water quality

Construction (temporary) and permanent effects associated with the proposed golf development and operation are summarised in WWLA report in Appendix 10 to AEE and summarised as follows:

- A catchment flow and water quality model was developed to assess potential changes in water quality associated with land use change from the current farming operation to the proposed golf resort development. Two scenarios were simulated, one representing the current land use of the Property, and a future post golf resort development scenario. The catchment flow and water quality model predicted a minor reduction in both TN concentration and in peak TSS concentrations.
- While the absolute reduction in total nitrogen (TN) and total suspended solids (TSS) concentrations is not an extreme change, it represents a decrease in median concentrations by approximately 5 %, which is an environmental improvement. The reason the reduction is not greater than approximately 5 % is because the area retired of sheep and beef, and dairy cows on the Property represents only approximately 7 % of the total Ōkiritoto Stream catchment, upstream of the downstream extent of the Property.
- High activity impermeable areas, such as car parks, paths, and roads, could result in stormwater contamination. A Stormwater Management Plan (SWMP) will be prepared to detail how stormwater quality will be managed from these areas. The SWMP will adhere to Auckland Council's Stormwater Management Devices in the Auckland Region GD01 guidelines. Runoff from carparks and roads, where practical, are proposed to be treated with at-source green infrastructure treatment devices, constructed upstream of discharge points. Options for bioretention treatment devices include vegetated swales, filter strips, and rain gardens.
- The SWMP will ensure all stormwater from high activity impermeable areas will be treated following best practice guidelines, before being discharged back to the environment, and thus resulting effects on water quality are likely to be no more than minor.
- The water quality effects on downstream water users are considered negligible (i.e. potentially not detectable to downstream water users) to positive.

Based on the summary of potential effects to catchment flow and water quality being low, negligible or positive (for the various components modelled or assessed by WWLA), the ecological effects are likely to also be negligible or positive. The predicted changes to water quality and quantity parameters are predicted to be not detectable, and therefore are very unlikely to be outside of the normal range of environmental tolerances of instream plant and animal communities.

5.4.5 Stormwater and flood flows

The impact of increased impermeable surfaces (e.g. due to the construction of buildings, roads, paths and carparks) on catchment flows was negligible and indistinguishable from the Basecase (WWLA report; Appendix 10 to AEE). These additional impermeable surfaces represent approximately 1 % of the total Property area, and less than 0.25 % of the total Ōkiritoto Stream catchment, upstream of the downstream extent of the Property.

In addition, a SWMP will be prepared for the proposed development, following the principles of water sensitive design (Auckland Council –GD04, 2014/004). Given the small (~1 % change in impermeable surfaces across the site and implementation of water sensitive design principles, the risk of increased flood flows in the Ōkiritoto Stream associated with an increase in impermeable surfaces within the catchment is considered no more than minor.

Together, these small changes to the existing baseline indicate that the level of potential adverse effects on instream water quality, habitat and fish and aquatic invertebrate population and habitat is likely to be nil, or at worst, so small as to be not measurable.

5.4.6 Wastewater

Effects from wastewater interactions are detailed in WWLA's report at Appendix 10 to AEE, and summarised as follows:

- Due to the Property's location, it cannot be connected to any public wastewater network, and therefore wastewater will be managed on-site, and discharged to ground. Given the nature of the proposed development, wastewater will be typical of domestic effluent (i.e. no industrial or trade waste).
- The Engineering Infrastructure Report (McKenzie and Co, 2021. Appendix 5 to AEE) details the principles and approach for on-site wastewater management, noting detailed design has not been undertaken at this stage.
- Effluent is proposed to undergo primary (septic tank(s)), secondary (textile media treatment and recirculation), and tertiary (UV filtering) treatment prior to disposal. Disposal of effluent is proposed via pressure compensating dripper lines. Configuration of dripper lines and application rates will be determined in accordance with Auckland Council guidelines (TP58).
- The 7,500 m^2 disposal field and reserve area is located on the north-western side of Muriwai Road, to the east of the helipad area (MCCL Drawing 1976-1-500 and 504). This location was selected to ensure it is accessible, and clear from high risk receiving environments, with the nearest wetland situated approximately 200 m to the south-east.

Wastewater treatment design has been selected to avoid sensitive receiving environments (streams and wetlands). Provided the overall wastewater treatment devices are designed and constructed in accordance with Council standards, the associated actual and potential ecological effects on ecological features and values are expected to be nil.

5.4.7 Wetland hydrology

The proposed development has considered the existing hydrological conditions in order to avoid potential and actual adverse effects to wetlands (WWLA report at Appendix 10 to AEE), by considering the following potential adverse effects:

- The discharge of sediment or other contaminants into these areas during earthworks and as part of the post-development design (e.g. stormwater runoff from roads);
- Earthworks intercepting and diverting groundwater flows; and
- Re-contouring and increasing impervious surfaces within the upper overland catchment resulting in the diversion or concentration (through discharging at a single point source) of overland flows.

A design philosophy to maintain natural flow paths and catchments, and best practice erosion sediment controls and filtering stormwater discharges has been adopted for the Project.

In order to maintain wetland integrity (i.e. wet soils) it is important that the catchment inputs and drainage for each wetland on the Property are not significantly altered from their current state. This requires avoiding and minimising disturbance to overland flows and groundwater sources for each wetland sub-catchment.

There are no direct adverse effects on wetlands associated with the proposed development. In particular, there are no earthworks, land disturbance or taking, using, damming, version or discharge of water within a wetland.

There are earthworks, land disturbance and vegetation clearance proposed within 10 m of the following wetlands:

- Lake Ōkaihau
- Wetlands W2, W3, W5, W6, W7, W8, W9 & W13

Wetlands on the Property are fed by surface water and/or ground water. As discussed above, four key wetland types have been identified on the Property by in the WWLA report at Appendix 10 to AEE), as follows:

1. Wetland Type 1 – Palustrine, found outside the saline margin in low-lying coastal floodplains;
2. Wetland Type 2 – Dune Lake (historically formed), associated with Lake Ōkaihau;
3. Wetland Type 3 – Valley floor, formed from groundwater seeps and surface water flows within narrow valley floors; and
4. Wetland Type 4 – Valley wall seepage, formed from groundwater seeps on the sides of valleys.

Figure 21 shows the distribution of Wetland Types 1-4 across the site, and the results of an analysis of the maximum earthworks cut that should be allowed upslope of each wetland such that shallow groundwater that feeds the wetland is not affected.

Type 1 and 2 wetlands are fed exclusively or primarily from surface water, Type 3 wetlands are maintained by surface water and groundwater and Type 4 wetlands are predominantly fed by groundwater.

WWLA (Appendix 10 to AEE) have assessed that in order for a Type 4 wetland to exist, an impermeable layer must be present, extending from the base of the wetland upstream. These impermeable layers restrict the vertical flow of groundwater and generates horizontal interface drainage that manifests at the surface as a "perched" valley wall seepage, which can sustain the presence of a wetland. Therefore, these wetlands are vulnerable to potential disturbance from earthworks if the groundwater source is intercepted.

An analysis of the maximum allowable cut size and proximity to Wetland Type 4 was undertaken (WWLA, Appendix 10X to AEE) in order to avoid disturbance to the groundwater hydrology (**Figure 21**). This analysis was used to inform the proposed earthworks on the Property, and to demonstrate that potential disturbance to groundwater regimes for Wetland Type 4 on the Property is being avoided.

The maximum wetland cut outputs were provided to the golf course designer (Kyle Phillips of Kyle Philips Golf Course Design) and the Project civil engineers McKenzie and Co, who produced the Site Earthworks Plans.

The proposed earthworks and site contouring does not exceed the recommended maximum cut contours, and therefore the potential for negative effects on Type 4 wetland hydrology resulting from the disruption of impermeable layers is considered negligible (WWLA, 2021a).

An analysis of the sub-catchment alteration pre-development versus post-development for each wetland on the Property has been prepared by McKenzie and Co (**Figure 22**).

McKenzie and Co Drawings 1976-1-450 to 1976-1-457 (, and the associated stormwater runoff calculations (SW-Q100-TP108 Calcs-Pre & Post) demonstrate that post development, the greatest change in wetland catchment area resulting from earthworks and contouring would be -5 % (Wetland C2 catchment – Drawing 1976-1-451). The average reduction in wetland catchment area is less than 1 %. Six of the twenty-three wetland catchments will increase in catchment extent by between 1 and 5 %.

This alteration in catchment size is unlikely to result in a measurable ecological effect to the localised wetland hydrology for any wetlands on the Property. In addition, the analysis demonstrates a very low change in the peak Q100 flow (m^3/s) for each sub-catchment, ranging from -0.25 (m^3/s) to +0.12 (m^3/s).

Given the minor changes to wetland catchment boundaries associated with proposed earthworks and contouring, potential changes in wetland hydrological function are considered to be well within what would be considered natural variation in flow volume. Given the 'colonising' nature of the wetland plant species within each wetland, and the resilience of these species to environmental changes (such as cattle browse, pugging, stock-generated nutrient saturation), the very small changes to flow that may arise are easily within the natural tolerances of the plant species present within the wetlands.

Overall, the actual or potential adverse ecological effects to the current or potential state of wetlands will be nil or negligible. In addition, there is unlikely to be a measurable change in wetland extent. Partial drainage, let alone complete drainage, of any wetlands is highly unlikely to occur as a result of the Project. The proposed retirement of large parts of the site from stock grazing, and protection of all wetlands from stock access will certainly improve water quality in those wetlands currently subjected to stock access and which have a substantial portion of their catchment in grazed land. Wetland extent is unlikely to improve with these changes, however hydrological functions such as water regulation, polishing, and habitat provision are expected to improve dramatically.

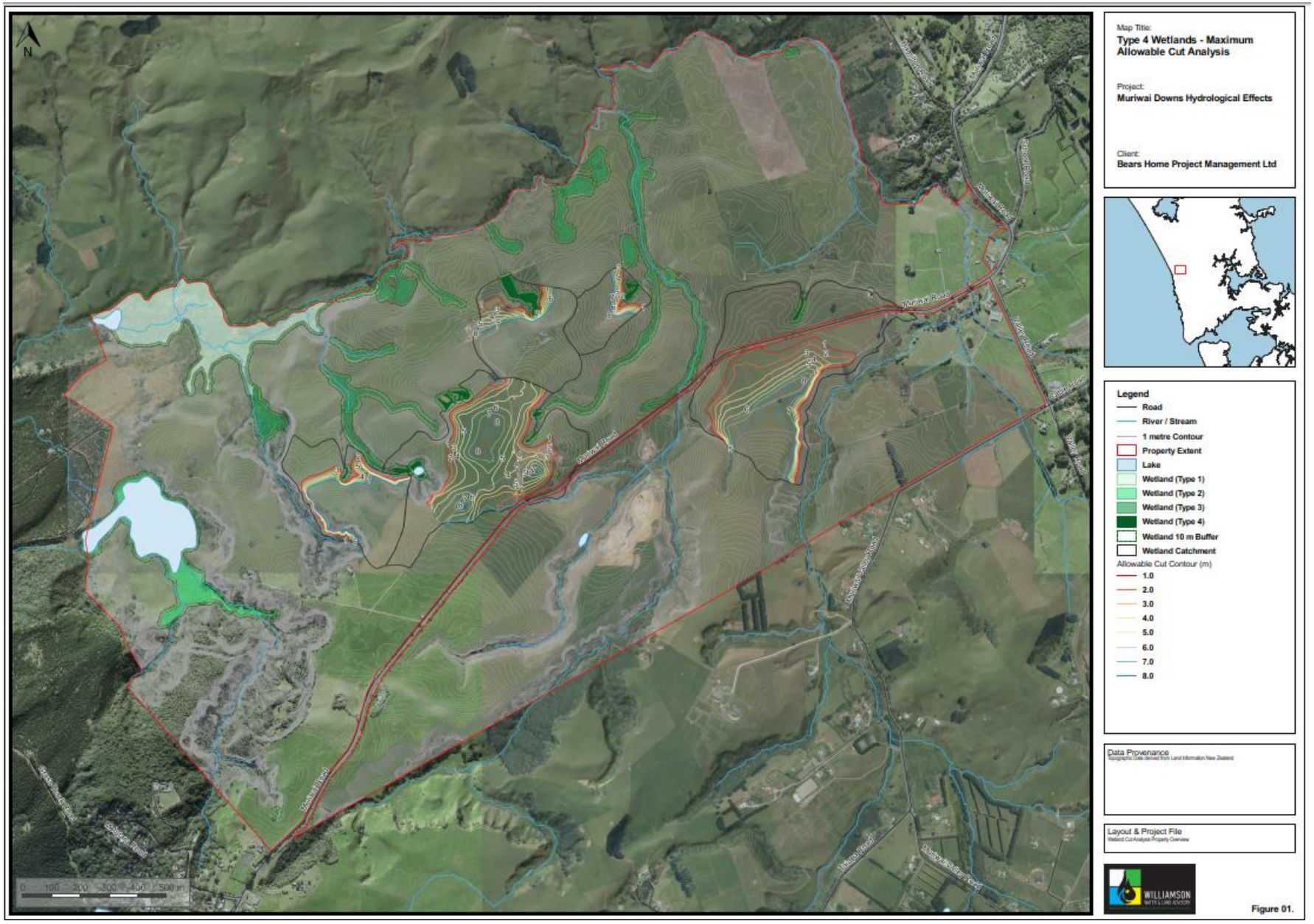

Figure 20. Type 4 Wetlands – maximum allowable cut analysis. Supplied by Williamson Water & Land Advisory Limited.

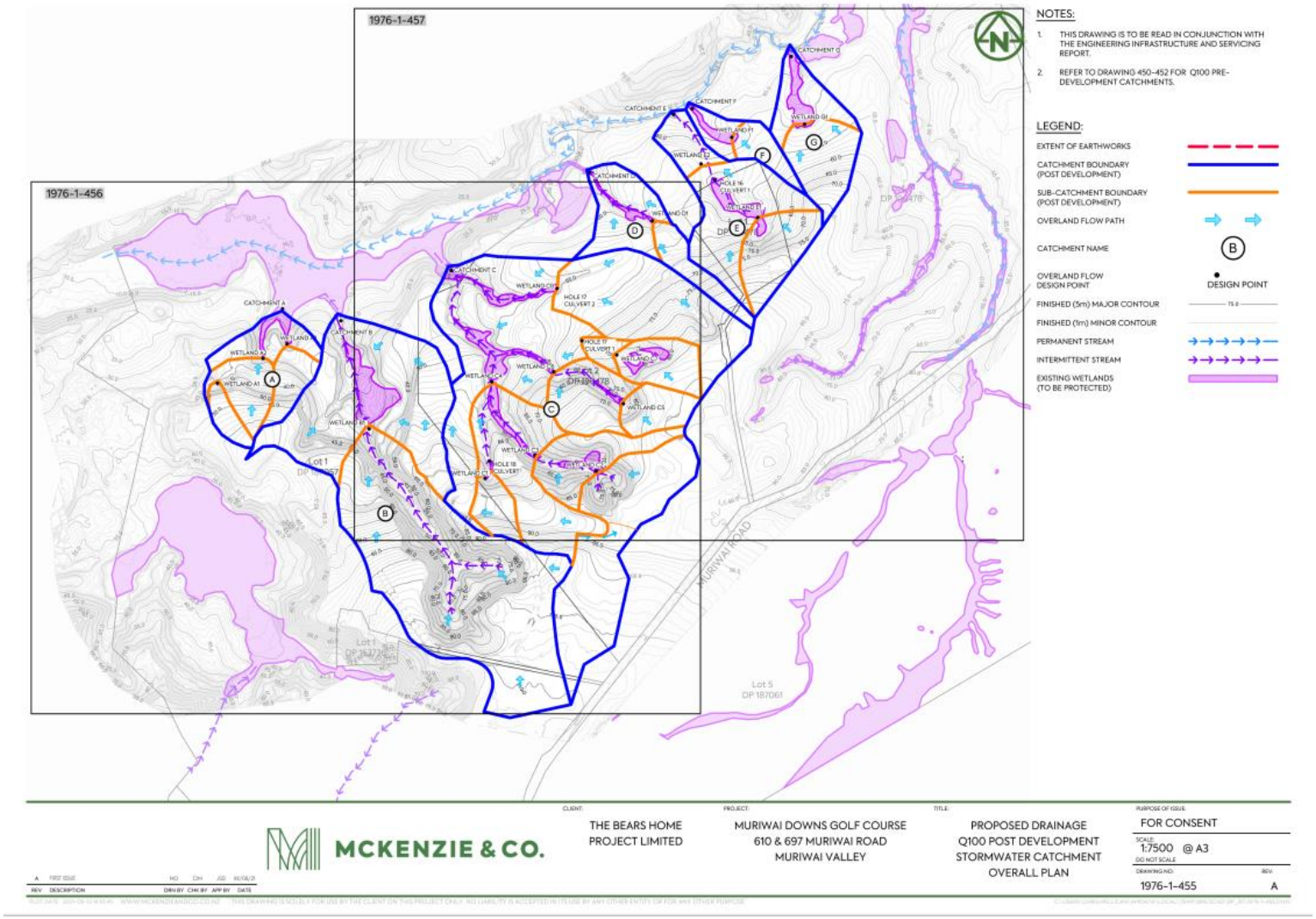

Figure 21. Proposed drainage Q100 post-development stormwater catchment plan. Supplied by McKenzie & Co Limited (Appendix 5 to AEE).

5.4.8 Lake Ōkaihau

Potential water related effects resulting from the proposed development on Lake Ōkaihau include changes to inflows, changes to outflows (i.e. artificial drainage), and changes in water quality resulting runoff from surrounding land where fertiliser application is proposed to maintain turf. Each of these effects are detailed in the WWLA report at Appendix 10 to AEE. The following conclusions are relevant to our assessment:

- No earthworks are planned within the surface water catchment to the south of the lake, and therefore there will be no change in inflows on this side of the lake. Minor earthworks and recontouring associated with the development of golf course Hole 2 are proposed along the northern margins of the lake. The proposed minor recontouring will maintain a gentle slope towards the lake similar to current, and thus minor surface water runoff into the lake will still occur along this lake edge. Based on the proposed site grading plans, change to inflows to the lake associated with site grading and contouring are considered to be no more than minor;
- Minor recontouring, but no major excavation, is planned along the northern margin of the lake, and additional flattening of the natural land surface approximately 200 m further north. As these are surficial grading and recontouring works, with no deep excavation that could develop tomos or preferential flow paths, the surficial earthworks will not cause or exacerbate seepage loss from Lake Ōkaihau; and
- A narrow margin of land along the north-western margins of the lake gently slopes down towards the lake, and therefore the lake will be subject to small contributions of surface runoff from this land during high intensity rainfall events. Provided best practice fertiliser application and management processes are followed (e.g. not applying fertiliser if heavy rain is forecast), the potential for fertiliser leaching or runoff to the lake is considered low.

Overall, potential ecological effects are considered to be negligible or unmeasurable. Combined with the enhancement works proposed for around the Lake (see Section 8) including stock removal and extensive revegetation plantings, the overall benefits of the Project to Lake water quality, buffering and ecological connectivity will be substantial and constitute clear net-benefits.

Additional potential adverse effects to Lake Ōkaihau include sediment discharges associated with earthworks (see Section 5.4.1) and golf balls in these environments (see Section 5.4.16). These potential effects are considered to be a low risk.

5.4.9 Stream modification

There are two streams that are proposed to be modified for the Project – Stream P3 and Stream I9. They are discussed in turn below.

Stream P3

The proposed development will result in the loss of ecological values associated with culverting and placing riprap over a total of 175 m of Stream P3.

Stream P3 consists of 190 m of a highly degraded and modified permanent stream, with a raupo dominated wetland in the upper catchment. The riparian vegetation has been cleared and now consists of short pasture grass and few exotic rushes (e.g. *Juncus effusus*), the stream bed and banks are completely channelised, and instream habitat for fauna is very limited due to instream

conditions consisting of a single shallow run with anoxic sediments supporting a mix of native and exotic macrophytes. The stream is expected to only support shortfin eel.

We have assessed this stream as having very poor ecological condition, and calculated an overall SEV current state score (excluding biological indices) of 0.279 and potential future state (with riparian planting and no instream modifications) as 0.405. The potential state for this stream is poor due to the significant modification of the watercourse via channelisation that cannot be remedied without extensive engineering interventions (e.g. recontouring to create habitat and morphological variation).

We have assessed the actual and potential adverse ecological effects of the five (5) key biophysical components on the Stream P3 current and potential future state (as per NES-F Appendix 1A) with culverting, as follows[6]:

- Water quality – the physical and chemical measures of the water, such as temperature, dissolved oxygen, pH, suspended sediment, nutrients and toxicants.
    - There will be no discernible change in water quality factors as almost all flow originates from the upstream wetland catchment, which will continue to managed in its current form (no change).
- Water quantity – the extent and variability in the level of flow of water.
    - There will be no discernible change in water quantity factors as the upstream catchment will be unchanged.
- Habitat - the physical form, structure and extent of the water body, its bed, banks and margins; its riparian vegetation; and its connections to the floodplain and to groundwater.
    - There will be a significant degradation in connectivity to the stream bed, margins and riparian vegetation across stream P3 as the culvert will severe the (poor) connections present.
- Aquatic life – the abundance and diversity of biota including microbes, invertebrates, plants, fish and birds.
    - There will be a significant localised degradation of macrophytes, invertebrates and fish across Stream P3 as the culvert will significantly reduce (but not eliminate) bed habitat and the ability to support these communities.
- Ecological processes – the interactions among biota and their physical and chemical environment such as primary production, decomposition, nutrient cycling and trophic connectivity.
    - There will be a significant degradation in all localised ecological processes across Stream P3 as the processes within this reach of the stream will be severed or reduced to simple pathways.

Overall, the modification of 175 m of Stream P3 will result in a moderate scale of magnitude, and result in a permanent ecological effect at the scale of the localised Stream P3 environment.

Considering the highly degraded state and poor potential future state, the culverting and placement of riprap on a 175 m reach of Stream P3 will have a low adverse ecological effect in respect of the wider Ōkiritoto Stream catchment due to the small magnitude of the effect (< 0.1 % of the total catchment), and relatively small change in ecological value and functions between its current state and proposed culverted state.

[6] The elements of biophysical components are described below, followed by an assessment of these components for Stream P3.

Stream I9

Stream I9 is a small intermittent stream, with the lower reach within a native forest catchment. The reach of stream proposed to be infilled consists of a small, predominantly dry channel, that does not have suitable habitat to support fish (i.e. pools are too shallow), and the intermittent nature prevents significant colonisation of freshwater macroinvertebrates and macrophytes. We have assessed this stream as having moderate ecological condition, and calculated an overall SEV score (excluding biological indices) of 0.469 and potential future state (with planting – albeit few opportunities given its already planted state) as 0.475. There is little change in potential future state due the existing riparian vegetation already consisting of seral (young) kānuka.

We have assessed the actual and potential adverse ecological effects of the five (5) key biophysical components on the Stream I9 current and potential future state, as follows[7]:

- Water quality - There will be no discernible change in water quality factors in Stream I9.
- Water quantity – There will be no discernible change in water quantity factors in Stream I9.
- Habitat - There will be no discernible change in habitat factors in Stream I9.
- Aquatic life – There will be no discernible change in aquatic life in Stream I9.
- Ecological processes – There will be no discernible change in ecological processes in Stream I9.

Overall, the infilling of 16 m of will have a very small magnitude of effect to the current and potential future state of Stream I9 and therefore will result in a low level of permanent ecological effect to the localised stream environment (Stream I9). This equates to less than minor effects.

In addition, there will be a negligible adverse ecological effect to the wider Ōkiritoto Stream catchment due to the small magnitude of the effect (< 0.01 % of the total catchment).

The level of loss of ecological value and functions arising from the combined culverting of Stream P3 and infilling of Stream I9 will be negligible at the scale of the Ōkiritoto Stream catchment.

With appropriate mitigation, potential effects on loss of fish and barriers to fish passage can be addressed (see next sections).

The level of residual adverse ecological effect that is likely to result (after mitigation has been applied) for Stream P3 is moderate, while for Stream I9 the level of adverse effect will be low.

It is best practice to address moderate residual effects (eg effects on Stream P3) through ecological redress in the form of a biodiversity offset – and we understand that the AUP requires this for this level of residual adverse effect. Stream offsetting (i.e. the selection of appropriate candidate stream enhancement sites as offset locations) is typically undertaken at the level of a catchment, although Auckland Council routinely approves offset sites that are instant from affected streams (e.g. several catchments separation).

In order to offset residual ecological effects of works on Stream P3, restoration works are proposed, the details of which are provided in Section 7.0.

[7] The elements of biophysical components are described above in the context of Stream P3, the assessment of these components for Stream I9 is provided here.

5.4.10 Fish passage

One culvert is proposed within a permanent or intermittent stream on the Property. This includes an approximately 160m culvert and approximately 15 m of riprap (rounded to 175 m affected stream in total) proposed for Stream P3 (**Figure 23**).

The attributes that require consideration for fish passage include water depth and velocity through the culvert, as well as preventing any vertical lips or overhangs at the inlet or outlet (NES-F: Regulation 70). As a general rule of thumb, a minimum water depth of 150 mm should be sufficient for passage of adult native fish[8].

With regard to the Stream P3 culvert, water velocity is the main factor influencing the upstream passage of fish. Ideally, a culvert span should seek to be greater than 1.3 x bank full width to meet the Fish Passage Guidelines (NIWA 2018)[9]. This is to ensure that there is no constriction of water through the culvert and that increased water velocities are minimised. Where this is not achievable, alternative solutions to mitigate water velocities can be provided (as discussed below).

To make upstream progress through a culvert, fish must be able to swim at a speed that exceeds the velocity of water in which they are swimming. Fish swimming ability increases with the size of fish. Given that the majority of New Zealand's native fish species migrate upstream at a small size, they require more conservative design criteria for ensuring fish passage. In this situation, the maximum allowable water velocity is defined by the requirements of the weakest species and/or life stage. Of the species recorded within the Ōkiritoto Stream catchment, shortfin eel, longfin eel and banded kōkopu are diadromous (spend portions of their life cycles partially in fresh water and partially in salt water) and could possibly undertake an upward migration within Stream P3. Migration is limited to only strong climbers that can pass over the Toroānui Falls.

In order to meet the latest Fish Passage Guidelines, reinforced by the NES-F (Regulation 70), a culvert should:

- Have sufficient stream embedding (200-300 mm) within the stream to ensure a continuous wetted surface;
- All culverts should be of a relatively flat gradient (1-2 %) as not to significantly increase flow velocity within the culvert;
- The inlet and outlet structures should not have any overhangs or vertical lips; and
- Each culvert span should seek to be greater than 1.3 x bank full width such that the constriction of water through the culvert and increased water velocities are minimised, thereby providing for effective fish passage.

For this Property, the existing stream width of Stream P3 has been modified, and the 2-3 m wide channel does not reflect the natural channel size that is expected from the small upper catchment. Based on the size of the catchment, the proposed 900 mm culvert is unlikely to significantly constrict instream flows during mean annual flow. However, the proposed gradient of 5.15 % will likely increase flows beyond fish swimming abilities, if no mitigation or remediation works are

[8] NIWA 2018. New Zealand Fish Passage Guidelines. For structures up to 4 metres.

proposed. To facilitate fish passage, baffles will be installed through the culvert. Baffles placed inside the culvert pipe are able to:

- Reduce velocity;
- Increase depth;
- Interrupt laminar flow;
- Extend range of flow characteristics;
- Retain stream bed material; and
- Create high and low flow passage.

Provided baffles are installed as per the proposed design (McKenzie and Co. 2021a, Appendix 5 to AEE), fish passage for the applicable species is likely to be achieved.

To monitor the effectiveness of the fish passage recommendations, a post-installation fish passage survey should be undertaken. The survey should be undertaken for the new culvert by a suitably qualified freshwater ecologist. This should be undertaken when first practicable following the first significant rain fall event (>100 mm in 24 hours) post-livening. The purpose of the survey will be to assess if any damage or changes to the culvert and riprap channel have occurred which may inhibit fish passage. Recommendations for any repairs, adjustments or retrofitting new structures should be made where applicable. A report detailing the outcome of the survey should be made available to Auckland Council upon request.

5.4.11 Fish salvage

To minimise potential adverse ecological effects to native fish, salvage of native fish from Stream P3 will be undertaken prior to instream works. The salvage of native fish will be undertaken by a qualified expert and in accordance with a Native Freshwater Fish Salvage and Relocation Plan outlining the approach for salvage and the location(s) where salvaged species will be released.

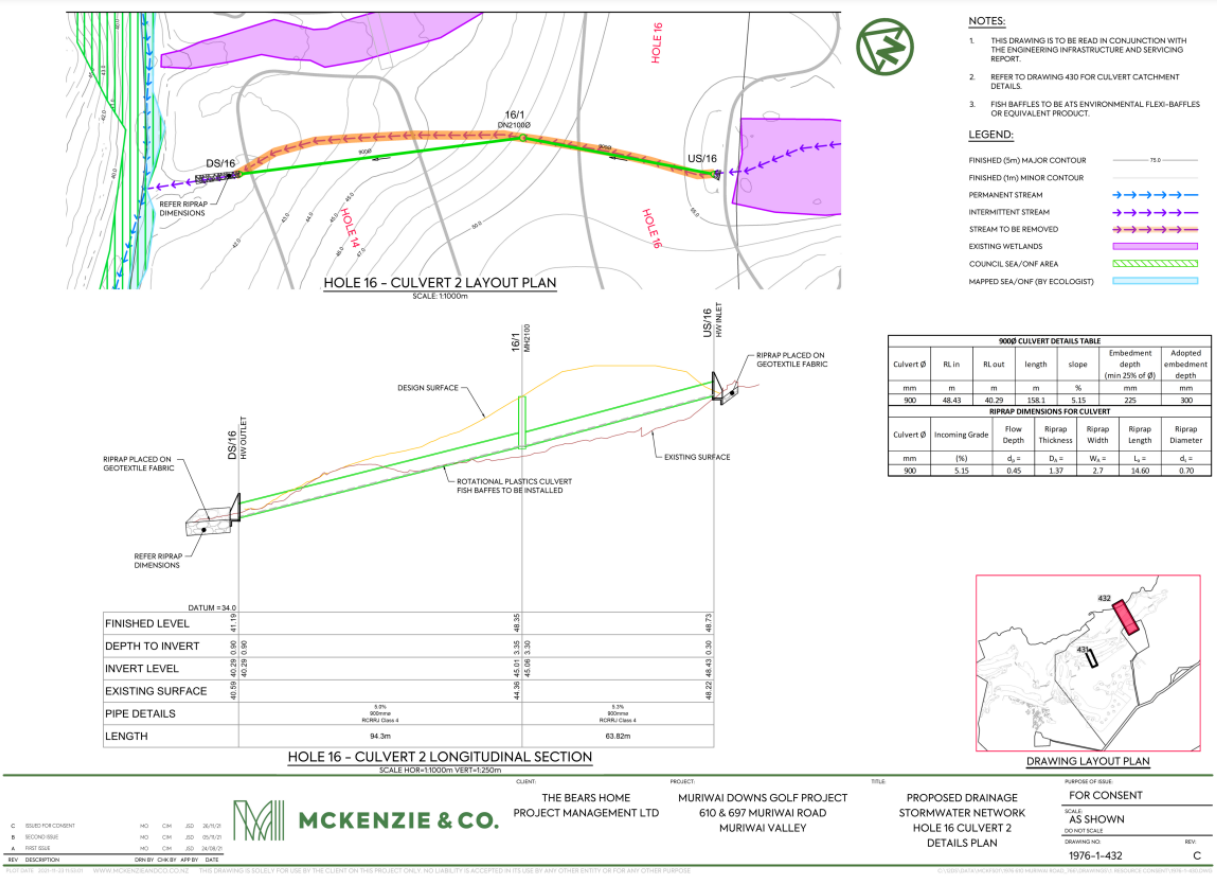

Figure 22. The proposed culvert design at Stream P3. Figure supplied by McKenzie and Co. 2021a, Appendix 5 to AEE).

5.4.12 Indigenous vegetation clearance

Indigenous vegetation clearance has been avoided and minimised to the greatest extent practicable. As discussed above, ecological considerations have been factored into the design process. The design has sought to avoid and minimise vegetation clearance and where such clearance cannot be avoided, has sought to reduce the amount of clearance and to remove vegetation which is less mature and rare, protecting old growth specimens or those that are less common in the local environment or those that are likely to support more complex animal or plant communities (i.e. those that are typically large, old and are canopy trees).

There are 13 locations on the Property that require indigenous vegetation clearance for the proposed development. Extensive detail, photographs and figures are provided in the Arboricultural Effects Assessment report prepared for the Property (Peers Brown Miller Limited 2021, Appendix 12 to AEE). The key areas relating to indigenous vegetation clearance are summarised in **Table 13** below.

Indigenous vegetation clearance includes clearance of young and mature trees outside of SEAs with no formal protections under the AUP, and approximately 1,396 m^2 of vegetation on the margins of SEA_T_5525. The overall extent of indigenous vegetation clearance within SEA_T_5525 has been calculated based on vegetation mapping undertaken by RMA Ecology, rather than relying on SEA boundaries mapped by Auckland Council. This is due to SEA boundaries being inaccurately mapped, and including areas of surrounding pasture. Examples are provided in **Figures 24** and **25** below.

In addition to clearance within SEA_T_5525, nine (9) mature native trees within pasture areas are proposed for clearance; these include tōtara, pōhutukawa, ti kouka, kahikatea and kānuka.

Where practicable, all significant trees within the proposed fairway and green areas will be retained. Any works within the Protected Root Zone (PRZ) are to be minor and involve the augmenting of the existing ground for the preparation of new turf or rough grass areas (Peers Brown Miller Limited 2021, Appendix 12 to AEE). We note that these trees stand in areas that are heavily grazed, with evidence of stock compaction and browsing. The removal of stock from the proposed golf course footprint will greatly improve the long-term prospects for these trees from a longevity perspective.

Methodologies for minimising effects to the surrounding forest and mature indigenous trees are outlined in the arboricultural report, including:

- Root protection protocols to avoid major root systems, and minimise effects on roots during excavations;
- Storage of excavated materials outside of the forest areas; and
- Pruning / crown lifting overhanging branches to facilitate keeping mature trees while maintaining a safe distance between trees and earthworks, and preventing potential harm to people using the site.

The following processes will be undertaken prior to all indigenous vegetation clearance within SEA_T_5525. These processes will be detailed as requirements in the EMP and the draft CEMP:

- Surveyors will mark out the extent of the clearance using equipment suitable for accurate delineation beneath forest canopies;
- The extent of clearance within SEA_T_5525 will be confirmed onsite by the Project Ecologist. A precautionary approach to clearance will be undertaken along the outer boundary extent, and where opportunities arise to minimise/ avoid significant vegetation, additional measures will be undertaken;
- The Project Ecologist, will identify and mark any stems and coarse woody debris that could be salvaged for restoration plantings;
- The extent of SEA_T_5525 that is to be retained will be delineated with appropriate fencing or flagging and identified with signage;
- The potential presence of indigenous fauna will be determined by the Project Ecologist and any specialist assessments or species salvage carried out as required; and
- Before works commence a vegetation clearance checklist will be completed with appropriate sign-off from the Project Ecologist confirming vegetation protection and species salvage has been completed.

Vegetation clearance includes mostly common native species. While some trees proposed to be cleared are classified as ‘Threatened’, we consider kānuka, mānuka and pōhutukawa as common native species, with their presence on this Property to be regarded in the context of their ecological value, rather than their precautionary conservation listing. The draft National Policy Statement for Indigenous Biodiversity supports this approach, making it clear that kānuka and mānuka should not be included in assessments of vegetation significance on the basis of its listing on the Threat Classification lists.

Clearance of vegetation within SEA_T_5525 consists of approximately 1,396 m^2 of vegetation on the margins of the forest, which constitutes ca. 1.3 % of the total area of SEA_T_5525 and 0.18 % of the total area of SEA forest within the property. In this total we have included vegetation that intersects the Project footprint from a bird's-eye-view; and for many of these smaller clearance areas, the clearance will not require the removal of whole trees, but rather trimming. In some cases, the intersect of the golf footprint with vegetation may represent an overlay of tree shadow, with a resultant outcome that no clearance will be necessary. Therefore, our assessment of the total clearance area of indigenous vegetation is conservative.

Mitigation planting that is proposed to be undertaken along the margins of SEA_T_5525 totals 12,731 m^2 or almost 10 times the area proposed to be cleared.

The actual and potential adverse effects associated with indigenous vegetation clearance is considered to be negligible, and a clear overall net-gain ecological outcome will result from the mitigation planting and voluntary restoration and enhancement planting proposed by the Applicant.

Table 13. Indigenous vegetation clearance details associated with Muriwai Downs Golf Project.

Location	Activity	Area	Vegetation	Minimisation strategy
Hole 1	Fairway area	180 m^2	Kānuka forest on the margin of SEA_T_5525 and a number of common native plants within the understory including karo (*Pittosporum crassifolium*), nikau (*Rhopalostylis sapida*), and ground ferns (*Doodia australis* and *Pteris tremula*) (**Plate 16**).	The extent of the proposed vegetation clearance in this area has been selected to avoid mature puriri trees immediately adjacent to the kānuka.
Hole 7	Pedestrian bridge	N/A	Mānuka saplings, and minor pruning of adjacent vegetation	The extent of the proposed vegetation clearance in this area has been selected to avoid mature native trees either side of the access bridge.
Hole 7	Green area	N/A	Crown lifting a mature kohekohe tree.	The kohekohe tree canopy will be crown lifted, with approximately 20 % of the lower canopy pruned, in accordance with best arboricultural practice
Hole 7 to 8	Pedestrian bridge	183 m^2	A discrete patch of forest within SEA_T_5525 as part of constructing a 4 m wide bridge to gain access to the proposed Hole 8 tee location. This will include the removal of young kānuka, mahoe and a mature tawa tree, with nikau, kawakawa (*Piper excelsum*) and seedlings within the understory (**Plate 17, Figure 27**).	The extent of the proposed vegetation clearance in this area has been selected to avoid mature native trees either side of the access bridge.

Hole 8	Tee area	380 m^2	Patches of mānuka scrub on the margins of SEA_T_5525. A single mature kahikatea tree (**Figure 26**)	The extent of the proposed vegetation clearance in this area has been selected to avoid mature native trees surrounding the proposed tee area. The kahikatea tree requires clearance due to it's poor condition and safety considerations.
Hole 8	Access track	170 m^2	Nikau seedlings within an area dominated by pasture grasses (**Figure 26**).	Alignment selected based on a previous track in the area to avoid mature vegetation with SEA_T_5525.
Hole 8	Sight line for fairway	419 m^2	Kānuka scrub on the margin of SEA_T_5525, with predominately pasture grass groundcover and occasional kawakawa and small leaved coprosma seedlings (**Figure 26**)	The extent of the proposed vegetation clearance in this area has been selected to avoid mature pōhutukawa immediately adjacent to the area
Hole 1 to 9	Pedestrian bridge	60 m	Forest on the margin of SEA_T_5525, including pruning one (1) mature pōhutukawa, two (2) kānuka and two (2) harakeke (*Phormium tenax*) and a cluster of mānuka (**Plate 18, Figure 28 and 29**).	The extent of the proposed vegetation clearance in this area has been carefully selected to avoid mature trees on the upper banks and within the lower gully.
Hole 16	Pedestrian bridge	N/A	Small patch of regenerating ti kouka and karamu (*Coprosma robusta*) saplings.	Care will be taken to avoid significant indigenous vegetation, with ti kouka growing within the central area of the wetland to be retained and protected, with the bridge to be constructed around any such vegetation.
Hole 18	Fairway area, pedestrian bridge, green.	N/A	The removal of one (1) dead kauri tree with kauri dieback disease, one (1) mature kauri tree, and two (2) mature karaka tree. Pruning of one (1) mature karaka tree and one (1) kahikatea tree.	The extent of the proposed vegetation clearance in this area has been selected to largely avoid mature native trees immediately adjacent to the area. Pruning will be undertaken in accordance with best arboricultural practice.
Lodge	Access road	N/A	The removal of one (1) mature tōtara tree.	The extent of the proposed vegetation clearance in this area has been selected to avoid mature other mature native trees (e.g. Pōhutukawa) immediately adjacent to the existing access road.

Clubhouse	Clubhouse and practice fairway area	N/A	The removal of two (2) dead kauri trees, two (2) mature kauri trees, one (1) mature tōtara tree, and four (4) mature ti kouka.	Nil.
Entrance	Road	N/A	One (1) planted, mature pōhutukawa	The extent of the proposed vegetation clearance in this area has been selected to avoid the native scrub vegetation on the southern road margin which consists of kānuka, harakeke, mapou and provides habitat for 'At Risk' copper skink.

Plate 17. The proposed extent of clearance (red area) at the margin of SEA_T_5525, consisting of young kānuka and ground ferns at the head of a gully.

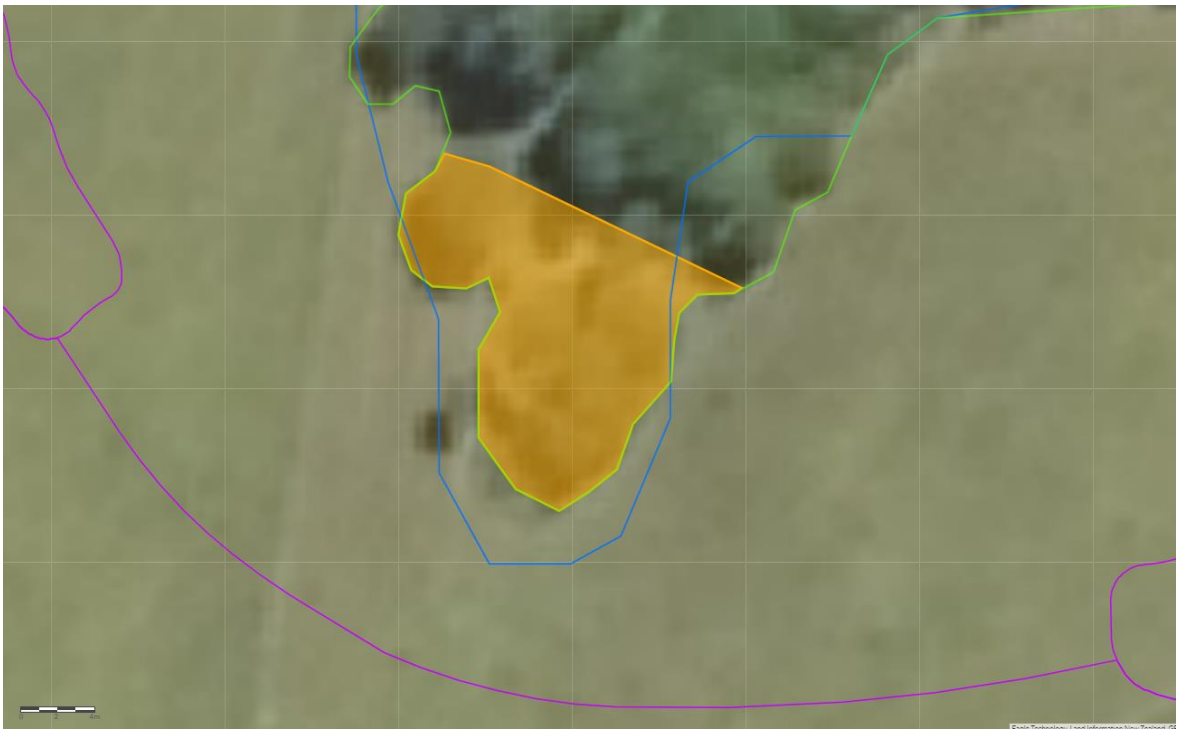

Figure 23. SEA_T_5525 boundary mapped by Auckland Council (blue line), indigenous vegetation mapped by RMA Ecology Ltd (green line), proposed extent of vegetation clearance as mapped on the ground (orange shaded area), course layout purple line.

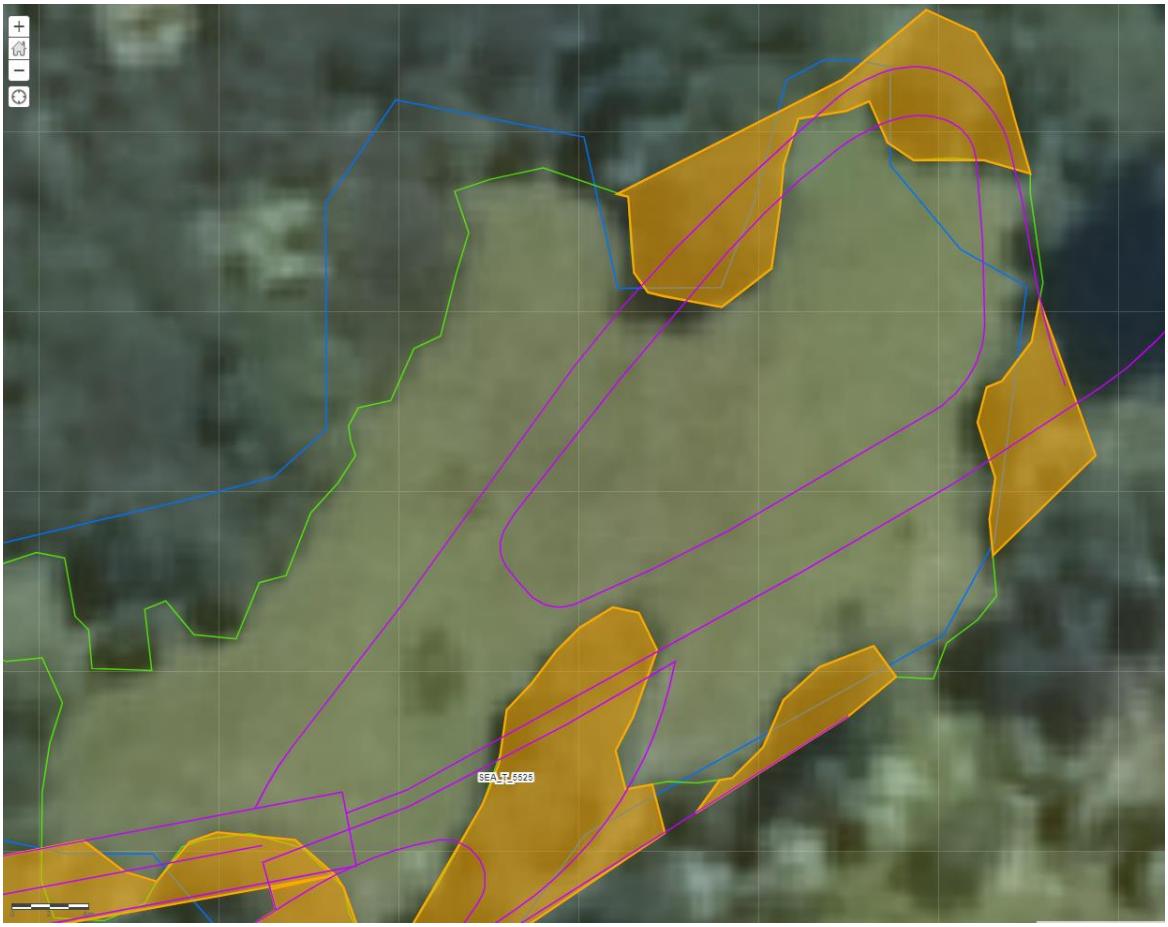

Figure 24. SEA_T_5525 boundary mapped by Auckland Council (blue line), indigenous vegetation mapped by RMA Ecology (green line), proposed extent of vegetation clearance as mapped on the ground (orange shaded area), course layout purple line.

Figure 25. SEA_T_5525 boundary mapped by Auckland Council (blue line), indigenous vegetation mapped by RMA Ecology Ltd (green line), proposed extent of vegetation clearance as mapped on the ground (orange area), course layout purple line.

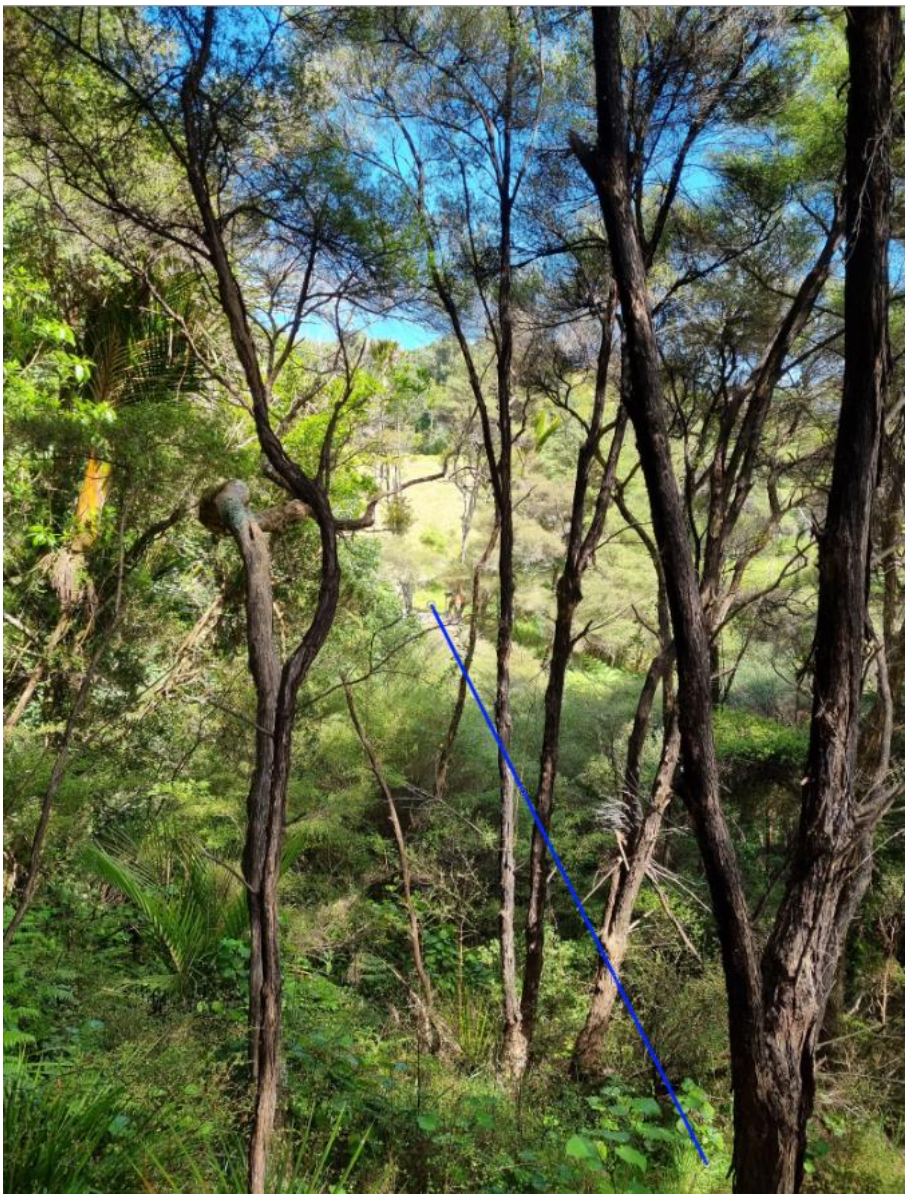

Plate 18. The approximate bridge alignment between Hole 8 and 9 (blue line). Image supplied by Peers Brown Miller Limited.

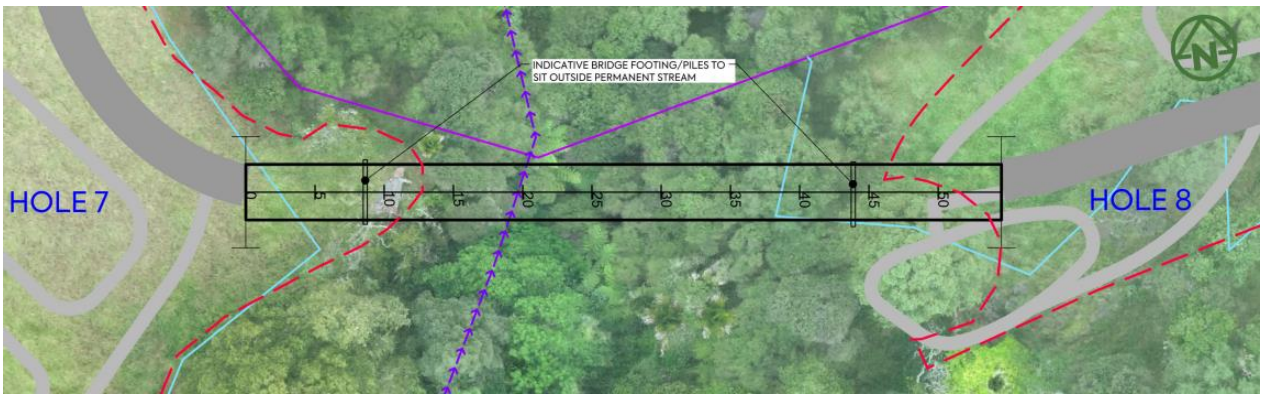

Figure 26. The proposed access bridge location between Hole 7 and Hole 8. Image supplied by Peers Brown Miller Limited.

Figure 27. The proposed access bridge location between Hole 1 and Hole 9. Image supplied by Peers Brown Miller Limited.

Figure 28. The proposed access bridge location between Hole 1 and Hole 9. Image supplied by Peers Brown Miller Limited.

5.4.13 Kauri management

The proposed development will include the removal of two mature kauri trees within grazed pasture areas, as well as the removal of dead, standing kauri trees (Peers Brown Miller Ltd 2021at Appendix 12 to AEE).

The presence of kauri dieback disease has been identified within the Property. A number of large kauri trees in pastoral areas have died and are standing dead, with dead trees and canopy dieback visible in a number of gulley and ridgeline kauri stands. As such, all kauri within the Project area will be treated as affected by kauri dieback disease and managed in accordance with the current biosecurity guidelines provided by the Ministry for Primary Industries and Auckland Council. This will include undertaking all works in accordance with Chapter E11.6.2 – Note 1 (6) of the AUP, which states the following:

> *(6) To prevent the spread of contaminated soil and organic material with kauri dieback disease, vehicle and equipment hygiene procedures must be adopted when working within 3 times the radius of the canopy drip line of a New Zealand kauri tree. Soil and organic material from land disturbance within 3 times the radius of the canopy drip line must not be transported beyond that area unless being transported to landfill for disposal.*

The management of kauri dieback within the Project area includes the management of soil and vegetative material during and post-earthworks (**Figure 30** and **Figure 31**).

Soils potentially infected by kauri dieback will be stockpiled separately and only used on the Property in areas that avoid the potential infection of kauri trees that are not already infected.

All woody / vegetated material proposed for removal will be disposed of (e.g. buried).

The proposed management protocols and principles relating to kauri dieback are provided in the draft CEMP (McKenzie and Co, 2021 and Peers Brown Miller Ltd 2021 at Appendices 18 and 12 to AEE respectively).

Provided kauri removal and works in proximity to kauri are managed to Council standards, the actual and potential adverse effects on the population locally and regionally are very low.

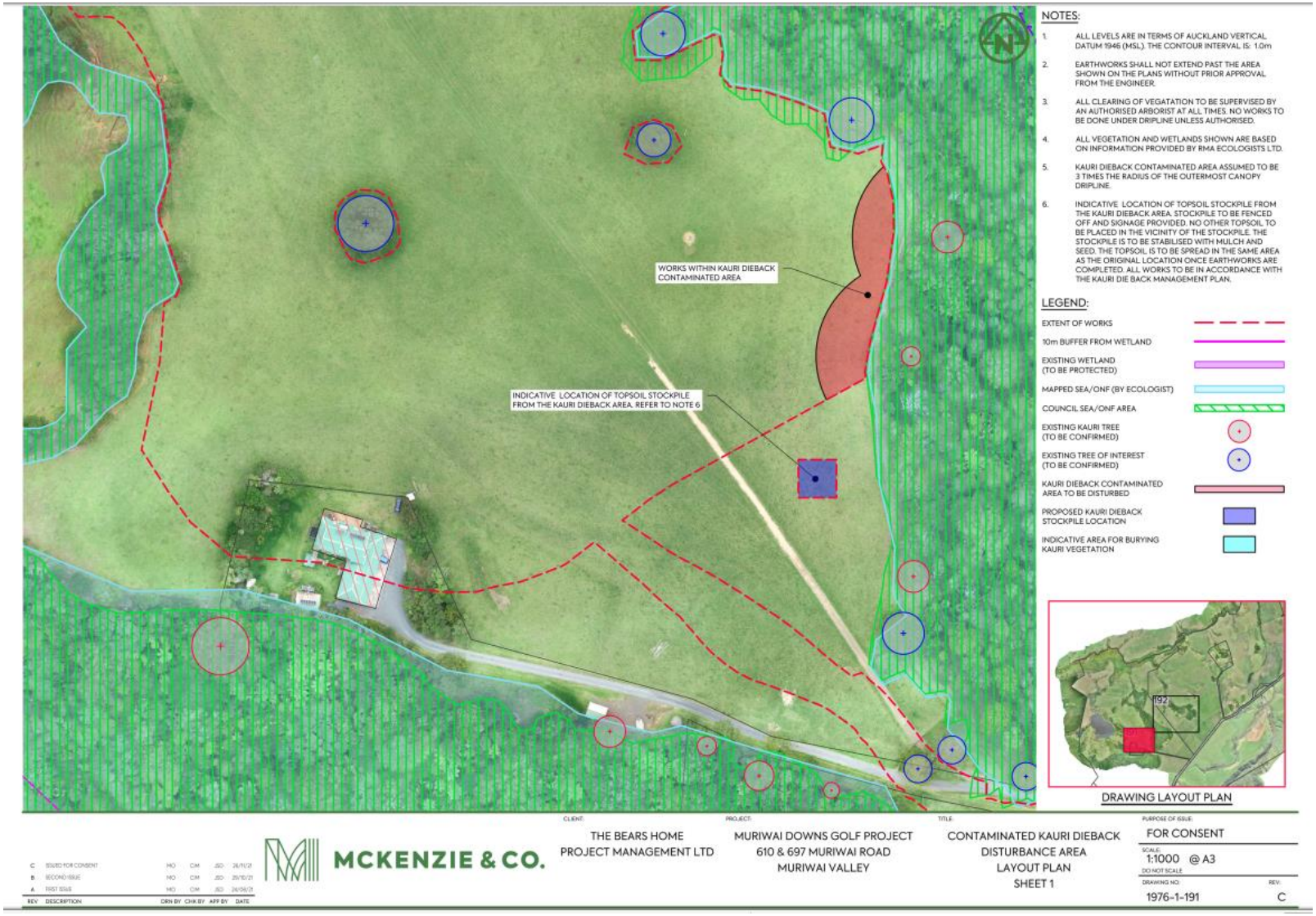

Figure 29. The contaminated Kauri Dieback disturbance areas within the site. Figure supplied by McKenzie and Co.

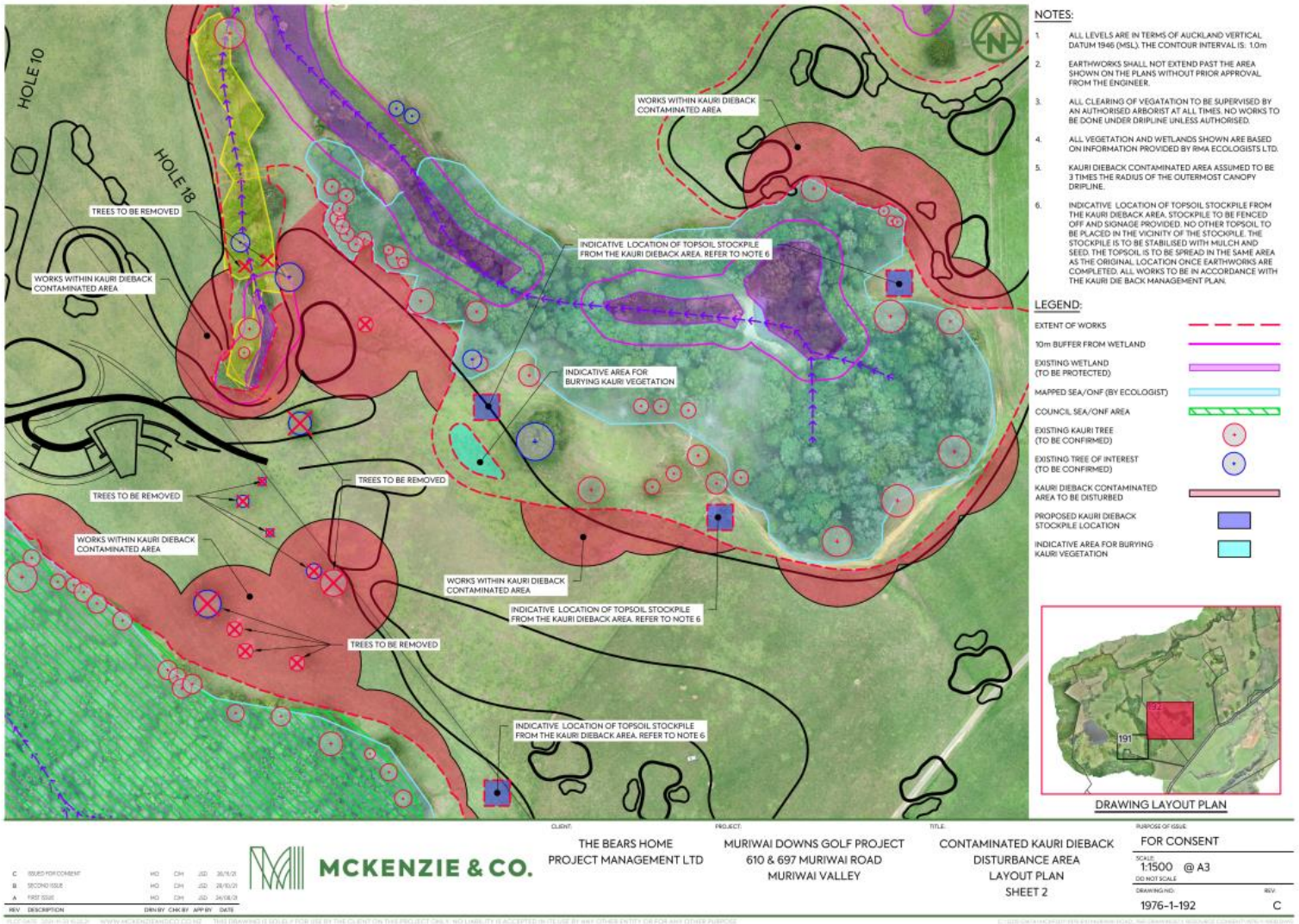

Figure 30. The contaminated Kauri Dieback disturbance areas within the site. Figure supplied by McKenzie and Co.

5.4.14 Lizard management

The areas of rank grass, and thick weedy vegetation surrounding the edges of forests, wetlands, and riparian vegetation on the Property provide suitable habitat for native skinks. In addition, the mature native forest and regenerating kānuka shrublands provide suitable habitat for native arboreal geckos.

The quality and extent of habitat for native lizards on the Property will not be significantly altered from the existing state. However, vegetation clearance poses a direct risk to 'At Risk' native lizard species including copper skink, ornate skink, elegant gecko and forest gecko if these species are present at this property (which we consider to be a high likelihood).

All native lizards are protected under the Wildlife Act 1953 (s63 (1)(c)). To avoid and minimise actual and potential adverse effects to native lizards, lizard-sensitive clearance protocols will be adopted. The survey and salvage, where necessary, of native lizards from areas of potential habitat will be undertaken in accordance with a Lizard Management Plan that will be prepared for the Property.

At this Property, this means ensuring that pasture grassland is progressively grazed down to a low-level by stock to remove clumps of dense pasture and allow any potential resident skinks to naturally disperse into surrounding habitats. If this is not achieved prior to earthworks commencing, a preclearance lizard survey will be undertaken by a DOC-permitted herpetologist to determine if native lizards are present within these areas on the Property.

In areas of contiguous indigenous vegetation (e.g. clearance within SEA_T_5525) lizard-sensitive clearance protocols will include ensuring that any tree crowns or branches felled are left on site on the ground for at least two weeks prior to mulching or removal to a final destination. That will ensure that if lizards are present within foliage or branch/trunk sections that they can leave of their own volition and seek refuge in live vegetation nearby.

Provided effects to lizards are managed to DOC standards, the actual and potential adverse effect to the population(s) locally (within the Property) and at catchment or district level will be negligible.

5.4.15 Avifauna management

With the exception of black shag, the birds recorded from the Property are all widely distributed throughout the Auckland region, and in most cases, throughout rural landscapes in general.

However, to avoid potential adverse effects to 'Threatened' or 'At Risk' nesting birds associated with vegetation clearance, a precautionary approach will be adopted. As such, the construction methodology will seek to undertake tree clearance outside of the key breeding period for native forest birds (breeding period is September to January inclusive). Where tree clearance cannot avoid the bird breeding period, any areas proposed for vegetation clearance will be assessed by a suitably qualified and experienced ecologist to ensure that 'Threatened' or 'At Risk' species of native birds are not breeding within those areas. These approaches will be included in the EMP.

Provided the above-mentioned mitigations are applied, the actual and potential adverse effect to the population(s) locally and regionally is likely to be very low.

5.4.16 Long-tailed bat management

At this Property, the likelihood of bats being present within mature forest areas adjoining parts of the development footprint indicates that undertaking a preclearance survey where potential roosting trees are

proposed to be removed would serve to avoid and minimise the risk of harm to bats, and therefore will be undertaken prior to the clearance or trimming of mature trees.

It is acknowledged that bats forage over wide areas, and given the suitability of the habitat within the Property, a survey in the stands of mature trees to be cleared will be undertaken to confirm presence/absence. The survey will be undertaken in general accordance with industry best practice outlined both the Bat Management Framework set out by Waka Kotahi New Zealand Transport Agency[10] (Smith *et al.,* 2017) and the DOC's best practice manual of conservation techniques[11] (Sedgeley *et al.,* 2012).

The Bat Management Framework protocols aim to provide clear procedures that are to be followed prior to the removal of all trees in the proposed area of vegetation clearance, with the goal of avoiding mortality or injury to long-tailed bats during clearance activities.

Trees that have potential to be used as a maternity roost will not be removed during the bat maternity period of November – February, and all relevant vegetation clearance work will be in accordance with Wildlife Act permit(s) issued by DOC.

The above-mentioned mitigations will be included as part of the EMP.

Provided effects to long-tailed bats are managed to DOC standards, the actual and potential adverse effect to any population(s) utilising the Property is likely to be very low.

5.4.17 Lighting

The potential ecological effects associated with an increase in artificial light and the magnitude of the adverse effects resulting in disturbance generally on wildlife is difficult to assess. It is assumed that the sensitivity of animals to lighting is moderate, based on previous exposure to light disturbance from streetlights in Muriwai village and the wider peri-urban environment. Even when there are obvious lighting effects on wildlife, such as changes in behaviour, it is not possible to state that the observed responses are detrimental to the population, without being able to link them to long-term changes in breeding success, mortality, population size or fitness.

In order to minimise potential light effects to indigenous fauna (e.g. long-tailed bats, seabirds transiting through the Muriwai local area at night), the proposed lighting for the Property includes a number of design features to reduce ambient light spilling into forest and wetland habitats, as well as wider pasture areas, including:

- Lighting design that requires light shields/buffers on pathways or internal road lights or downlights to minimise light spillage;
- Downlights included in buildings and paths to be down-facing only; and
- No flood lights within areas facing forest vegetation.

Indicative lighting concepts are provided in **Figures 32** to **35**.

Lighting near to native forest/SEA areas will comprise of downlights and shielded lights. These are the areas where, if bats are present, the greatest risk of adverse effects on bats could arise.

[10] Smith, D., Borkin, K., Jones, C., Lindberg, S., Davies, F., & Eccles, G. (2017). Effects of land transport activities on New Zealand's endemic bat populations: review of ecological and regulatory literature. NZ Transport Agency research report 623.

[11] Sedgeley, J., O'Donnell, C., Lyall, J., Edmonds, H., Simpson, W., Carpenter, J., Hoare, J., McInnes, K. 2012. DOC best practice manual of conservation techniques for bats. Inventory and monitoring toolbox: bats DOCDM-131465. Department of Conservation, Wellington.

Flood lights will be used on the driving range. However, the direction of lighting and location of the floodlights will be far from forest areas and distant from the main river and open streams that are likely to attract bats (if they are present) as foraging sites.

For nocturnally active seabirds using the Flyway, the above lighting design guides that minimise spillage should also minimise the risk that seabirds will be attracted or distracted from their natural flight path. We note that the Flyway includes substantial areas of Auckland city, townships, villages and rural lifestyle areas that each contain a wide range of lighting types and have extensive lighting. It is unlikely that the addition of lighting for the Muriwai Downs Golf Project will add significantly to this, especially if the above design criteria are followed.

Overall, the potential effects of lighting on bats (if present) and seabirds is unknown. However, the design criteria and placement of major sources of lighting will be designed to minimise light spillage and minimise the potential to change the behaviour of these species.

Figure 31. An indicative concept of lighting for the proposed driving range. Source Bernardus Range.

Figure 32 An indicative concept of lighting for the proposed driving range. Source Bernardus Range.

Figure 33 An indicative concept of lighting for the proposed driving range. Source Bernardus Range.

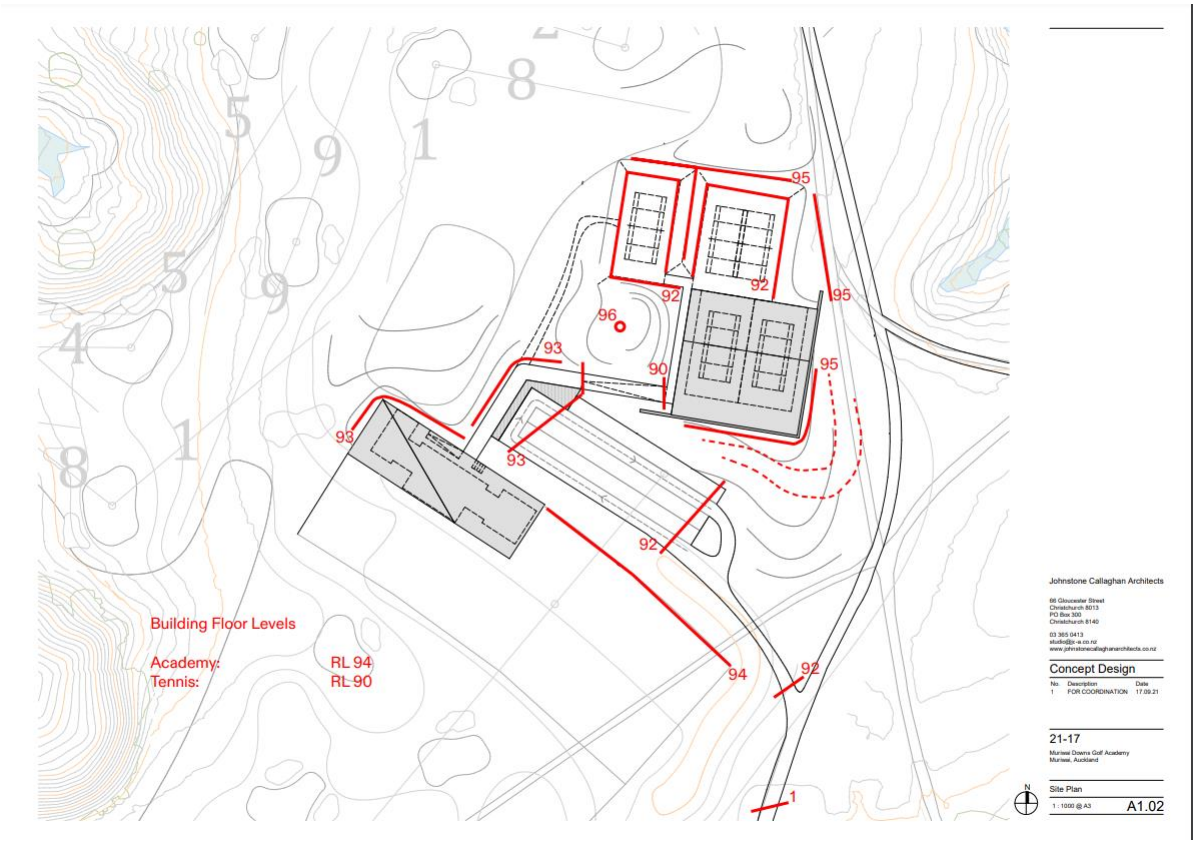

Figure 34. Lighting area concept. Figure supplied by Johnstone Callaghan Architects Limited.

5.4.18 Golf balls in the environment

The proposed golf course is likely to result in golf balls straying from playing surfaces and entering into sensitive receiving environments, including native forest remnants, wetlands, streams, and Lake Ōkaihau. If golf balls enter sensitive receiving environments, there is the potential for adverse effects.

We understand that the design principles for the golf course include wide fairways with wide areas on the opposite side of any hole where wetlands or other sensitive areas run alongside. This design approach is expected to result in fewer golf balls being hit into sensitive receiving environments (Kyle Phillips Golf Course Design, 2021, Appendix 2 to AEE).

Based on the proposed business model for the development, approximately 12,000 rounds of golf could be undertaken annually, and given the location of the holes relative to sensitive receiving environments, it is conservatively estimated by the course designers that the number of golf balls that may enter into sensitive receiving environments annually could be in the order of hundreds, but not thousands.

Based on the hole positions, the majority of the golf balls that may be hit into sensitive receiving environments will most often be rolling in, rather than being hit deep within a wetland or Lake Ōkaihau, and therefore most are expected to be easily recoverable with limited disturbance to the local environment (Greg Turner, Golf Strategy Group *pers comm*.); for example, within an arm length into adjoining rush and scrub areas.

To minimise potential adverse effects associated with golf balls being hit into sensitive receiving environments, a standard operating procedure for the retrieval of golf balls from these areas has been prepared (Muriwai

Downs Standard Operating procedure: Golf ball retrieval from wetlands and Lake Ōkaihau; attached to report by NZ Sports Turf Institute & Steve Marsden Turf Services, 2021, Appendix 3 to AEE). This includes:

- Signage to advise golfers to KEEP OUT of sensitive environments;
- Retrieving golf balls visible from the Lake Ōkaihau shoreline or wetland margins using a telescopic ball scoop;
- Monthly checks of native forest, streams, wetland margins and Lake Ōkaihau margin to retrieve all golf balls within the 3-5 m edge without entering the environment; and
- Once/year in late summer retrieval of all golf balls within wetland centres, Lake Ōkaihau and forest areas. This timing avoids the key breeding season for avifauna, and is when wetlands are expected to be at their driest point and at least risk of being disturbed by human foot traffic.

In addition, wetland riparian margins within the proposed golf course will be planted with a dense margin of native rushes and shrubs which will minimise golf balls rolling into these areas and minimise the risk of golf balls penetrating deeper into sensitive wetland or stream environments (Section 8.0).

Golf balls that enter wetlands or the lake have a very low likelihood of being swept downstream into the Ōkiritoto Stream or Toroānui Falls, as 1) the lake is not directly connected to the stream and 2) vegetation within the wetlands will form a very thick swathe that will dissipate water flow and impede the passage of any golf balls downstream. The proposed regime of golf ball retrieval will prevent golf balls accumulating in the few localised areas where balls may be deposited.

When considering:

- the course design layout, which seeks to avoid and minimise golf balls being hit into sensitive environments;
- measures that have been proposed to screen rolling balls entering adjacent wetlands (through dense riparian planting); and
- the golf ball retrieval strategy which minimises golf balls left in the environment,

the overall number of golf balls entering and/or remaining in sensitive environments following these strategies, and the associated actual and potential adverse effects to these environments, is considered to be low.

6.0 Assessment of significance of adverse effects

This section provides a concise summary of the potential adverse effects on features of ecological value on the site after initiatives to avoid, remedy or mitigated have been applied. In this way, this section differs from the previous section, which focusses on the nature of various effects and how mitigation will be applied to lessen (minimise) the extent or magnitude of any adverse effects.

The effects assessment in this section of the report follows the steps in the effects management hierarchy. These steps identify the expected residual level of adverse effects on ecological features following the Applicant's proposals to avoid, minimise and remedy the Project's adverse effects. If following this exercise, residual effects are considered more than minor, the steps also require identification of whether these residual effects can be redressed through a biodiversity offset, and if not, whether environmental compensation is required.

The effects assessment considers only the potential adverse effects of the proposed development, not the potential benefits that may occur from extensive ecological enhancement proposed as part of the development of the Property away from areas where effects may occur.

For example, forest buffer planting around SEA_T_5525 which directly mitigates adverse ecological effects (e.g. forest edge effects, loss of habitat for fauna) has been considered as relevant contextual mitigation. However, the extensive forest revegetation planting that is proposed around Lake Ōkaihau is voluntary restoration works (rather than mitigation planting).

The significance of the above adverse effects on ecological values can be assessed by considering the rarity value of the species or ecosystem being affected, and the magnitude of its loss at the local (catchment or District) level.

The tool used to assess significance of effects is the matrix approach as described by the EIANZ. The EIANZ matrix approach, and the guidelines within which it is included, has been developed as a guide for ecologists undertaking effects assessments under the RMA (EIANZ, 2018). The EIANZ guidelines and the impact assessment matrix in particular, provides a robust, concise and consistent approach to effects assessment, whilst ensuring that individual expert evaluation and opinion is preserved.

Table 14 summarises the results of the matrix analysis, with the level of adverse effect determined after the application of mitigation proposed across the Property. The values considered in the significance assessment are those that are indigenous in nature, or which provide habitat and resources to support indigenous species.

Not considered in the analysis was the exotic vegetation such as the pasture grass, tree lupin scrub and mature exotic trees on the Property (e.g. macrocarpa). This is because such vegetation does not trigger any of the criteria by which ecological features are typically judged in terms of supporting species or communities of indigenous biodiversity.

Contextual information considered in the analysis is provided in Section 5.4 above.

Table 14. Assessment of significance of ecological effects using the EIANZ matrix method[12].

Factor	Value of resource[a]	Magnitude of effect[b]	Level of effect[c] after mitigation
Lake Ōkaihau	High	Negligible	Very low
Wetlands	High	Negligible	Very low
Okirirtoto catchment	High	Negligible	Very low
Stream I9	Moderate	Minor	Low
Stream P3	Low	High	Moderate
Indigenous fish	High	Minor	Low
Significant Ecological Areas (SEA)	High	Negligible	Very low
Kauri trees	High	Minor	Low
Other indigenous vegetation & mature native trees	High	Minor	Low
Indigenous lizards	High	Minor	Low
Avifauna	High	Minor	Low
Longtail bat	High	Minor	Low
Pasture and treeland habitat for indigenous birds and lizards	Low	Negligible	Very low

[a] *EIANZ matrix tables 5 and 6.*

[b] *EIANZ matrix table 8; measured in the context of the catchment (streams) or District (terrestrial values).*

[c] *EIANZ matrix table10.*

Overall, the actual or potential adverse effects on ecological values that may result from construction activities will be generally low or very low provided works are appropriately implemented - such as applying

[12] As contained within the EIANZ EciA guidelines. Roper-Lindsay, J., Fuller S.A., Hooson, S., Sanders, M.D., Ussher, G.T. 2018. Ecological impact assessment. EIANZ guidelines for use in New Zealand: terrestrial and freshwater ecosystems. 2nd edition

erosion and sediment controls, clearance that minimises effects on birds, surveys to avoid effects on bats, and salvage of fish and lizards, the level of adverse effect under the RMA is considered to be less than minor or negligible. For potential effects that are (ecologically) low or very low the equivalent level of effect under the RMA is minor or less than minor, and no response through a biodiversity offset or ecological compensation is considered to be necessary.

When the ecological benefits of the extensive planting programme for forests, wetlands and streams is taken into account, a clear net-benefit for ecology and ecological values across the Property will result.

For potential effects that are considered to be more than minor, such as for the culverting of Stream P3, ecological enhancements and protections are proposed as an offset package to address residual adverse effects.

Whilst there is a less than minor ecological effect to Stream I9 (and offsetting is not required), voluntary restoration is also proposed to address any residual adverse effects, in combination with the residual effects management for Stream P3. That restoration type and amount for Stream I9 has been calculated using standard biodiversity offsetting principles and accounting methods that are that same as those used for the calculation of the offset for adverse effects on Stream P3.

The initiatives proposed to achieve this are described in the next section of this report.

In summary, apart from the adverse effect associated with the culverting of a section of Stream P3, all other potential adverse effects will be nil or less than minor, assuming that good practice construction management and wildlife salvage, management and relocation also undertaken as mitigation.

The extensive programme of ecological enhancement described in Section 8 of this report which is proposed as additional enhancements provides assurance that a clear net-benefit for stream, lake, wetland and forest communities and the Muriwai Downs ecological system will result as part of this proposed development.

The enhancements proposed can be divided into several categories – primarily those that are required to remedy or mitigate effects and proposed ecological restoration and enhancement volunteered by the Applicant as part of the Project.

1. Ecological works required to address adverse effects that cannot be avoided:
    a. Mitigation – planting of forest margins for SEA_T_5525 to replace native vegetation clearance within SEA_T_5525.
    b. Offset – Stream enhancement works to Stream P2 (326 m) to provide ecological redress for culverting and reclamation of Stream P3 (see Section 7).
2. Ecological restoration and enhancement volunteered by the Applicant:
    a. Extensive indicative ecological restoration and enhancement works within streams, Lake Ōkaihau and forest areas to protect and enhance ecological values;
    b. Stream daylighting and riparian enhancement works to a section of piped Stream I2 (31 m); and
    c. Restoration for wetlands within the Project area (not all of the Property).

7.0 Offset of ecological values

The offset stream enhancement work is intended to address the loss of ecological values associated with the culverted and reclaimed stream (P3) within the Project area. The level at which offset restoration can

address effects is the subject of the SEV:ECR calculations that are laid out in **Appendix C** and are detailed in the attached Excel spreadsheet SEV:ECR models.

Following the standard ECR analysis, and applying the residual loss of culverting and placing riprap over a total of 175 m of permanent stream, the length of stream restoration required (for Stream P3 effects) or volunteered (for Stream I9 effects from infilling 16 m of this intermittent stream) at the restoration sites to achieve no-net-loss of stream length and ecological functions is estimated to be 357 m. This includes enhancements to 326 m of existing degraded permanent Stream P2 (offset for Stream P3 works), and re-creation of 31 m of intermittent Stream I2 (through daylighting) (voluntary restoration).

Locations for the proposed stream offset/restoration reaches are shown in **Figure 36**.

Restoration includes stock removal, planting of 20 m wide riparian margins, weed control, fencing, and in perpetuity protection for part of Stream P2. In addition, a 16 m reach of Stream I2 will be 'daylighted' (i.e. the removal of historic piping of a portion of the headwater) to ensure there is no net loss of stream extent associated with the project area.

Our recommendations relevant to the proposed offset are set out below.

To ensure that restoration is successful, mitigation planting areas will have ongoing maintenance and environmental weed management until canopy closure is achieved, or be maintained for a minimum of 5 years, whichever is achieved first. Replanting will include native species specific to the former forest types in this part of the Rodney Ecological District. All planting will be protected in perpetuity by covenant or similar protection mechanism. The details for restoration management will be included as part of an EMP prepared for this Property.

Upon 5 years following offset enhancement works to Stream P2, a Stream Ecological Valuation (SEV) will be undertaken by a suitably qualified freshwater ecologist, to confirm whether the restoration area of Stream P2 is on track to achieving the predicted SEV score (which forms the basis for assurance of no-net-loss of effects). Where the monitoring concludes that the SEV values of the stream enhancement to Stream P2 have not reached the predicted SEV value, a Further Mitigation and Offset Works Plan will be prepared by a suitably qualified ecologist, within 2 months following the SEV. That plan will propose repair or improvement of the offset works along the enhanced stream reach and further monitoring at two yearly intervals, until such time that the requirements of the Further Mitigation and Offset Works Plan are achieved. A report detailing the outcome of the survey will be made available to Auckland Council upon request.

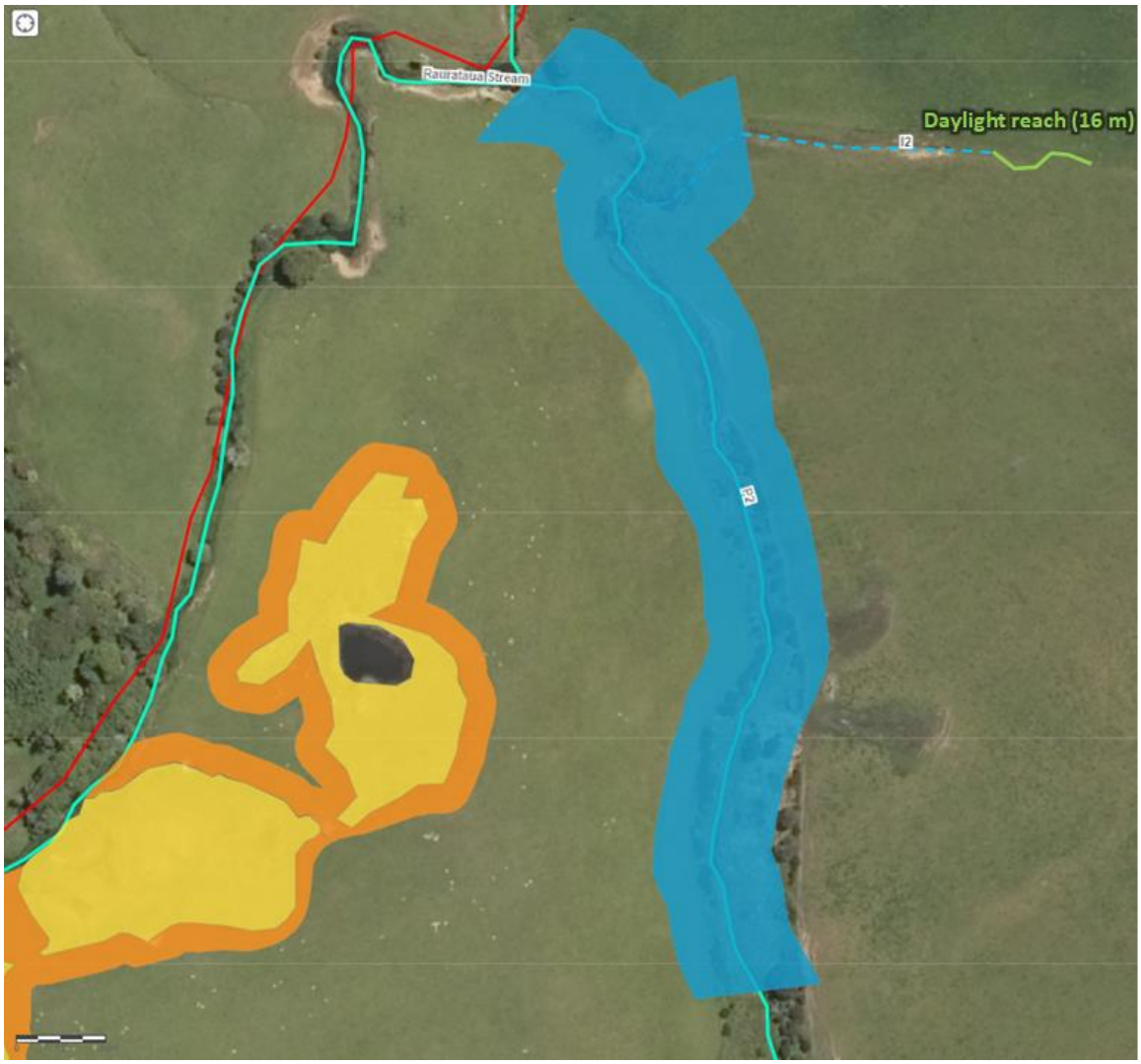

Figure 35. The approximate extent of ecological offsetting (blue area) proposed for enhancement at stream P2 and I2, and the approximate extent of daylighting at Stream I2 (green line). Permanent stream (solid blue line), intermittent stream (dashed line), Property boundary (red line). Yellow and orange areas are nearby wetland and restoration buffer planting – these are not included in this stream ecological offsetting programme.

8.0 Ecological benefits

The proposed development includes an extensive indicative enhancement and restoration programme which will result in significant ecological benefits to Lake Ōkaihau, indigenous forest, streams, wetlands and associated indigenous wildlife at the Property.

These enhancements and restorations are separate from the mitigations and biodiversity offset mentioned in previous sections, and will be detailed in a separate Restoration Management Plan (which will be a separate document to the site Ecological Management Plan). These have been put forward as indicative options to allow for further refinement and open discussions with Mana Whenua who have requested these be developed in conjunction with them and in accordance with tikanga Māori (see Te Kawerau ā Maki Cultural Impact Assessment 2021, Appendix 21 to AEE).

At this time, the proposed total enhancement and restoration area for the Property is approximately 28.7 ha, and includes six restoration treatment options as follows (**Figures 37 to 41** provide indicative plans):

1. Golf course – riparian planting (approximately 6.0 ha). This is a planting treatment surrounding wetlands and streams and includes low-stature native grasses, rushes, sedges and shrubs for ecological and amenity purposes.
2. Golf course – wetland restoration and planting (approximately 4.9 ha). This involves removal of pest species and an enrichment planting treatment within the centres of wetlands and includes low-stature native grasses, rushes and sedges for ecological and amenity purposes.
3. Golf course – forest planting (approximately 3.2 ha). This is a planting treatment surrounding forests and includes early successional native shrubs and trees for ecological buffering and amenity purposes.
4. Ecological restoration – riparian planting (approximately 3.9 ha). This is a planting treatment following best practice guidelines surrounding wetlands and streams. The intended goal of the riparian margin revegetation is to provide multi-tiered, dense native plantings for bank stabilisation, habitat provision, water temperature regulation and organic inputs into streams, as well as preventing golf balls from entering wetlands and streams.
5. Ecological restoration – wetland restoration and planting (approximately 2.3 ha). This involves removal of pest species and planting treatment following best practice guidelines and includes wetland plants appropriate for the project area. The intended goal of the wetland revegetation is to provide multi-tiered, dense native plantings to filter organic inputs into wetlands and create habitat for indigenous fauna.
6. Ecological restoration – forest planting (approximately 8.4 ha). This is a planting treatment following best practice guidelines and includes the full suite of terrestrial forest plants appropriate for the Property. The intended goal of the forest revegetation is to extend and connect existing forest remnants, selecting species in accordance with Auckland Council's predicted ecosystem GIS layer (Singers *et al,* 2017).

The proposed ecological enhancements include:

- Restoration planting, weed control and associated pest animal control around Lake Ōkaihau which is expected to improve water quality, and provide significant habitats for indigenous fauna (indicative planting shown in **Figure 38**). The restoration of Lake Ōkaihau includes the below

initiatives to the extent practicably feasible (that is, adjustments may occur to the areas identified below if such restoration significantly impedes the ability of the Project to provide its intended purpose):

  - Approximately 10 m wide riparian margin around the majority of Lake Ōkaihau;
  - Planting the wetlands within the upper catchment which feed into Lake Ōkaihau;
  - An assessment of the viability of controlling pest fish (rudd) in the Lake; and
  - Planting indigenous forest surrounding SEA_T_5524, which will greatly expand the extent of the SEA, connect adjoining forest fragments, and provide a full transition of ecotones and ecological sequences from the ridgeline, valley, valley floor and through to Lake Ōkaihau. This is separate from the mitigation planting described in Section 5.4.12.

- Planting the forest margins of forest remnants within close proximity to the development to not only buffer the forest edges from the development, but also for the purpose of enhancing these remnants by minimising existing forest edge effects (exposure to environmental extremes). The forest margin plantings range between approximately 2 m to 55 m wide planting swathes;
- Planting an approximately 10 m wide riparian margin along the lower 80 m reach of Stream P4;
- Planting the riparian margin and enrichment planting of wetland centres in close proximity to the golf course for the purposes of amenity and ecological benefits for 10 wetlands (W1 to W10). The indicative species lists for these areas consist of eco-sourced natives that have been selected based on a low-growing stature, to enhance the areas, but also allow for compatibility with golf-play in the surrounding margins;
- Planting a riparian margin along Wetland W7 for the purpose of restoration in all areas away from golf playing lines;

Ecological principles that underpin the enhancement and restoration are:

- Use indigenous species that are representative of natural, local plant communities and which provide appropriate community structure;
- Planting to create habitats that benefit native fauna;
- Source seed and plants locally (eco-sourcing from the Rodney Ecological District, or if appropriate local stocks are not available, the Tamaki Ecological Region) in order to select strains that are best suited to local environmental conditions and to maintain the integrity of local genetic stocks;
- Plant species that benefit terrestrial, as well as aquatic, ecosystems and which give long-term benefits for ecosystem health; and
- Reduce or eliminate potential threats to the restored system; in New Zealand these threats are largely from introduced weeds and animal pests.

The general approach to planting will involve five steps:

1. Plant locally sourced species that are ecologically appropriate to this site.
2. Plant in late winter/early spring to avoid winter frosts, but provide time for root systems to develop before summer dry periods occur, using combi-guards (or similar).
3. Before planting, use an appropriate herbicide to kill grass to lessen the competition for water while the seedlings/saplings establish.

4. Undertake release weeding to clear encroaching grass/herbs after planting. Once root systems have developed (over the first three growing seasons, or as appropriate based on monitoring of survival and growth) plants should readily survive grass and herb competition.

5. Aftercare maintenance for ecologically important weeds (e.g. climbing vines and woody weeds) will be undertaken biannually in all planted areas for the first 5 years following planting, or until canopy closure is achieved.

The full operational details for the proposed ecological enhancement at the Property will be detailed in an RMP, prepared for the Property. The RMP will include the following planting management details including:

- mechanisms for protection in perpetuity;
- roles and responsibilities;
- maintenance;
- monitoring; and
- reporting.

A draft wetland restoration plan prepared in accordance with the NES-F is provided in **Appendix F** in respect of the wetland restoration works proposed as part of the Project.

Provided the enhancements and restoration described in this section are undertaken in general accordance with the indicative plans (as generally illustrated in **Figures 37 – 41**), the development can be expected to result in a significant net-benefit for Lake Ōkaihau, indigenous forest, streams, wetlands and associated indigenous wildlife at the Property.

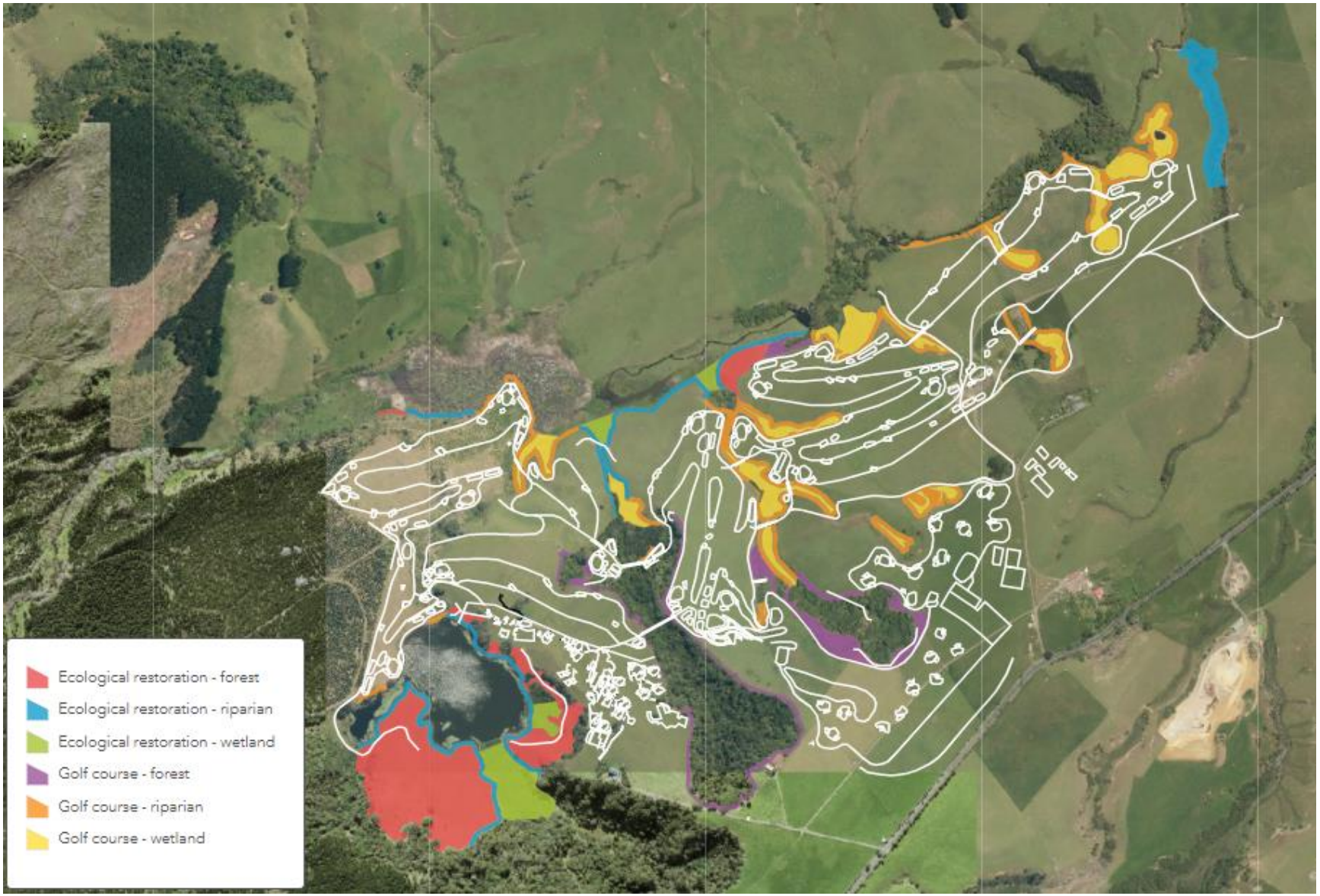

Figure 36. The proposed restoration concept (indicative) for the project area. Development layout (white lines) restoration treatments (coloured areas), property boundary (red line).

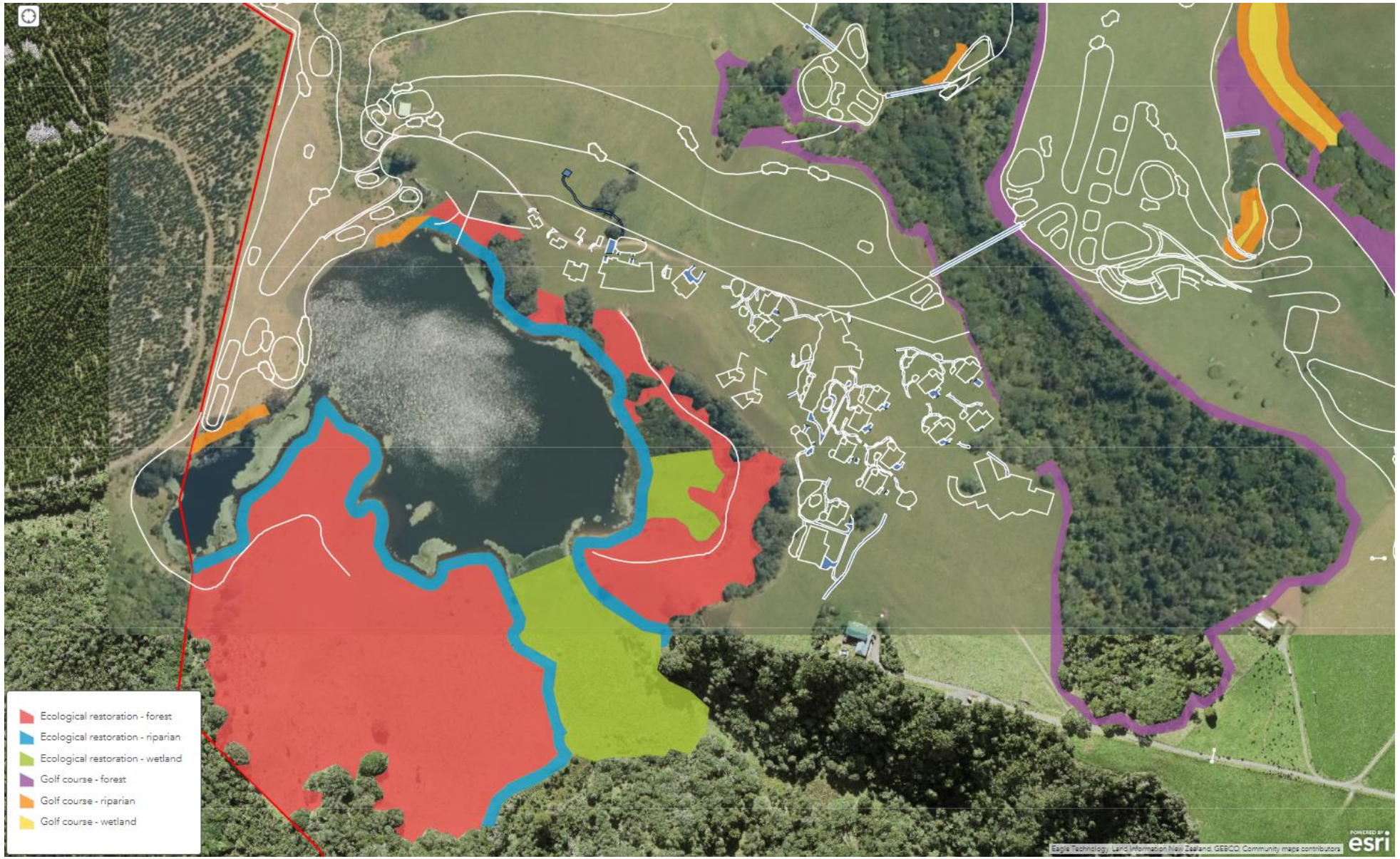

Figure 37. The proposed restoration concept (indicative) for the south-western extent of the project area. Development layout (white lines) restoration treatments (coloured areas), property boundary (red line).

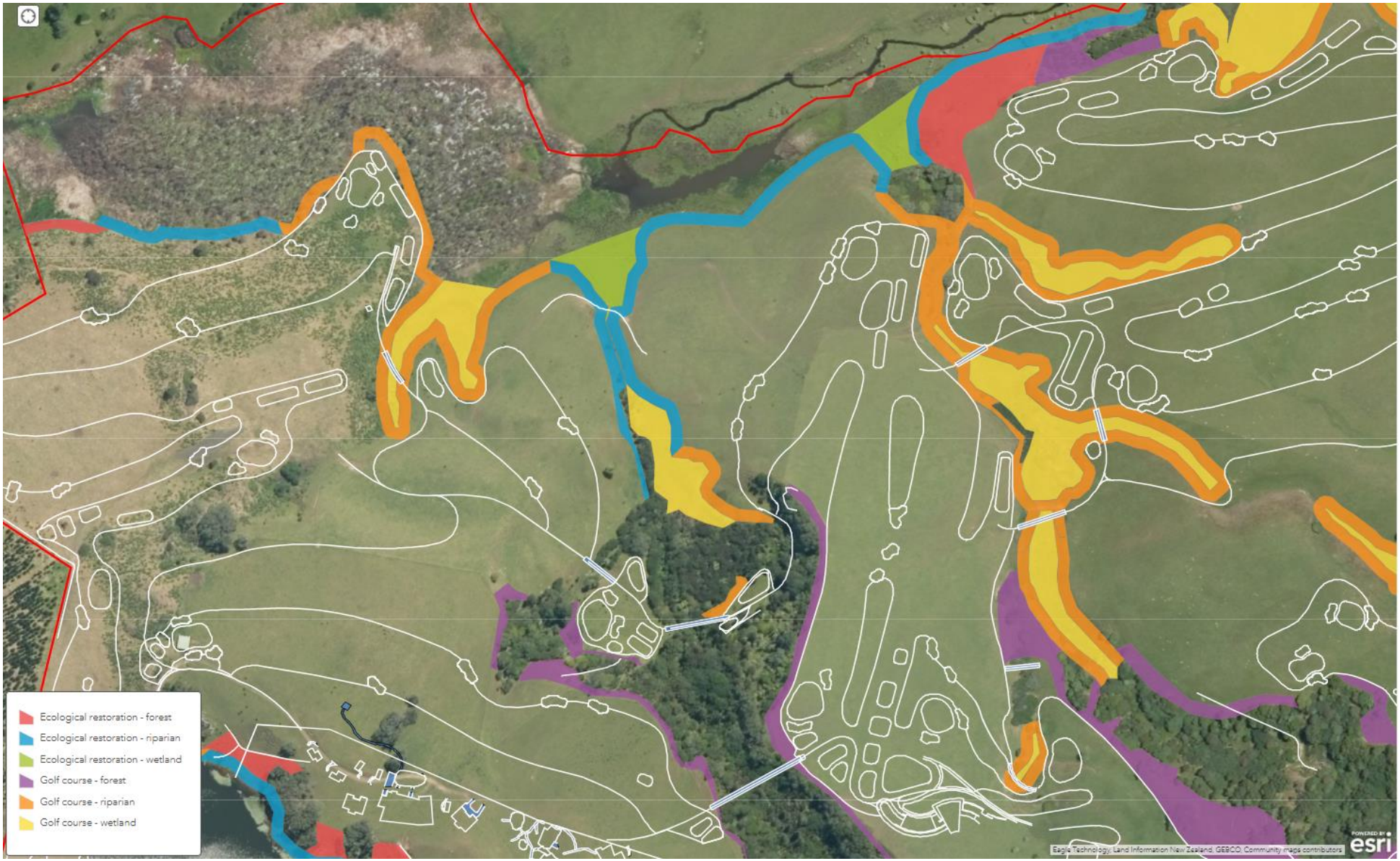

Figure 38. The proposed restoration concept (indicative) for the north-western extent of the project area. Development layout (white lines) restoration treatments (coloured areas), property boundary (red line).

Figure 39. The proposed restoration concept (indicative) for the south-eastern extent of the project area. Development layout (white lines) restoration treatments (coloured areas), property boundary (red line).

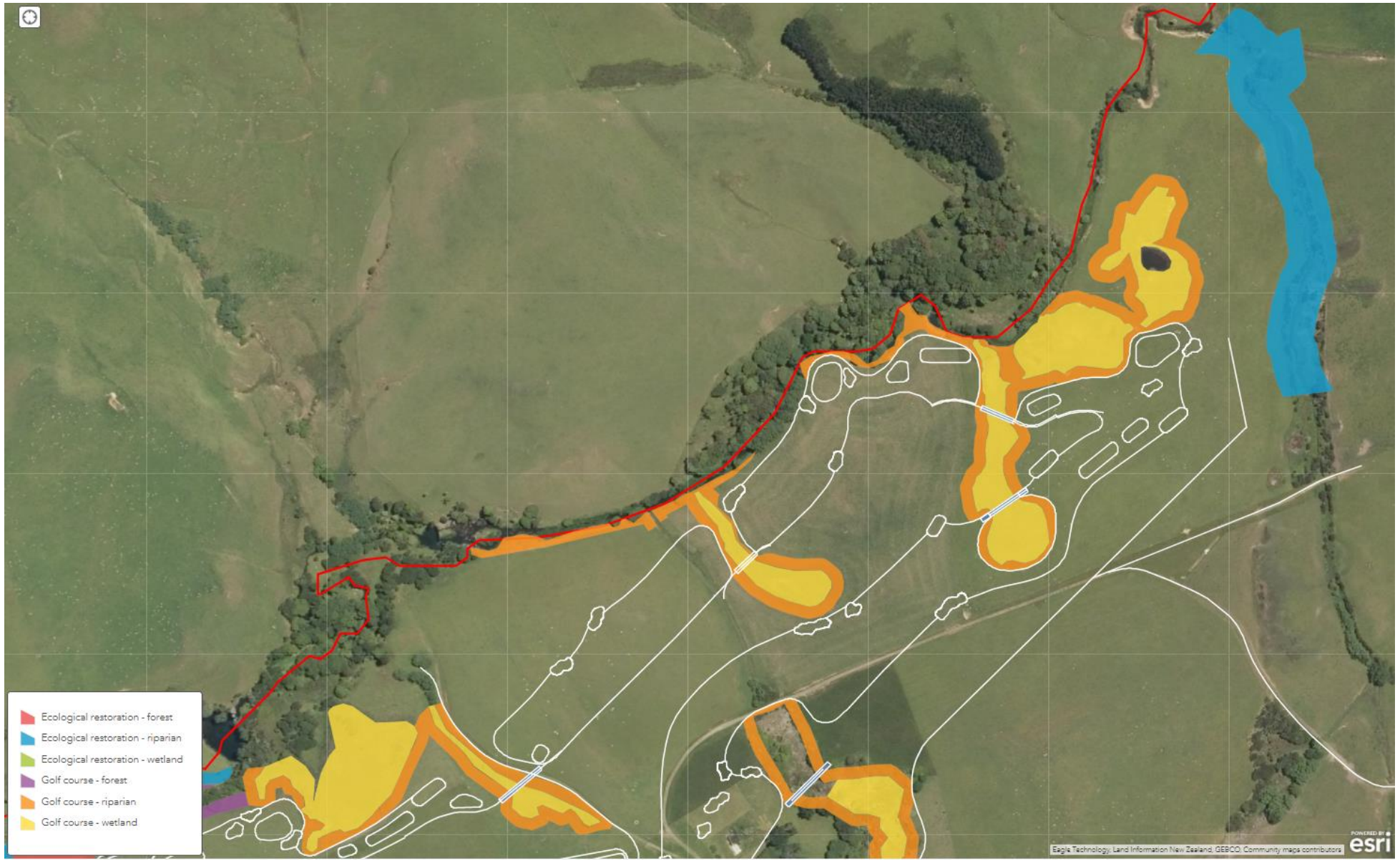

Figure 40. The proposed restoration concept (indicative) for the south-western extent of the project area. Development layout (white lines) restoration treatments (coloured areas), property boundary (red line).

9.0 Recommendations

The following actions are recommended to ensure that potential adverse ecological effects of the proposed development are minimised (mitigated) to the extent practicably feasible. These initiatives should be incorporated into the construction methodology proposed for this project, and include monitoring to ensure adherence to standards, protocols and correct processes. Some of these have already been or will be included in proposed plans, including the draft CEMP and proposed SWMP.

1. Manage potential adverse effects on the aquatic communities of the downstream receiving environments by implementing sediment and erosion controls in accordance with best practice standards (GD05) (McKenzie and Co. 2021b, Appendix 18 to AEE).
2. The management of Kauri Dieback Disease within the project area, including the management of soil and vegetative material during and post-earthworks, in accordance with the procedure described in the arboricultural report by Peers Brown Miller Ltd (Appendix 12 to AEE), and in accordance with drawings prepared by Mackenzie and Co showing appropriate disposal areas for materials treated as contaminated with Kauri Dieback Disease pathogen (see draft CEMP and Peers Brown Miller arboricultural report 2021, Appendix 12 to AEE).
3. To minimise potential adverse ecological effects to native fish, salvage of native fish from Stream P3 (and I9 for the 16 m of infilling proposed) should be undertaken prior to instream works. The salvage of native fish should be undertaken by a qualified expert and in accordance with a Native Freshwater Fish Salvage and Relocation Plan outlining the approach for salvage and the location(s) where salvaged species will be released. Native fish are protected under the Conservation Act 1987 and an Authority is required for the harvest of them under the Freshwater Fisheries Regulation 1983, including 'take' that occurs as a result of the planned removal of habitat. Permits are required from MPI for the capture and handling of native fishes (including eels) and their release in adjoining waterbodies. An authority will be required for this recommendation.
4. To monitor the effectiveness of the fish passage recommendations, a post-installation fish passage survey should be undertaken on the installed culvert at Stream P3. The survey should be undertaken by a suitably qualified freshwater ecologist. This should be undertaken when first practicable following the first significant rainfall event (>100 mm in 24 hours) post-livening. The purpose of the survey will be to assess if any damage or changes to the culvert and riprap channel have occurred which may inhibit fish passage. Recommendations for any repairs, adjustments or retrofitting new structures should be made where applicable. A report detailing the outcome of the survey should be made available to Auckland Council upon request.
5. To avoid potential adverse effects to 'Threatened' or 'At Risk' nesting birds associated with vegetation clearance, a precautionary approach will be adopted. As such, the construction methodology will seek to undertake tree clearance outside of the key breeding period for native forest birds (breeding period is September to January inclusive). Where tree clearance cannot avoid the native bird breeding period, any areas proposed for vegetation clearance will be assessed by a suitably qualified and experienced ecologist to ensure that 'Threatened' or 'At Risk' species of native birds are not breeding within those areas at the time of vegetation clearance (these provisions will be included in the EMP).
6. All native lizards are protected under the Wildlife Act (1953, s63 (1) (c)). To avoid and minimise actual and potential adverse effects to native lizards, lizard-sensitive clearance protocols should be adopted. The survey and salvage, where necessary, of native lizards from areas of potential habitat should be undertaken in accordance with a Lizard Management Plan (LMP) prepared for the Property (these LMP provisions will be included in the EMP).

7. If long-tailed bats are present on the Property, the possibility of harming bats triggers provisions of the Wildlife Act 1953 that require avoidance of effects. Avoidance of effects is usually achieved by a pre-clearance site survey and, if necessary, relocation of bats if roosts are substantial or permanent (which is possible in this type of environment). Trees suspected with potential to be used as a maternity roost should not be removed during the bat maternity period of November – February, and all relevant vegetation clearance work should be in accordance with Wildlife Act permit(s) issued by DOC (these provisions will be included in the EMP).
8. Lighting for the Property should include design features to reduce ambient light spilling into forest and wetland habitats (these provisions will be included in the lighting design concept for the site).
9. To minimise actual and potential adverse effects associated with golf balls being hit into sensitive receiving environments, the standard operating procedure for the retrieval of golf balls should be implemented.
10. To ensure ecological enhancement areas indicatively illustrated and listed in Section 8 of this report are successful, planting areas should have ongoing maintenance, environmental weed control, and pest animal control (if needed) until 80 % canopy closure is achieved, or a minimum of 5 years of planting maintenance, whichever comes first. Replanting should include native species from the Rodney Ecological District or if appropriate stock is not available, the Tamaki Ecological Region. All planting areas should be protected in perpetuity by covenant or similar. The details for enhancement planting should be included as part of a Restoration Management Plan prepared for the site, except where this may overlap with landscape planting, which will be addressed elsewhere.
11. Where disturbance of the bank margin of the Rarautaua Stream occurs associated with the water take, the surrounding bank margin should be planted in native riparian vegetation to promote stabilisation of the surrounding bank. All planting details, maintenance, monitoring and reporting should be also be included in the EMP.
12. Upon 5 years following completion of the riparian planting along the margins of Stream P2, a SEV should be undertaken by a suitably qualified freshwater ecologist, to confirm whether the riparian planting in Stream P2 is on track to achieving the predicted SEV score. Where the monitoring concludes that the SEV value of the enhancement works has not reached the predicted SEV value, a Further Mitigation and Offset Works Plan should be prepared by a suitably qualified ecologist, within 2 months following the SEV. The plan shall propose repair or improvement of offset works along the enhanced stream reach and further monitoring at two yearly intervals, until such time that the requirements of the Further Mitigation and Offset Works Plan are achieved. A report detailing the outcome of the survey shall be made available to Auckland Council upon request.

Overall, if Project works are appropriately implemented in general accordance with the above recommendations and proposed Management Plans there should be an overall, substantial, positive ecological outcome as a result of this Project.

10.0 References

Auckland Regional Pest Management Plan 2019-2029.

Borkin, K.M., Parsons, S., 2009. Long-tailed bat' use of a Pinus radiata stand in Kinleith Forest: implications for monitoring. New Zealand Journal of Forestry 53 (4):38-43.

de Lange, P.J.; Rolfe, J.R.; Barkla, J.W.; Courtney, S.P.; Champion, P.D.; Perrie, L.R.; Beadel, S.M.; Ford, K.A.; Breitwieser,I.; Schonberger, I.; Hindmarsh-Walls, R.; Heenan, P.B.; Ladley, K. 2018: Conservation status of New Zealand indigenous vascular plants, 2017. New Zealand Threat Classification Series 22. Department of Conservation, Wellington. 82 p.

de Winton, M and Burton, T (2017). LakeSPI assessment of 33 Auckland lakes: 2017 update. Prepared by the National Institute for Water and Atmospheric Research, NIWA for Auckland Council. Auckland Council technical report, TR2017/028

Dunn, N.R.; Allibone, R.M.; Closs, G.P.; Crow, S.K.; David, B.O.; Goodman, J.M.; Griffiths, M.; Jack, D.C.; Ling, N.; Waters, J.M.; Rolfe, J.R. 2018: Conservation status of New Zealand freshwater fishes, 2017. New Zealand Threat Classification Series 24. Department of Conservation, Wellington. 11 p.

Hitchmough, R.A.; Barr, B.; Knox, C.; Lettink, M.; Monks, J.M.; Patterson, G.B.; Reardon, J.T.; van Winkel, D.; Rolfe, J.; Michel, P. 2021: Conservation status of New Zealand reptiles, 2021. New Zealand Threat Classification Series 35. Department of Conservation, Wellington. 15 p.

McKenzie and Co. 2021a. Muriwai Downs Golf Course Construction Management Plan.

McKenzie and Co. 2021b. Muriwai Downs Golf Course Stormwater Management Plan.

McKenzie and Co. 2021c. Muriwai Downs Golf Course Engineering Infrastructure Report.

Neale MW, Storey RG, and Quinn JL. 2016. Stream Ecological Valuation: Application to Intermittent Streams. Auckland Council Technical Report 2016/023.

NIWA 2018. New Zealand Fish Passage Guidelines. For structures up to 4 metres.

Robertson, H.A., Baird, K., Dowding, J.E., Elliott, G.P., Hitchmough, R.A., Miskelly, C.M., McArthur, N., O'Donnell, C.F.J., Powlesland, R.G., Sagar, P.M., Scofield, R.P and Taylor, G.A., 2016. Conservation status of New Zealand birds, 2016. Department of Conservation, New Zealand Threat Classification Series 19.

Roper-Lindsay, J., Fuller S.A., Hooson, S., Sanders, M.D., Ussher, G.T. 2018. Ecological impact assessment. EIANZ guidelines for use in New Zealand: terrestrial and freshwater ecosystems. 2nd edition.

Singers N, Osborne B, Lovegrove T, Jamieson A, Boow J, Sawyer J, Hill K, Andrews J, Hill S and Webb C. 2017. Indigenous terrestrial and wetland ecosystems of Auckland. Published by Auckland Council.

Storey RG, Neale MW, Rowe DK, Collier KJ, Hatton C, Joy MK, Maxted JR, Moore S, Parkyn SM, Phillips N and Quinn JM. 2011. Stream Ecological Valuation (SEV): A method for assessing the ecological functions of Auckland streams. Auckland Council Technical Report 2011/009.Walker, S., Cieraad., Barringer., 2015. The Threatened Environment Classification for New Zealand 2012: a guide for users. Landcare Research.

Tzivanis, M. J., M. L. Binette, T. J. Kennedy, and J. L. Nealon. 2003. United States Patent 6,520,870 B2. United States.

Walker, S., Cieraad., Barringer., 2015. The Threatened Environment Classification for New Zealand 2012: a guide for users. Landcare Research.

Weber, A. K., Weber, M. W. and Savoca, M. W. 2019. Quantifying marine debris associated with coastal golf courses. Marine Pollution Bulletin 140 (2019) 1–8

Williamson Water & Land Advisory (WWLA). 2021a. Muriwai Downs Golf Course Project – Water Effects Summary Report. Prepared for Bears Home Project Management Ltd.

Williamson Water & Land Advisory (WWLA). 2021b. Lake Ōkaihau Water Balance Assessment. Prepared for Bears Home Project Management Ltd.

Williamson Water & Land Advisory (WWLA). 2021c. Muriwai Downs Hydrological effects study: wetland catchment allowable cut analysis. 3 March 2021. 5 p.

Williamson Water & Land Advisory (WWLA). 2021d. Muriwai Downs Golf Course Project – Site Water Balance and Water Strategy Report. Prepared for Bears Home Project Management Ltd.

Report prepared by:

.....

Tony Payne

Senior Ecologist

Reviewed by:

.....

Graham Ussher

Principal Ecologist

Appendix A: Survey methodology

Desktop Assessment

A desktop assessment of the development footprint and surrounding area was undertaken to identify sites of ecological value, as well as sites already listed as being ecologically significant based on a review of the AUP. Legacy District and Regional Plans were reviewed for completeness and to cross-verify against the descriptions and extents of features identified in the AUP.

These resources were also used, where available, to provide insight as to the reasons why areas were significant, and the ecological values they comprise. Areas with ecological values that were not listed as ecologically significant in the various reviewed documents were assessed against the significance criteria of the AUP (Schedule 3 – Significant Ecological Areas: Terrestrial Schedule).

The Auckland Council GIS was reviewed to identify existing vegetation, streams and overland flow paths present on the Property and to establish an understanding of the ecological status of the waterways present. Maps of these existing features (streams and overland flow paths (categories 4,000 m^2 to 3 ha and > 3 ha)) were then ground-truthed.

The following documents and databases were reviewed for the ecological assessment:

- National Amphibian and Reptile Database System (Herpetofauna) to gather information on lizard species that have been recorded in proximity to the Property;
- Land Environments of New Zealand (LENZ); Threatened Environment Classification (TEC);
- iNaturalist and Bird Atlas of New Zealand (E-Bird);
- Department of Conservation New Zealand bat database;
- NIWA New Zealand Freshwater Fish Database; and
- AUP (OP).

Any species found were recorded and their threat status checked against the relevant national threatened species classification lists (Hitchmough *et al.* 2021, Robertson *et al.* 2016 and de Lange *et al.* 2018).

Site Survey

Eight (8) site surveys were undertaken in August 2020, September 2020, May 2021, June 2021 and July 2021, September 2021, October 2021 and November 2021. The purpose of the survey was to assess the location, type and state of ecological features (watercourses, wetlands, vegetation, and fauna habitat) on the Property to inform the layout of the golf course design.

During the site survey, native and exotic plant species and communities were recorded, and a qualitative assessment of vegetation habitats for herpetofauna (frogs and lizards), birds and bats was conducted. The assessment included, but was not limited to, areas of vegetation on the Property most likely to be impacted or removed by the proposed golf course layout, focusing on the botanical and ecological value of identified plant communities.

During the site survey all waterways and flow paths were mapped as being permanent, intermittent or ephemeral based on the definitions in the AUP (see below). Photographs were taken and a general description of the waterway was undertaken to note characteristics including riparian species and cover, and connectivity to other waterways.

The definitions of stream types within the AUP are listed below in italics.

Permanent river or stream

The continually flowing reaches of any river or stream.

Intermittent stream

Stream reaches that cease to flow for periods of the year because the bed is periodically above the water table. This category is defined by those stream reaches that do not meet the definition of permanent river or stream and meet at least three of the following criteria:

1. *it has natural pools;*
2. *it has a well-defined channel, such that the bed and banks can be distinguished;*
3. *it contains surface water more than 48 hours after a rain event which results in stream flow;*
4. *rooted terrestrial vegetation is not established across the entire cross-sectional width of the channel;*
5. *organic debris resulting from flood can be seen on the floodplain; or*
6. *there is evidence of substrate sorting process, including scour and deposition.*

Ephemeral stream

Stream reaches with a bed above the water table at all times, with water only flowing during and shortly after rain events. This category is defined as those stream reaches that do not meet the definition of permanent river or stream or intermittent stream.

All waterways within the Property were walked with the first classification being whether the waterway was natural or an artificial farm drainage canal ('drain'). Waterways were classified as farm drains based on GIS and historical aerial photograph and likelihood based on topography and location. If a waterway was deemed to be natural (straightened or not) it was then assessed using the AUP criteria above.

Wetlands were assessed using the definition within the AUP and the RMA, as follows:

- ***Wetland****: 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, including within the coastal marine area.*

Wetlands on the Property were also assessed based on the definition within the recently released NPS-FM:

- ***Natural inland wetland:*** *means a wetland (as defined in the Act) that is not:*

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

  (b) a geothermal wetland; or

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

Terrestrial indigenous vegetation was assessed against the criteria used by Auckland Council for the identification of Significant Ecological Areas (SEA) in Schedule 3 of the AUP (OP), which are:

1. Representativeness;
2. Threat status and rarity;
3. Diversity;
4. Stepping stones, migration pathways and buffers; and
5. Uniqueness or distinctiveness.

Appendix B: Stream classification and condition

Table B1. Assessment of watercourses against the AUP criteria for classifying permanent and intermittent streams (and by omission, ephemeral streams) for the Muriwai Downs Golf Course site. Permanent streams meet the single permanent criterion and are based on expert judgement. Intermittent streams are not permanent and meet ('yes' response) at least three of the intermittent stream criteria. Ephemeral streams do not meet at least three of the stream criteria. The 'Surface flow 48 hours after rain' and 'continuously flowing' criteria were not strictly assessable (N/A) due to recent rain, and judgement was used as part of this assessment to differentiate stream classifications.

	Permanent	Intermittent criteria						
Stream	**Continually flowing?**	**Has natural pools?**	**Has a well-defined channel?**	**Surface flow 48 hrs after rain?**	**No rooted terrestrial vegetation across channel?**	**Organic debris on floodplain?**	**Evidence of substrate sorting?**	**Classification**
Ōkiritoto Stream	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Permanent
Raurataua Stream	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Permanent
P1	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Permanent
P2	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Permanent
P3	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Permanent
P4	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Permanent
P5	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Permanent

	Permanent	Intermittent criteria						
Stream	**Continually flowing?**	**Has natural pools?**	**Has a well-defined channel?**	**Surface flow 48 hrs after rain?**	**No rooted terrestrial vegetation across channel?**	**Organic debris on floodplain?**	**Evidence of substrate sorting?**	**Classification**
P6	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Permanent
P7	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Permanent
P8	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Permanent
I1	No	Yes	Yes	Yes	Yes	No	Yes	Intermittent
I2	No	Yes	Yes	Yes	Yes	No	Yes	Intermittent
I3	No	Yes	Yes	Yes	Yes	No	Yes	Intermittent
I4	No	Yes	Yes	Yes	Yes	No	Yes	Intermittent
I5	No	Yes	Yes	Yes	Yes	No	Yes	Intermittent
I6	No	Yes	Yes	Yes	Yes	No	Yes	Intermittent
I7	No	Yes	Yes	Yes	Yes	No	Yes	Intermittent
I8	No	Yes	Yes	Yes	Yes	No	Yes	Intermittent

	Permanent	Intermittent criteria						
Stream	**Continually flowing?**	**Has natural pools?**	**Has a well-defined channel?**	**Surface flow 48 hrs after rain?**	**No rooted terrestrial vegetation across channel?**	**Organic debris on floodplain?**	**Evidence of substrate sorting?**	**Classification**
I9	No	Yes	Yes	Yes	Yes	No	Yes	Intermittent
I10	No	Yes	Yes	Yes	Yes	No	Yes	Intermittent
I11	No	Yes	Yes	Yes	Yes	No	Yes	Intermittent
I12	No	Yes	Yes	Yes	Yes	No	Yes	Intermittent
I13	No	Yes	Yes	Yes	Yes	No	Yes	Intermittent

Table B2. Summary of characteristics and overall condition for permanent and intermittent streams for the Muriwai Downs Golf Course site. See footnotes for explanation of qualitative assessments.

Stream	Type	Riparian diversity[1]	Channel shade[2]	In stream habitat[3]	Bed characteristics[4]	Overall condition[5]
Ōkiritoto Stream	Permanent	Good	Moderate	Good	Good	4 – Good
Raurataua Stream	Permanent	Good	Good	Very good	Very good	5- Very good
P1	Permanent	Poor	Poor	Moderate	Moderate	2 – Poor

Stream	Type	Riparian diversity[1]	Channel shade[2]	In stream habitat[3]	Bed characteristics[4]	Overall condition[5]
P2	Permanent	Poor	Poor	Moderate	Poor	2 – Poor
P3	Permanent	Very poor	Very poor	Poor	Very poor	1 – Very poor
P4	Permanent	Good	Moderate	Good	Good	4 – Good
P5	Permanent	Very good	Very good	Very good	Very good	5 – Very good
P6	Permanent	Moderate	Moderate	Good	Moderate	3 - Moderate
P7	Permanent	Moderate	Moderate	Moderate	Poor	3 - Moderate
P8	Permanent	Moderate	Moderate	Moderate	Poor	3 - Moderate
I1	Intermittent	Poor	Poor	Poor	Poor	2 – Poor
I2	Intermittent	Poor	Very poor	Very poor	Very poor	1 – Very poor
I3	Intermittent	Poor	Very poor	Very poor	Very poor	1 – Very poor
I4	Intermittent	Poor	Poor	Very poor	Very poor	1 – Very poor
I5	Intermittent	Poor	Poor	Very poor	Very poor	1 – Very poor
I6	Intermittent	Poor	Poor	Very poor	Very poor	1 – Very poor

Stream	Type	Riparian diversity[1]	Channel shade[2]	In stream habitat[3]	Bed characteristics[4]	Overall condition[5]
I7	Intermittent	Moderate	Good	Very poor	Very poor	2 – Poor
I8	Intermittent	Very good	Very good	Very good	Very good	5 – Very good
I9	Intermittent	Good	Good	Poor	Moderate	3 – Moderate
I10	Intermittent	Very good	Very good	Very good	Very good	5 – Very good
I11	Intermittent	Very good	Very good	Very good	Very good	5 – Very good
I12	Intermittent	Poor	Poor	Very poor	Very poor	1 – Very poor
I13	Intermittent	Moderate	Good	Very poor	Very poor	2 – Poor

1 Riparian diversity assessed as: no vegetation (very poor), pasture or grass or monoculture of low weeds (poor), several woody plant species either native or exotic (moderate), many woody plant species; mixed exotic/ native/ successional species (good); highly diverse range of native plant species forming a mature or maturing canopy with understorey and ground tiers (very good).

2 Channel shade assessed as: fully open; lack of canopy cover (very poor); <20 % water surface shaded (poor); 20 – 60 % water surface shaded; mostly open with shaded patches (moderate); 60 – 80 % water surface shaded; mostly shaded with some open patches (good); > 80 % water surface shaded; full canopy (very good).

3 In stream habitat assessed as: favourable habitats (woody debris, rooted aquatic vegetation, leaf packs, undercut banks, root mats, stable habitat) limited and coverage <10 % channel (very poor); favourable habitat diversity limited to 1-2 types; woody debris rare, coverage 10 – 30 % of channel (poor); moderate variety of habitat types (3-4 types) covering 30 – 50 % channel (moderate); most habitat types present, covering 50 – 75 % channel (good); all habitat types present covering >75 % of channel (very good).

4 Bed characteristics assessed as: Very high loading of un-natural silt and uniform hydrologic conditions (very poor); un-natural siltation with limited variety of hydrological conditions (poor); mostly natural bed substrates with moderate variety of hydrologic conditions (moderate); natural bed substrates with a good variety of pools, runs, riffles (good); natural bed substrates with the full range of hydrologic conditions present (deep and shallow pools, chutes, runs, riffles) (very good).

5 Overall condition assessed as a combination of the four key characteristics with scores all or predominately of 'poor' returning an overall poor condition or very poor, scores predominantly or mostly of 'moderate' returning an overall moderate condition, and scores all or predominately of 'good' returning an overall good condition

Appendix C: SEV:ECR calculations

The Stream Ecological Valuation (SEV) method is used here to offset unavoidable effects on streams impacted at the Muriwai Downs Property.

The method used is as described in Storey *et al.* (2011) and Neale *et al.* (2016) for the calculation of change in stream ecological value functions with development or enhancement.

The methodology applied here comprises five parts, applied sequentially.

Step 1. An assessment of the current SEV score for streams that will be impacted on the site.

Step 2. Description of the values that will be removed due to the proposed development, expressed as change in SEV score over a known length and width of stream.

Step 3. Description of the potential improvements to streams proposed for restoration on the Property, including identification of an appropriate baseline state against which to calculate gains that are additional and able to be claimed by the developer.

Step 4. Calculation of Environmental Compensation Ratios (ECR) for each pair of impacted-restored streams on the Property.

Step 5. Application of the ECR to each and a summing of the potential losses and gains to stream ecological function across the site to assess whether no-net-loss of stream values can be achieved.

We have made assumptions with how ecological values are addressed in the calculations. Following the standard application of SEV, we have scored culverted stream as 0.20 SEV function score. Stream that is infilled/reclaimed has a post-construction SEV score of 0.00. In addition, where streams are proposed to be infilled, we have assumed that the loss of stream ecological functions will be immediate.

Step 1. Current SEV scores for Stream P3 and Stream I2 that will be impacted. Current scores follow the SEV method guide and exclude IFI and FFI function scores.

Table C1. Current SEV scores.

	Stream P3	Stream I9
Overall mean SEV score (current state)	**0.279**	**0.469**

Step 2. Change in SEV score for each impacted stream over a known length and width of stream.

Table C2. Impacted stream and post-construction SEV scores. Existing state SEV scores (without FFI and IFI scores) and potential future value SEV scores.

	Stream P3	Stream I9
Overall mean SEV score (current state)	**0.279**	**0.469**
Potential future value	0.405	0.475
Reach impacted (m)	175	16
Type of impact	piped	infilled
Post-impact SEV	0.200	0.000

Step 3. Description of the potential improvements to streams proposed for restoration, including identification of an appropriate baseline state against which to calculate gains that are additional and able to be claimed by the developer.

Restoration for both streams will include installing fence lines to 20 m to exclude stock, riparian planting of native trees and shrubs to 20 m wide margins both sides of the streams, weed control and protection in perpetuity. For Stream I2 restoration will also include the creation of new channel via daylighting and recontouring banks within the lower reach.

The benefits of stream enhancement are as per the usual SEV calculation, namely:

Benefit claimed by the developer = (benefits from full restoration - existing baseline state)

The additional benefits over and above current management for the restoration stream is shown in **Table C3**. See **Appendix C1a** for function scores for the proposed enhancement sites.

Most of the enhancements to the streams are aimed at creating improved habitat for invertebrates and fish to encourage more diverse and abundant populations of both. The SEV method does not encourage predictions of invertebrate or fish population improvements (i.e. predictions of FBI and MCI-sb scores) and so we have left these biodiversity scores blank in the SEV spreadsheets.

Table C3. Predicted SEV scores for restoration reaches at the offsite offset sites with planting and additional channel and habitat enhancements. Existing state SEV scores (without FFI and IFI scores).

	Stream P2	**Stream I2**
SEV (existing state)	0.570	0.324
SEV (potential future value)	0.783	0.876
Length available (m)	1,163	136
SEV improvements claimed as offset	**0.214**	**0.552**

Step 4. Calculation of Environmental Compensation Ratios (ECR) for each pair of impacted-restored streams on the Property.

ECR ratios are calculated for each of the individual impact and offset stream combinations as summarised in **Table C4**.

The standard ERC formula has been adopted as per the SEV guidelines.

ECR = [(SEVi-P – SEVi-I) / (SEVm-P – SEVmC)] x 1.5

Table C4. ECRs for combinations of impact and offset streams.

ECR calculations	**SEVi-C**	**SEVi - P**	**SEVi -I**	**SEVm- C**	**SEVm- P**	**multiplier**	**ECR**
Impact Stream I9 infilled - offset Stream I2	0.469	0.475	0.000	0.324	0.876	1.5	1.29
Impact Stream P3 piped - offset Stream P2	0.279	0.405	0.200	0.570	0.783	1.5	1.44

Step 5. Application of the ECR to each and a summing of the potential losses and gains to stream ecological function across the Property to assess whether no-net-loss of stream values can be achieved.

Calculation of the stream lengths required to offset to no-net-loss level the impacted stream reaches involves calculating the ECR-adjusted stream area impacted compared to the offset stream area and available length over which the offset can occur. **Table C5** provides a breakdown of the allocation of offset streams to impact reaches.

Table C5. Calculation of stream impacts able to be offsite by restoring streams within the Property.

Impact reach				ECR		Restoration Reach					Length to restore (m)	Restoration stream length still available (m)	Outstanding area not compensated (m2)
Stream	Length (m	Width (m)	Area (m2)	ECR	ECR x Area	Stream	Length available (m)	Width (m)	Area available (m2)	Restoration length required to be restored (m)			
Stream P3 piped	175.0	2.24	391.6	1.44	564.61	Stream P2	1163.0	1.7	2012.0	326.4	326.4	836.63	-1003.76
Stream I9 infilled	16.0	0.55	8.8	1.29	11.36	Stream I2	136.0	0.8	106.1	14.6	14.6		
						Daylighting extent					16.0		
Loss across stream	191.0										356.9		
Loss offset	191.0										Restore (m)		

Notes:

1. Streambed area impacted is based on channel widths at 10 SEV cross sections (where applicable). Stream I9 impact length is 16 m and three (3) representative wetted widths were recorded. The downstream reach of this stream changes morphology outside of impact reach as it transitions to a forested catchment, and is therefore not representative of the impact reach.
2. Length of restoration stream to restore is calculated by ('ECR X Area' / 'Restoration Width'). Restoration length defaults to 1:1 length if total restored lengths relating to that stream are shorter than that impacted.
3. Restoration stream length still available after being used in the assessment is calculated by (('Area available'-'ECR X Area)/ Restoration reach 'Width') with amount transferred to "Restoration reach length available' in the next row if applicable.
4. The amount of streambed area that has not been mitigated for ('Outstanding area not compensated') is transferred to 'Impact Reach Area' on the next row if applicable for additional compensation calculation using the next available restoration reach. The outstanding amount is determined by ('Restoration reach Area available' – 'ECR X Area')/ ECR values. The squares in orange are the outstanding amounts that have been transferred to the next row in the 'Impact Reach Area' column.
5. Blue highlight cells show residual restoration reach length available after 'Length to restore' from the previous row as been subtracted.
6. Some values in the column 'Length to Restore' may be minimum lengths needed to achieve NNL of stream length, rather than only reflecting NNL of stream area.

Appendix C1a. Current (SEVi-C) and potential future state (SEVi-P) for the impact streams and current (SEVm-C) and predicted future state (SEVm-P) function scores for the offset sites that are proposed to be restored.

Potential future (SEVm-P) assumes riparian planting of an average of 20 m width on both banks and maturation of riparian planting for 15 years and is compared against current state (SEVm-C).

		P2 SEVm-C	P3 SEVi-C	I2 SEVm-C	I9 SEVi-C	P2 SEVm-P	P3 SEVi-P	I2 SEVm-P	I9 SEVi-P
Function category	Variable (code)								
	Vchann	0.70	0.10	0.48	0.40	0.70	0.10	1.00	0.40
	Vlining	0.80	0.80	0.80	0.80	1.00	0.80	1.00	0.80
	Vpipe	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Hydraulic	=	0.73	0.33	0.59	0.53	0.80	0.33	1.00	0.53
	Vbank	0.68	0.04	0.28	0.20	0.76	0.04	1.00	0.20
	Vrough	0.71	0.19	0.19	0.63	1.00	0.75	1.00	0.75
Hydraulic	=	0.48	0.01	0.05	0.13	0.76	0.03	1.00	0.15
	Vbarr	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Hydraulic	=	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
	Vchanshape	0.49	0.20	0.80	0.72	0.49	0.20	1.00	0.72
	Vlining	0.80	0.80	0.80	0.80	1.00	0.80	1.00	0.80
Hydraulic	=	0.70	0.60	0.80	0.77	0.83	0.60	1.00	0.77
	Hydraulic function mean score	0.73	0.49	0.61	0.61	0.85	0.49	1.00	0.61
	Vshade	0.36	0.00	0.00	0.36	1.00	0.40	1.00	0.36
biogeochemical	=	0.36	0.00	0.00	0.36	1.00	0.40	1.00	0.36
	Vdod	0.60	0.40	0.45	0.60	1.00	0.40	1.00	0.60
biogeochemical	=	0.60	0.40	0.45	0.60	1.00	0.40	1.00	0.60
	Vripar	0.20	0.00	0.00	0.30	1.00	0.50	1.00	0.50
	Vdecid	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
biogeochemical	=	0.20	0.00	0.00	0.30	1.00	0.50	1.00	0.50
	Vmacro	0.47	0.50	0.71	0.93	0.47	0.50	0.71	0.93
	Vretain	0.60	0.20	0.28	0.56	0.60	0.20	1.00	0.56
biogeochemical	=	0.47	0.20	0.28	0.56	0.47	0.20	0.71	0.56
	Vsurf	0.83	0.53	0.42	0.41	0.35	0.53	0.31	0.41
	Vripfilt	0.96	0.20	0.21	0.92	1.00	0.60	1.00	0.60
biogeochemical	=	0.89	0.36	0.31	0.66	0.67	0.56	0.66	0.50
	Biogeochemical function mean score	0.50	0.19	0.21	0.50	0.83	0.41	0.87	0.50
	Vgalspwn	1.00	1.00	1.00	0.85	1.00	1.00	1.00	0.85
	Vgalqual	1.00	0.00	0.00	0.00	1.00	0.00	1.00	0.00
	Vgobspwn	0.20	0.10	0.10	0.10	0.20	0.10	0.10	0.10
habitat provision	=	0.60	0.05	0.05	0.05	0.60	0.05	0.55	0.05
	Vphyshab	0.61	0.13	0.15	0.67	0.77	0.32	0.82	0.67
	Vwatqual	0.17	0.04	0.02	0.14	0.60	0.12	0.55	0.14
	Vimperv	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
habitat provision	=	0.60	0.32	0.33	0.62	0.79	0.44	0.80	0.62
	Habitat provision function mean score	0.60	0.19	0.19	0.33	0.69	0.24	0.67	0.33
	Vfish	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Biodiversity	=	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Vmci	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
	Vept	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
	Vinvert	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Biodiversity	=	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
	Vripcond	0.33	0.11	0.10	0.43	0.80	0.50	0.80	0.50
	Vripconn	0.60	0.70	0.20	0.10	0.60	0.70	1.00	0.10
Biodiversity	=	0.20	0.07	0.02	0.04	0.48	0.35	0.80	0.05
	Biodiversity function mean score	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
Overall mean SEV score (excluding IFI and FFI functions)		0.570	0.279	0.324	0.469	0.783	0.405	0.876	0.475

Appendix C2.

1. Assumptions made for stream functions for all streams as part of:

- Predicting future state for Stream P2 with riparian planting, 15 years maturity (SEVm-P). The assumptions are made against the existing state of the stream.

Function category	Stream P2 SEVm-P
Overview	Assumes fencing to exclude stock, riparian planting of native trees and shrubs to 20 m wide margins both sides of stream, weed control, protection covenant or similar.
Hydraulic	
Vchann	Assumes less incision and erosion as banks are protected from stock and have rank vegetation established, and less excessive roughness elements as macrophytes decline with margin planting.
Vlining	Removal of stock results in less fine sediment in channel and increase in proportion of natural channel
Vpipe	No change
Vbank	Removal of stock will result in a more natural channel for degraded streams, over time, and greater hydrological connectivity with the flood plain
Vrough	Change from mostly grazed, short grasses to a mix of regenerating native shrubland/ forest, some of which is assumed to be diverse and multi-tiered.
Vbarr	No change
Vchanshape	Auto-populated
Biogeochemical	
Vshade	Assumes improvement as planted margins establish.
Vdod	Assumes improvement with removal of stock from stream beds.
Vveloc	No change
Vdepth	No change
Vripar	Assumes a considerable improvement to 1 representing a fully vegetated margin of 20 m wide either side of the stream.
Vdecid	Change from mainly grass to almost all evergreen natives.
Vmacro	Assumes a reduction in emergent aquatic vegetation because of increased stream shade
Vretain	Auto-populated
Vsurf	Increase in small and medium size woody debris, and leaf litter. Reduction on aquatic vegetation due to improved stream shading.
Vripfilt	Assumes improvement to high and very high filtering activity from improvements in state of riparian vegetation
Habitat provision	

Vgalspwn	No change
Vgalqual	Some improvement with removal of stock and promotion of vegetation growth
Vgobspwn	Auto-populated
Vphyshab	Moderate improvements to habitat diversity, abundance and hydrologic heterogeneity with removal of stock damage, improved shading and woody debris/ leaf litter inputs and improved bank stability and more natural stream channel. Considerable improvements to channel shade and riparian integrity to streams with grazed grass margins.
Vwatqual	No change
Vimperv	No change
Biodiversity	
Vfish	Excluded from model
Vmci	Excluded from model
Vept	Auto-populated
Vinvert	Auto-populated
Vripcond	Auto-populated
Vripconn	Slight improvement to some streams where previous stock access was severe and erosion cut deep channels. Assumes that stock removal and planted margins will assist with bringing root zone closer to stream flows.

Predicting future state for Stream I2 with daylighting, recontouring and riparian planting, 15 years maturity (SEVm-P). The assumptions are made against the existing state of the stream.

Function category	Stream I2 SEVm-P
Overview	Assumes fencing to exclude stock, riparian planting of native trees and shrubs to 20 m wide margins both sides of stream, weed control, protection covenant or similar.
Hydraulic	
Vchann	Assumes banks contoured to allow for spawning habitat (< 10 degrees), less incision and erosion as banks are protected from stock and have rank vegetation established, and less excessive roughness elements as macrophytes decline with margin planting.
Vlining	Removal of stock results in less fine sediment in channel and increase in proportion of natural channel
Vpipe	No change
Vbank	Recontouring and removal of stock will result in a more natural channel for degraded streams, over time, and greater hydrological connectivity with the flood plain
Vrough	Change from mostly grazed, short grasses to a mix of regenerating native shrubland/ forest, some of which is assumed to be diverse and multi-tiered.
Vbarr	No change

Vchanshape	Auto-populated
Biogeochemical	
Vshade	Assumes improvement as planted margins establish.
Vdod	Assumes improvement with removal of stock from stream beds.
Vveloc	No change
Vdepth	No change
Vripar	Assumes a considerable improvement to 1 representing a fully vegetated margin of 20 m wide either side of the stream.
Vdecid	Change from mainly grass to almost all evergreen natives.
Vmacro	Assumes a reduction in emergent aquatic vegetation because of increased stream shade
Vretain	Auto-populated
Vsurf	Increase in small and medium size woody debris, and leaf litter. Reduction on aquatic vegetation due to improved stream shading.
Vripfilt	Assumes improvement to high and very high filtering activity from improvements in state of riparian vegetation
Habitat provision	
Vgalspwn	No change
Vgalqual	Improvements from recontouring, and removal of stock and promotion of vegetation growth
Vgobspwn	Auto-populated
Vphyshab	Significant improvements to habitat diversity, abundance and hydrologic heterogeneity with recontouring, removal of stock damage, improved shading and woody debris/ leaf litter inputs and improved bank stability and more natural stream channel. Considerable improvements to channel shade and riparian integrity to streams with grazed grass margins.
Vwatqual	No change
Vimperv	No change
Biodiversity	
Vfish	Excluded from model
Vmci	Excluded from model
Vept	Auto-populated
Vinvert	Auto-populated
Vripcond	Auto-populated
Vripconn	Slight improvement to some streams where previous stock access was severe and erosion cut deep channels. Assumes that stock removal and planted margins will assist with bringing root zone closer to stream flows.

Appendix D: Wetland classification

As part of the survey of the entire Property, the Clarkson Rapid Test was applied to identify areas of possible wetland vegetation. Locations of particular interest were gully heads, stream margins, and slope seeps. In general, wetlands on the Property are easily delineated by the dominance of obligate wetland species such as reed sweet grass (*Glyceria* maxima), *Isolepis prolifera* and swamp millet (*Isachne globose*), in conjunction with a rapid change to contour or rapid change to complete dominance of dryland pasture grassland species (**Plate D1**).

A total of six (6) vegetation plots and a further ca. 30 soil core samples were taken in representative locations across the subject areas. All 6 vegetation plots had an associated soil sample, and additional soil samples were taken in either nearby upland grass communities to demonstrate where wetlands terminated, or in low-lying areas to determine whether wetland soils were present. The purpose of the vegetation plots was to reaffirm the Clarkson Rapid Test for a number of wetlands delineated on the Property.

The methodology applied for the assessment of wetlands at this Property was as follows:

1. Apply the Clarkson (2013) method cited in the NPS-FM 2020 Wetland Assessment Protocol (see **Figure D1** for summary flow chart);
2. Assess soils by applying the criteria outlined in Fraser (2018) for identifying hydric (wetland) soils (see **Figure D2** for summary flow chart). This involved excavating a hole ca. 400 mm deep to assess and photograph soil moisture, topsoil structure, subsoil structure and presence of gleyed soils and mottling (See **Plate D2**); and
3. When analysing data from the field plots, plots with a vegetation community that met the definition of improved pasture and were >50 % exotic pasture species dominant were excluded from being NPS-FM-level wetlands; the Clarkson method for the Rapid Test and/or Dominance Test/ Prevalence Test was then followed to assess whether an RMA-level wetland was present or not (see **Table D1**).

In order to accurately delineate wetlands, an initial on-site assessment of wetland boundaries was undertaken by an ecologist using a GPS +/- 5 m. The wetland transition points/ boundaries at this Property were then accurately delineated assessing site data with high-resolution aerial imagery using GIS. Therefore, the boundaries of the polygons provided in this report include an element of expert judgement.

The supporting calculations for determining wetlands, site photographs including soil samples are provided below.

Plate D1. Wetland W5. The distinctive light green *Isolepis prolifera,* with soft rush margins (*Juncus effusus*) and immediate change in topography provides an obvious delineation between terrestrial and wetland vegetation.

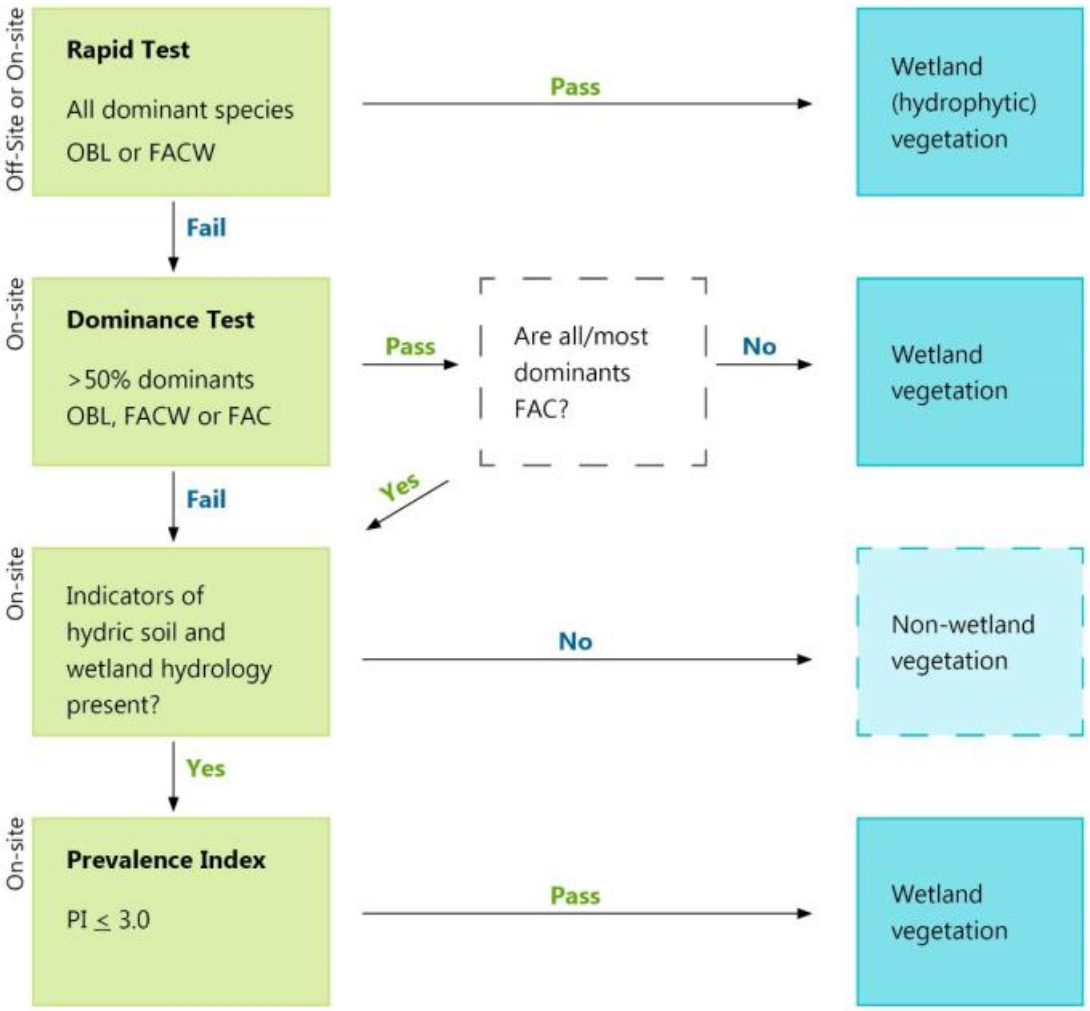

Figure D1. Flow chart of steps for hydrophytic (wetland) vegetation determination. Wetland indicator status abbreviations: FAC= facultative; FACW = facultative wetland; OBL = obligate wetland (sourced from NPS-FM MfE Wetland Delineation Protocols 2020).

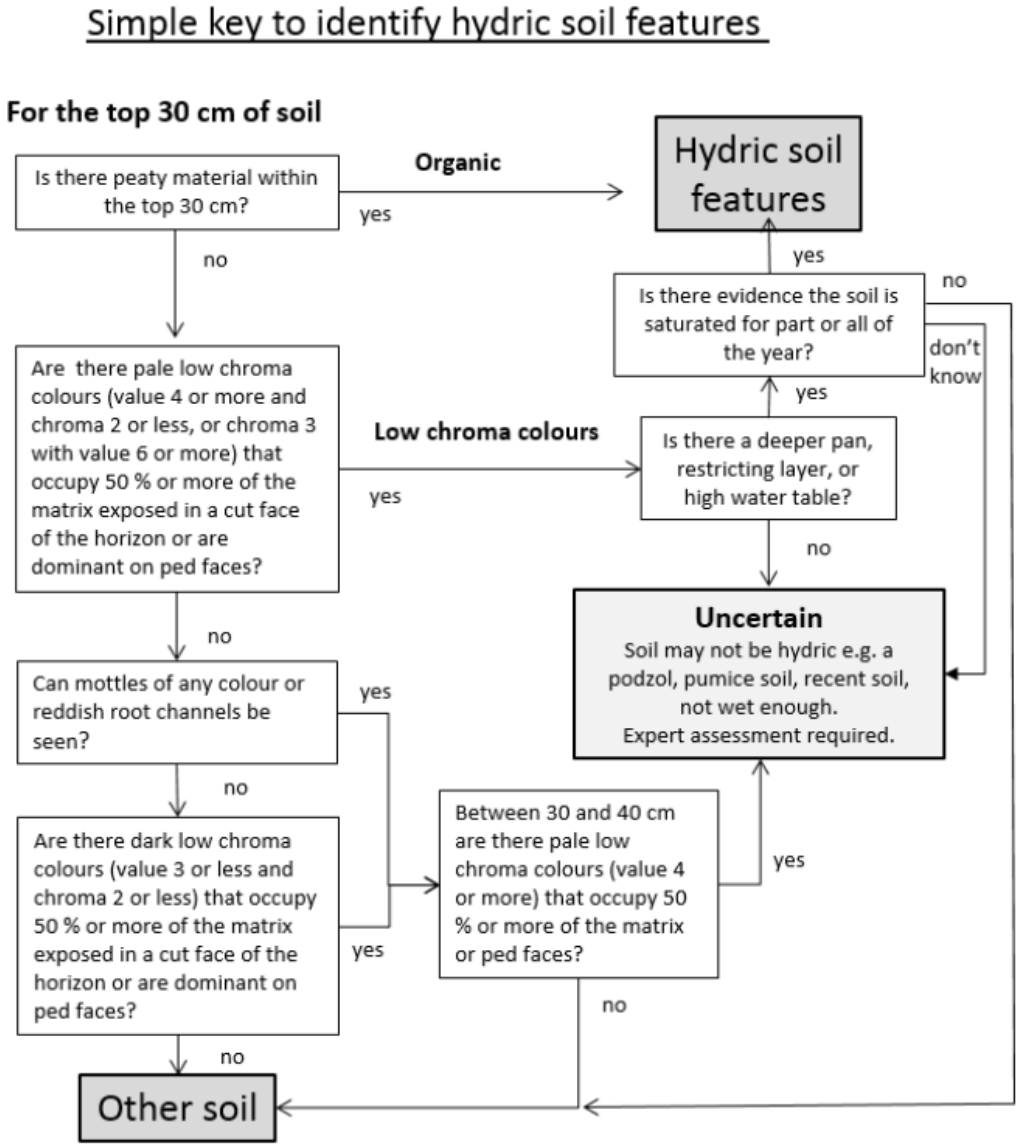

Figure D2. Key to identifying hydric soils (from Fraser *et al.* 2018).

Plate D2. Soil Core W7, an example of a typical low-chroma, saturated wetland soil core which qualifies as a wetland soil.

Table D1. Raw data of wetland vegetation criteria as per Clarkson (2013) method.

Site	**2042 Muriwai Downs Golf Course**				pasture grasses				
Date	**4-Aug-21**								
Common name	**Species (hydrotype)**	**group score**		**W31**	**W33**	**W3**	**W4**	**W5**	**W6**
Creeping bent	*Agrostis stolonifera* FACW	2					5%		
Spike sedge	*Eleocharis acuta* OBL	1					2%		
Sweet reedgrass	*Glyceria maxima* OBL	1					10%		2%
Yorkshire fog	*Holcus lanatus* FAC	3				5%	5%		
Swamp millet	*Isachne globosa* OBL	1				40%	40%	20%	
	Isolepis aucklandica OBL	1					2%		
	Isolepis prolifera OBL	1				20%	20%	60%	90%
	Juncus edgariae FACW	2					10%	20%	7%
Soft rush	*Juncus effusus* FACW	2		70%	60%	10%			
Perennial ryegrass	*Lolium perenne* FACU	4		25%	35%				
Lotus	*Lotus pedunculatus* FAC	3			1%				
	Machaerina articulata OBL	1				10%			
	Machaerina teretifolia FACW	2				15%			
Water forget-me-not	*Myosotis laxa* OBL	1					1%		
Water cress	*Nasturtium officinale* OBL	1					1%		2%
Water pepper	*Persicaria maculosa* FACW	2					1%		1%
Creeping buttercup	*Ranunculus repens* FAC	3		5%	1%				
White clover	*Trifolium repens* FACU	4							
Bare ground					5%				
			Total cover	100%	102%	100%	97%	100%	102%
			% pasture grasses	25%	36%	5%	5%	0%	0%
Prevalence Index (Hydrophytic vegetation ≤3)			as per Clarkson calculation	2.6	2.6	1.4	1.3	1.2	1.1
Excluded as NPSFM wetland (>50% pasture in improved pasture?)			Yes = conclude at Row "RMA wetland' No = conclude at Row 'NPSFM wetland'	No	No	No	No	No	No
Dominance test score (>50%) for OBL, FACW, or FAC			Yes = go to 'all or most FAC'	Yes	Yes	Yes	Yes	Yes	Yes
			No = go to 'hydric soil present'						
All or most dominants FAC?			Yes = go to 'hydric soil present' No = wetland	Yes	Yes	Yes	Yes	Yes	Yes
Hydric Soil Present	M = mottling; G = gleyed; W = wet		Yes = go to 'prevalence index'	Yes	Yes	Yes	Yes	Yes	Yes
			No = not wetland; stop						
Wetland Hydrology Present			Yes = go to 'prevalence index' No = not wetland; stop	Yes	Yes	Yes	Yes	Yes	Yes
Prevalence Index (≤ 3.0)			Yes = wetland	Yes	Yes	Yes	Yes	Yes	Yes
			No = not wetland; stop						
NPSFM wetland (Yes or No)									
RMA Wetland (Yes or No)									

Appendix E: Plant species list

Table E1. Plant species recorded within the project area, including their threat status and Auckland Regional Pest Management Plan (RPMP) status. Common exotic pasture grasses and herbs are not included.

Scientific name	Common name	Threat Status (de Lange et al., 2018)	Relevant RPMP Status (2020-2030)
Acacia melanoxylon	Blackwood	Exotic - Introduced and naturalised	Exotic pest plant - Not a legally declared pest plant
Adiantum cunninghamii	Common Maidenhair	Native - Not threatened	-
Alnus sp.	Alder	Exotic - Introduced and naturalised	Exotic pest plant - Not a legally declared pest plant
Agapanthus praecox	Agapanthus	Exotic - Introduced and naturalised	Whole region — Sustained control
Agathis australis	Kauri	Native - Threatened – Nationally Vulnerable	-
Arthropodium cirratum	Rengarenga	Native - Not threatened	-
Asparagus scandens	Climbing asparagus	Exotic - Introduced and naturalised	Significant Ecological Areas — Site-led Whole region — Sustained control
Asplenium flaccidum	Hanging spleenwort	Native - Not threatened	-
Asplenium oblongifolium	Shining Spleenwort	Native - Not threatened	-
Astelia banksii	Coastal astelia	Native - Not threatened	-
Astelia hastata	Tank lily	Native - Not threatened	-
Austroblechnum lanceolatum	Lance fern	Native - Not threatened	-
Beilschmiedia taraire	Taraire	Native - Not threatened	-
Bolboschoenus fluviatilis	Marsh clubrush	Native - Not threatened	-
Brachyglottis repanda	Rangiora	Native - Not threatened	-
Carpodetus serratus	Putaputaweta	Native - Not threatened	-
Carex secta	Purei	Native - Not threatened	-
Carex geminata	Rautahi	Native - Not threatened	-
Carex uncinata	Bastard grass	Native - Not threatened	-
Clematis paniculata	Puawhananga	Native - Not threatened	-
Coprosma areolata	Thin-leaved Coprosma	Native - Not threatened	-
Coprosma crassifolia		Native - Not threatened	-
Coprosma rhamnoides		Native - Not threatened	-
Coprosma robusta	Karamu	Native – Not threatened	-
Cordyline australis	Ti kouka	Native – Not threatened	-
Cordyline banksia	Forest cabbage tree	Native – Not threatened	-
Corybas sp.	Helmet Orchid	Native – Assumed not threatened	-
Cortaderia selloana	Pampas	Exotic – Introduced and naturalised	Whole region — Sustained control
Corynocarpus laevigatus	Karaka	Native – Not threatened	-
Cupressus macrocarpa	Macrocarpa	Exotic – Introduced and naturalised	-
Cyathea cunninghamii	Gully fern	Native – Not threatened	-
Cyathea dealbata	Ponga	Native – Not threatened	-

Scientific name	Common name	Threat Status (de Lange et al., 2018)	Relevant RPMP Status (2020-2030)
Cyathea medullaris	Mamaku	Native – Not threatened	-
Dacrycarpus dacrydioides	Kahikatea	Native – Not threatened	-
Dacrydium cupressinum	Rimu	Native – Not threatened	-
Dendroconche scandens	Fragrant fern	Native - Not threatened	-
Deparia petersenii subsp. *congrua*		Native - Not threatened	-
Dicksonia squarrosa	Wheki	Native - Not threatened	-
Didymocheton spectabilis	Kohekohe	Native – Not threatened	-
Doodia australis	Rasp fern	Native – Not threatened	-
Earina autumnalis	Bamboo orchid	Native – Not threatened	-
Egeria densa	Oxygen weed	Exotic – Introduced and naturalised	Whole region — Sustained control
Eleocharis acuta	Spike sedge	Native - Not threatened	-
Eucalyptus spp.	Gum tree	Exotic – Introduced and naturalised	-
Freycinetia banksii	Kiekie	Native - Not threatened	-
Gahnia lacera	Cutty grass	Native - Not threatened	-
Geniostoma ligustrifolium var. ligustrifolium	Hangehange	Native – Not threatened	-
Glyceria maxima	Reed sweet-grass	Exotic - Introduced and naturalised	Whole region — Sustained control
Griselinia lucida	Puka	Native - Not threatened	-
Histiopteris incisa	Water fern	Native - Not threatened	-
Hymenophyllum demissum	Irirangi	Native - Not threatened	-
Icarus filiformis	Thread fern	Native - Not threatened	-
Isachne globosa	Swamp millet	Native - Not threatened	-
Isolepis aucklandica		Native - Not threatened	-
Isolepis prolifera		Native - Not threatened	-
Juncus edgariae		Native - Not threatened	-
Juncus effusus	Soft rush	Exotic - Introduced and naturalised	-
Knightia excelsa	Rewarewa	Native - Not threatened	-
Kunzea robusta	Kānuka	Native - Threatened – Nationally Vulnerable	-
Leptospermum scoparium var. *scoparium*	Mānuka	Native - At Risk – Declining	-
Leucopogon fasciculatus	Mingimingi	Native - Not threatened	-
Ligustrum lucidum	Tree privet	Exotic - Introduced and naturalised	Whole region — Sustained control
Ligustrum sinense	Chinese privet	Exotic - Introduced and naturalised	Whole region — Sustained control
Litsea calicaris	Mangeao	Native - Not threatened	-
Lonicera japonica	Japanese honeysuckle	Exotic - Introduced and naturalised	Whole region — Sustained control
Lupinus arboreus	Tree lupin	Exotic - Introduced and naturalised	Whole region — Sustained control
Lycium ferocissimum	Boxthorn	Exotic - Introduced and naturalised	Significant Ecological Areas — Site-led

Scientific name	Common name	Threat Status (de Lange et al., 2018)	Relevant RPMP Status (2020-2030)
			Whole region — Sustained control
Machaerina articulata	Jointed Baumea	Native - Not threatened	-
Machaerina teretifolia		Native - Not threatened	-
Melicope ternata	Wharangi	Native - Not threatened	-
Melicytus ramiflorus	Mahoe	Native - Not threatened	-
Metrosideros excelsa	Pōhutukawa	Native - Threatened – Nationally Vulnerable	-
Metrosideros perforata		Native - Threatened – Nationally Vulnerable	-
Muehlenbeckia australis	Pohuehue	Native - Not threatened	-
Myoporum insulare	Tasmanian ngaio	Exotic - Introduced and naturalised	Significant Ecological Areas — Site-led Whole region — Sustained control
Myrsine australis	Maupo	Native - Not threatened	-
Nymphaea mexicana	Mexican water lily	Exotic - Introduced and naturalised	Whole region — Sustained control
Olearia furfuracea	Tree daisy	Native - Not threatened	-
Oplismenus hirtellus subsp. *imbecillis*		Native - Not threatened	-
Parablechnum minus	Swamp kiokio	Native - Not threatened	-
Parapolystichum glabellum	Smooth shield fern	Native - Not threatened	-
Peperomia urvilleana	Peperomia	Native - Not threatened	-
Pennisetum clandestinum	Kikuyu	Exotic - Introduced and naturalised	Exotic pest plant - Not a legally declared pest plant
Phormium tenax	Harakeke	Native - Not threatened	-
Piper excelsum	Kawakawa	Native - Not threatened	-
Phyllocladus trichomanoides	Tanekaha	Native - Not threatened	-
Phyllostachys aurea	Bamboo	Exotic - Introduced and naturalised	Whole region — Sustained control
Phytolacca octandra	Inkweed	Exotic - Introduced and naturalised	Exotic pest plant - Not a legally declared pest plant
Pinus spp.	Wilding pine	Exotic - Introduced and naturalised	Exotic pest plant - Not a legally declared pest plant
Pittosporum crassifolium	Karo	Native - Not threatened	-
Pittosporum eugenioides	Tarata	Native - Not threatened	-
Pittosporum tenuifolium	Kohuhu	Native - Not threatened	-
Podocarpus tōtara	Totara	Native - Not threatened	-
Polystichum neozelandicum subsp. *neozelandicum*	-	Native - Not threatened	-
Pseudopanax arboreus	Five finger	Native - Not threatened	-
Pseudopanax crassifolius	Lancewood	Native - Not threatened	-
Pteris macilenta	Sweet fern	Native - Not threatened	-
Pyrrosia eleagnifolia	Leather-leaf fern	Native - Not threatened	-
Pteridium esculentum	Bracken	Native - Not threatened	-
Rhabdothamnus solandri	New Zealand gloxinia	Native - Not threatened	-
Rhopalostylis sapida	Nikau	Native - Not threatened	-

Scientific name	Common name	Threat Status (de Lange et al., 2018)	Relevant RPMP Status (2020-2030)
Rosa sp.	Wild rose	Exotic - Introduced and naturalised	Exotic pest plant - Not a legally declared pest plant
Rubus cissoides	Bush lawyer	Native - Not threatened	-
Rubus fruiticosus agg.	Blackberry	Exotic - Introduced and naturalised	Whole region — Sustained control
Salix fragilis	Crack willow	Exotic - Introduced and naturalised	Whole region — Sustained control
Selaginella kraussiana	African Club Moss	Exotic - Introduced and naturalised	Whole region — Sustained control
Solanum mauritianum	Woolly Nightshade	Exotic - Introduced and naturalised	Whole region — Sustained control
Sophora microphylla	Kowhai	Native - Not threatened	-
Tradescantia fluminensis	Tradescantia	Exotic - Introduced and naturalised	Whole region — Sustained control
Typha orientalis	Raupo	Native - Not threatened	-
Ulex europaeus	Gorse	Exotic - Introduced and naturalised	Whole region — Sustained control
Vitex lucens	Puriri	Native - Not threatened	-
Zantedeschia aethiopica	Arum lily	Exotic - Introduced and naturalised	Whole region — Sustained control
Zealandia pustulata subsp. *pustulata*	Kowaowao	Native - Not threatened	-

Appendix F: Draft Wetland Restoration Plan

1. Details of activity site and natural wetlands

Physical address:

451, 610, 614, 670, 680, and 697 Muriwai Road

Name of site owners:

The Bears Home Company Limited.

Contact details:

TBC

Site legal description:

Lot 1 DP 187057
Lot 1 DP 191137 and Section 1 SO Plan 69201
Lot 2 DP 196478
Lot 3 DP 196479, Sec 3 SO 41485
Lot 4 DP 187060, Sec 3 SO 41485
Lot 5 DP 187061
Lot 1 DP 163736
Lot 1 DP 196478

Location and boundaries:

See **Figure F1** attached below.

Legal status of wetlands:

Below is a table which identifies the wetlands on the Property which are addressed in the Draft Wetland Restoration Management Plan. The first column provides the identifier for the wetland, with reference to the RMA Ecology Report date December 2021 for the Muriwai Downs Golf Project. The location of these wetlands is shown on Map F1 attached to this draft plan.

All of these wetlands (apart from Lake Ōkaihau) meet the criteria as natural inland wetlands in the NPS-FM.

Lake Ōkaihau (W14) is listed as SEA_T_5527 in the AUP.

Wetland W7 is listed as SEA_T_6575 and SEA_T_5527 (in part) in the AUP.

Wetland	Type of wetland	Area (m^2)
W2	Type 3	4,245
W3	Type 3	4,381
W4	Type3	5,191
W5	Type 3	2,556
W6	Type 4	4,831
W7	Type 1, Type 3	121,666

W8	Type 3	3,038
W9	Type 3	11,942
W10	Type 3	580
W11	Type 4	873
W12	Type 4	1,044
W13	Type 4	207
W14	Lake, Type 2	83,630

2. Features and values of natural wetlands

Type of natural wetlands:

- Wetland Type 1 - Palustrine
- Wetland Type 2 - Dune Lake
- Wetland Type 3 - Riverine
- Wetland Type 4 – Seepage

This draft Plan captures all four wetland types found on the Property.

The vegetation in the natural wetlands, including the dominant types of vegetation and any species of note:

- Palustrine wetlands - dominated by reed sweet-grass (*Glyceria maxima*), with occasional pampas (*Cortaderia selloana*) and ti kouka (*Cordyline australis*)
- Dune Lake margins - dominated by raupo (*Typha orientalis*), jointed baumea (*Machaerina articulata*) and kukuraho (*Bolboschoenus fluviatilis*)
- Riverine and seepage wetlands - common species include *Isolepis prolifera,* swamp millet (*Isachne globosa*), Yorkshire fog (*Holcus lanatus*), spike sedge (*Eleocharis acuta*), mānuka (*Leptospermum scoparium*) and, jointed baumea.

No rare plant species have been identified in these wetlands.

The hydrology of the natural wetlands:

- Wetland Type 1 - Palustrine –Wetland along the margins of the Ōkiritoto Stream;
- Wetland Type 2 - Dune Lake – Lake Ōkaihau is a dune lake (historically formed);
- Wetland Type 3 - Valley floor – these wetlands are maintained by stream flows (riparian margins); and
- Wetland Type 4 - Valley wall seepage – these wetlands are maintained by shallow groundwater flows and infiltration from the upper catchment. Typically found at the head of catchments or valley sides.

The types of soil in the natural wetlands:

All wetlands within the Property are within the Awhitu Group

Any artificial features in the natural wetlands:

There are a number of access tracks and culverts in valley floor wetlands.

Any fauna known to use the natural wetlands or its surrounding area:

Swamp harrier, black swan, white-faced heron, welcome swallow, southern black-backed gull, black shag, little shag, pukeko, fantail, paradise shelduck, sacred kingfisher, spur-winged plover, mallard, and Canada goose. Many of these species also use surrounding pasture and forest (non-wetland) areas.

Any special features of the natural wetlands:

Lake Ōkaihau is classified as SEA_T_5527

3. Issues with natural wetlands

Description of the current state or condition of the features and values of the natural wetlands:

In general, wetlands on the Property have been modified through historic agricultural land use resulting in the clearance of native plant species and associated habitats for wetland fauna, the proliferation of invasive weed species proliferating and damage to wetland soils from stock. Most wetlands are in poor ecological condition.

Discussion of the threats to the natural wetland and the opportunities for restoring its features and values:

Threats to natural wetlands include continued degradation of habitats for fauna from invasive weeds and the continued access / damage from stock. The opportunities for restoring the wetlands features include removing ecological weeds and planting native species which will provide habitat for native fauna. The planting will also increase carbon sequestered by these systems, and improve filtration of nutrients and sediment for the wider Ōkiritoto Stream catchment.

4. Management objectives for natural wetlands

To be completed

5. Operational details for achieving management objectives

See next section for indicative methods and timing.

The timelines for the activities and the persons responsible for resourcing and delivering them:

Project implementation, project management and performance monitoring will be managed internally by the consent holder with fieldwork delivered mainly by contractors.

Details of roles and responsibilities associated with this management plan are provided in **Table F2.**

Table F2. Roles and responsibilities associated with this Management Plan.

Position	Accountable Task
The Bears Home Project Management Limited (Consent Holder)	Provide adequate resources for the implementation of this draft Plan and ensure it is implemented in accordance with any consent requirements; Report the results of the works to Auckland Council in accordance with the monitoring and reporting requirements of this draft Plan; Organise the annual work programme as described in the relevant parts of this Plan; Facilitate any monitoring required as part of this draft Plan; Ensure the instruction of workers, and ensure the implementation of the requirements of this draft Plan, including monitoring the effectiveness of the methods set out in this draft Plan; and Ensure monitoring is conducted, recorded and communicated as per the requirements of this draft Plan.

Suitably qualified ecologist – (staff or contractor)	Provide technical advice, including on-site assistance (e.g. planting audits, monitoring and technical reporting) as may be required by this draft Plan and by the consent holder;
Contractors	Undertake works associated with weed control, animal pest control, planting, and maintenance; Ensure all personnel are fully trained and aware of relevant requirements under this draft Plan; and Undertake work practices that comply with this draft Plan.

Scale plans showing the operational areas:

See **Figure F2**.

The planting to be done:

The restoration areas will be planted with mostly root trainers and 2L grade (PB4 grade) native plants, at the specified densities and proportions, during late winter - early spring months as a single stage of planting.

Planting will be undertaken as a single stage at each site using a mix of pioneer and secondary canopy species. The establishment of a complete secondary forest community will occur naturally over time, particularly given the proximity to extensive mature native forest areas that support a range of long-lived canopy native tree within podocarp-broadleaved forest that are likely to be dispersed to the Property (by birds) and establish quickly.

All plants will be eco-sourced from the Rodney Ecological District or where appropriate, the Tamaki Ecological Region.

Draft planting plan concepts, and recommended species lists are **attached** below as Figure F2 and indicative planting plans.

Planting timing

The timing of planting activities during the year is largely dictated by climatic conditions and the plant growth patterns. The annual work cycle is focussed on late winter/spring planting with the aim of gaining full benefit from the period when soil moisture is likely to be at a peak. However, plants must also be suitably hardened off prior to planting in order to withstand conditions at the time of planting. Sites protected from severe frost may be planted in late July, but in more frost-sensitive sites planting should be delayed until August or September.

Work shall only be undertaken when the weather is suitable i.e. mild, dull and moist. All plant material will be hardened off to cope with the climatic conditions of the Property.

Planting Layout

The planting contractor shall be cognisant of the specific conditions relating to individual species location. Plantings will be set out in general accordance with the draft planting plans **attached** to this draft Plan. The various species shall be distributed within the mix at specified centres. Generally, no more than five specimens of the same species shall be located together in a single cluster. The exception to this is where conditions of a particular site are suited to only one or a few individual species within the mix, where only species tolerant of such conditions shall be planted. Unless shown otherwise, trees within these mixes shall be distributed randomly and in small clusters, as they would occur naturally, in accordance with the average spacing specified.

Planting Holes

The planting holes for individual plants shall be well cultivated and large enough to contain the plants roots without distortion. All holes for plants shall be hand dug with the sides and the bottom of the hole well loosened to remove glazing and to allow root penetration.

Planting Method

Backfill material shall consist of the material from the planting hole well cultivated prior to backfilling. If roots are formed in a tight mass, they will be gently freed prior to planting. All care will be taken to keep the rootball of the plant intact during placement. Root bound plants will be discarded and replaced with suitable replacements. The base of the planting hole will be filled and firmed with backfilling material to a level where the top of the plant rootball is level with surrounding ground. On sloping sites this level will relate to the bottom edge of the hole. Backfill in a maximum of 150 mm layers firming material evenly without compaction. When the backfilling is complete the plant will be gently firmed in.

Ensure placement on the upper slope side of plants. On completion, CombiGuards, Em Guard (or similar) with coir fibre at base will be installed on each plant. This approach provides protection from grazing, spray, creates a "microclimate" with greater shelter etc., and assists with re-finding plants when undertaking subsequent monitoring.

Any vegetation to be removed, including species and methods of removal

Weed control is required in order to facilitate natural succession.

The existing wetland vegetation in the restoration areas is largely dominated by reed sweet-grass and a range of pasture weeds (e.g. Yorkshire fog). Important ecological weeds (exotic woody species, scrambling and climbing vines) are generally in low densities as a result of pasture farming. However, localised infestations of ecological weeds could proliferate without active management.

The key objectives of weed control in the plantings areas are to:

- Control the competition of weeds within the planting areas;
- Control and contain outbreaks of infestations of invasive environmental weed species; and
- Ensure minimal damage to native plants during weed control operations.

A comprehensive control programme will be undertaken to remove and kill infestations of ecological weeds listed in the Auckland Council Regional Pest Management Plan 2021-2030 using the methods approved by Auckland Council. The approach that will be implemented at this Property is to undertake pre-planting control of ecological weeds within the planting zone to nil or near-zero presence over an approximately five-year period, with the exception of prolific infestations of reed sweet-grass, recognising the damage that will be caused to surrounding plants and the wetland system when attempting to control these infestations with herbicide.

Methods

Weed control will be undertaken by an appropriately qualified and certified pest control contractor such that the objectives within this draft Plan are achieved. Weed control will follow accepted industry practice and will form part of ecological restoration planning, including:

- Knock-down of weeds using methods and herbicides approved by Auckland Council, as part of site preparation prior to planting. For most weeds this will involve cutting or spot spraying herbicide a minimum of 14 days to planting;

- A single application of approved spray will be applied, occurring in April/ May prior to planting;
- Every effort will be taken to ensure non-target species are not contaminated,
- All operations should comply with the Agrichemical Users Code of Practice (NZ Agrichemical Education Trust);
- Herbicide application will adhere to the New Zealand Standard 8409 Code of Practice for the Management of Agrichemicals, commonly known as GROWSAFE®;
- A programme of follow-up monitoring of plantings to ensure that weeds are supressed or removed as part of revegetation objectives, described further below; and
- Subsequent to the above, monitor weed incidence and distribution twice-annually over five years to determine weed control needs and control weeds as necessary, until native plant growth and canopy cover targets have been achieved, in order to reduce the likelihood of weed establishment.

Any machinery to be used and the purpose of its use:

No machinery is proposed to be used.

Description of the approach to water management:

No changes to water levels are proposed.

Approach to managing erosion and sediment to be used during all of the works:

Work will be undertaken manually and there are no erosion or sediment risks associated with planting or weed control. No management is required.

Animal pest control to be carried out:

It is likely that animal control will be needed in relation to planted areas, as rabbits, hares and possums are ubiquitous throughout the District.

The control of animal pests is necessary to minimise unwanted effects by mammalian browsers. A pest animal control plan will be prepared by an appropriately qualified and certified pest control contractor such that the control is achieved.

It is anticipated that the animal pest control programme would consider and, if appropriate, incorporate the following factors:

1. For rabbits, assess the level of rabbit presence prior to the start of the planting programme and use rabbit-proof plant guards, poison or other approved control methods to reduce numbers until planted trees are resistant to rabbit browse;
2. For possums, undertake a knock-down control operation using encapsulated cyanide, tamper-proof traps, bait stations or some other method as advised by an appropriately qualified and certified pest control contractor, and maintain ongoing control on a regular basis; and
3. If obvious signs of pukeko-caused plant mortality are apparent, consider localised control (shooting) or protection of plants (plant guards/ pinning plants).

The size of the restoration site makes monitoring of pest control effectiveness difficult – given that standard monitoring techniques cannot provide an adequate number of independent samples for assessing possum or rabbit densities over such large areas.

Instead, for possums the focus will be on assessing the levels of trap kills or bait take (as appropriate), and where at all feasible, work in with monitoring being undertaken by Council to provide a more robust picture of pest animal populations over these and adjoining sub-catchments.

Animal pest management and maintenance measures will be implemented for a period of no less than 5 years (following final completion of the relevant works) or until 80 % canopy closure of all areas has been achieved.

Review and reporting:

Monitoring

Monitoring shall be undertaken at each planting area to report on progress towards meeting the respective objectives, to identify potential management issues, and to enable corrective actions to be made.

Monitoring at each planting zone will comprise:

- Where ecological weed control, planting and pest animal control have been undertaken, there will be a report (included in the annual Monitoring report described below) submitted to Auckland Council annually from the start of the planting programme.
- The annual Monitoring report shall include:
    - The date of the inspection;
    - The person carrying out the inspection and their qualifications;
    - The condition of native plantings undertaken at each site, including their coverage in respect to gaps, and overall health;
    - A map showing the general locations of ecological weeds recorded and controlled over the previous year;
    - Observations of any damage to plants within planting areas (whether caused by people, pest animals or natural events);
    - The locations of pest animal traps and control methods applied in that year together with an estimate of the number of pest animals removed or the effectiveness of control techniques at reducing pest densities; and
    - Corrective actions undertaken to reduce threats to planted areas and levels of pest animals, as appropriate.

Reporting

An annual Monitoring report will be submitted to Auckland Council by 1st June annually from the commencement of this planting plan for the first 5 years.

Reporting shall be on an annual basis up until 5 years following the completion of the planting programme, after which the frequency and detail of the monitoring will be subject to site requirements, and as agreed with Auckland Council.

Muriwai Downs wetland restoration draft planting plans

The draft species lists below are based on Auckland Council TP148. Large trees and shrubs (e.g. kahikatea, mānuka etc.) have been omitted from plantings within close proximity to the golf course to avoid obstructions with sight lines.

Wetland restoration plan	
Actions	Planting period (approximately July to Sept inclusive) Ongoing weed/ pest control, infill planting monitoring and reporting for 5 years
Site planting area	[to be confirmed] m^2 (XX ha) of enrichment planting to be planted with low stature eco-sourced native grasses, rushes and sedges.
Revegetation objective	Plant weed tolerant, dense, fast-growing, native plantings to enrich wetlands
Existing vegetation	Mosaic of exotic and native grasses, sedges and rushes. Mostly pasture grass along margins. Some infestations of *Glyceria maxima*
Site Preparation	Remove ecological weeds, where present. Remove all willow/ acacia trees. Control *Glyceria maxima* where practicable
Planting	Planting at 2 m centers
Monitoring	Assess planted area annually in Years 2 to 5 following completion. Monitor ecological weeds and animal pest damage.
Maintenance (up to five years)	Ecological weed control a minimum of 2 times/ year for Years 1-5, in spring and summer. Infill planting as required to ensure vegetation closure. Undertake pest animal control as needed.

Muriwai Downs – Golf course: indicative wetland planting treatment					
Botanical Name	**Common Name**	**Plant size at time of planting**	**Planting centers (m)**	**Percentage mix (%)**	**Numbers required (TBC)**
Bolboschoenus fluviatilis	Kukuraho	Root trainer	2	12.5	
Carex secta	Purei	Root trainer	2	12.5	
Carex geminata	Rautahi	Root trainer	2	12.5	
Cyperus ustulatus	Coastal cutty grass	Root trainer	2	12.5	
Eleocharis sphacelata	Kutakuta	Root trainer	2	12.5	
Machaerina articulata	Jointed Baumea	Root trainer	2	12.5	
Parablechnum minus	Swamp kiokio	Root trainer	2	12.5	
Schoenoplectus tabernaemontani	Kuawa	Root trainer	2	12.5	
			TOTAL	**100**	

Muriwai Downs – Golf course: indicative wetland riparian margin buffer planting treatment					
Botanical Name	**Common Name**	**Plant size at time of planting**	**Planting centers (m)**	**Percentage mix (%)**	**Numbers required (TBC)**
Apodasmia similis	Oioi	Root trainer	1	10	
Austroderia fulvida	Toetoe	PB3/ 2 L	1	5	
Carex virgata	Purei	Root trainer	1	10	
Carex geminata	Rautahi	Root trainer	1	10	
Carex testacea	Speckled sedge	Root trainer	1	10	
Cyperus ustulatus	Coastal cutty grass	Root trainer	1	10	
Ficinia nodosa	Wiwi	Root trainer	1	20	
Juncus edgariae	Wiwi	Root trainer		10	
Juncus sarophorus	Broom rush	Root trainer	1	10	
Hebe stricta var. *stricta*	Koromiko	PB3/ 2 L	1	5	
			TOTAL	**100**	

Muriwai Downs – Ecological Restoration: Indicative wetland restoration planting treatment (away from golf play lines)					
Botanical Name	**Common Name**	**Plant size at time of planting**	**Planting centers (m)**	**Percentage mix (%)**	**Numbers required (TBC)**
Austroderia fulvida	Toetoe	PB3/ 2 L	1	5	
Bolboschoenus fluviatilis	Kukuraho	Root trainer	1	5	
Carex secta	Purei	Root trainer	1	5	
Carex geminata	Rautahi	Root trainer	1	5	
Coprosma tenuicaulis	Swamp coprosma	PB3/ 2 L	1.4	10	
Cordyline australis	Ti Kouka	PB3/ 2 L	1.4	10	
Cyperus ustulatus	Coastal cutty grass	Root trainer	1	5	
Eleocharis sphacelata	Kutakuta	Root trainer	1	5	
Dacrycarpus dacrydioides	Kahikatea	PB5/ 3 L	5	5	
Laurelia novae-zelandiae	Pukatea	PB5/ 3 L	5	5	
Leptospermum scoparium	Mānuka	PB3/ 2 L	1.4	10	
Machaerina articulata	Jointed Baumea	Root trainer	1	5	
Parablechnum minus	Swamp kiokio	Root trainer	1	5	
Phormium tenax	Harakeke	Root trainer	1.4	10	
Schoenoplectus tabernaemontani	Kuawa	Root trainer	1	5	
Syzygium maire	Swamp maire	PB5/ 3 L	5	5	
			TOTAL	**100**	

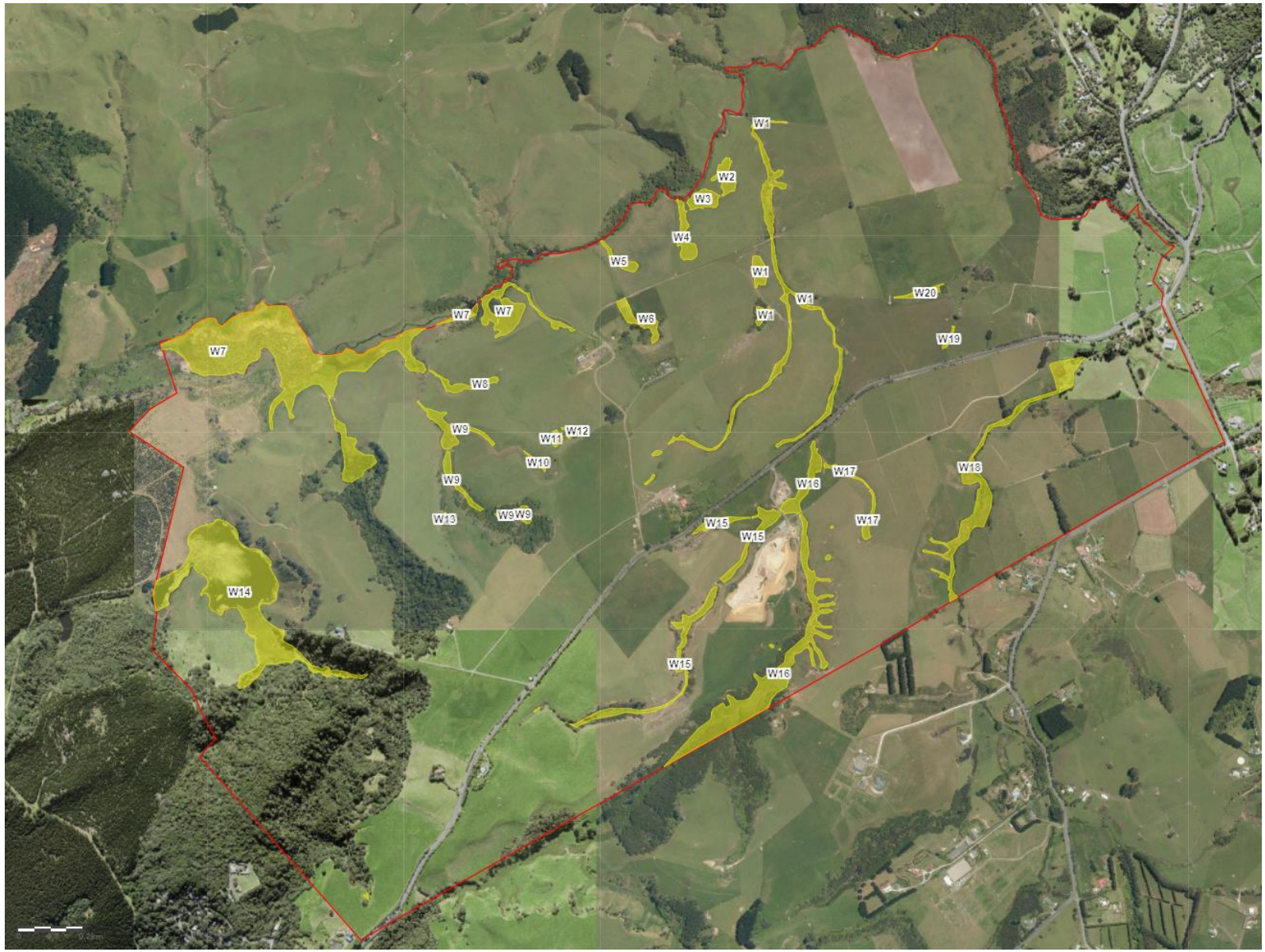

Figure F1. Wetlands on the Muriwai Downs Golf Course property. Note not all of these are proposed to be restored. See **Figure F2** for the relevant wetlands that form the basis of this draft Wetland Restoration Management Plan.

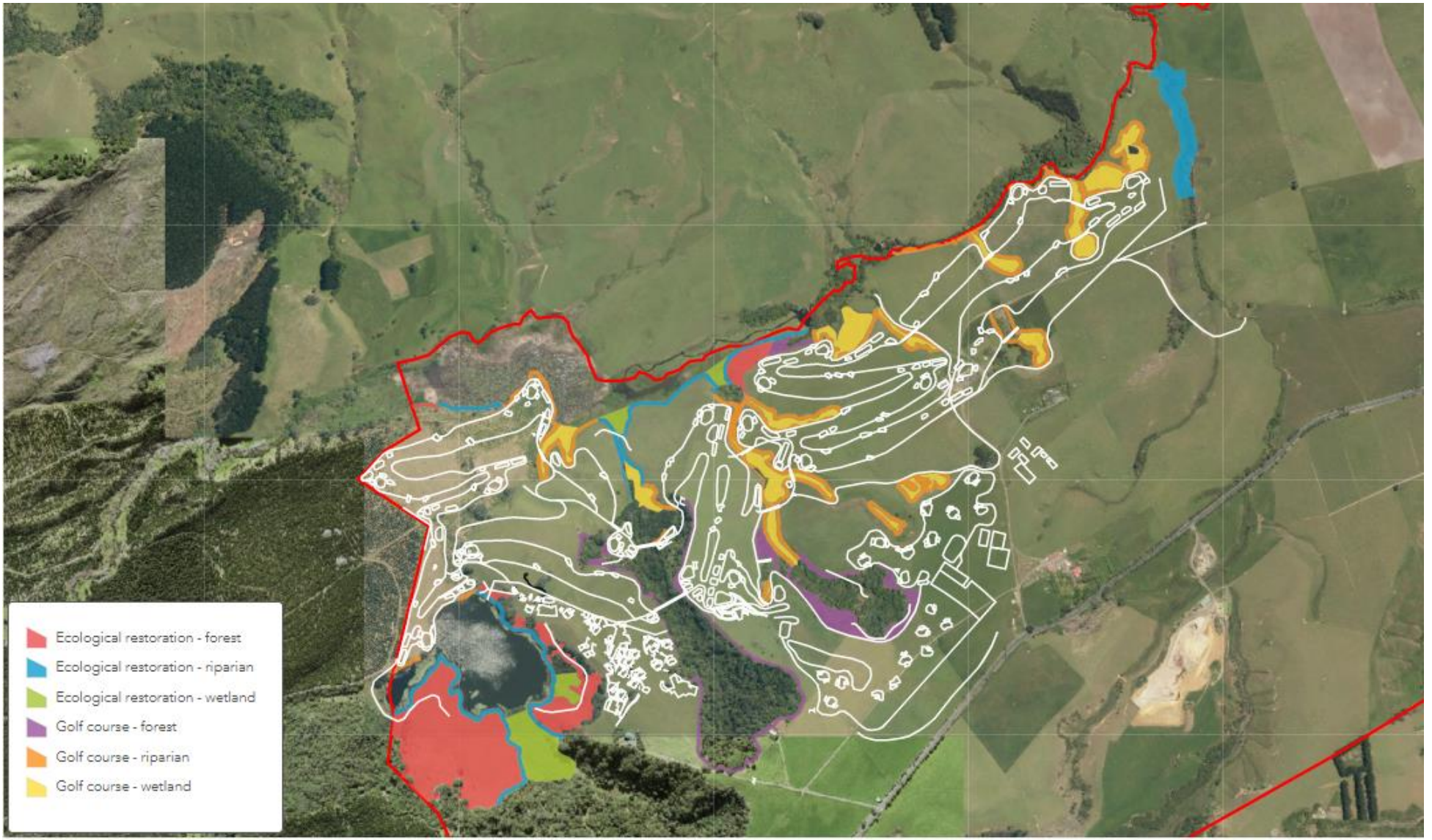

Figure F2. The proposed restoration concept for the Muriwai Downs Golf Course site (indicative). Development layout (white lines) restoration treatments (coloured areas), property boundary (red line). Areas relevant to this draft Wetland Restoration Management Plan are the Ecological Restoration – wetland, and Golf Course – wetland areas. Other restoration areas will be implemented through a separate site Restoration Management Plan.